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Supply Chain Integration:
A Case-based Investigation of
Status, Barriers, and Paths to
Enhancement

**A thesis submitted for the degree
of
Doctor of Philosophy in Management Systems
at
The University of Waikato
by
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Abstract

In a global marketplace supply chain integration is recognised to be one of today's competitive advantages; where the aim is to optimise material- and information-flows inside the focal company and also across supply chain companies. However, many academics report that such supply chain excellence is still rare, and that guidance is missing on how supply chain integration is achieved in practise. This exploratory research utilised a stepwise methodology to investigate pathways to supply chain integration. First, a suitable investigation method was identified and further developed, before being used to assess the current status of supply chain integration in New Zealand. Next, because removal of barriers is recognised to be crucial, the internal and external barriers to supply chain integration were investigated. Finally, longitudinal case studies were used to investigate ways of supply chain integration enhancement and to develop a deeper and more complete understanding of current integration status, barriers, and ways of enhancement. In total, some 240 person days were spent in eleven different companies from multiple industry sectors to investigate supply chain integration in practise.

Current practises of a large sample of New Zealand value streams were evaluated using the Quick Scan Audit Methodology. The Quick Scan Audit Methodology is carried out by a team of researchers (investigator triangulation) which utilise multiple and rigorous data collection techniques and methods (data- and method triangulation). The research revealed that supply chain integration practise rarely resembles the theoretical ideal and, similarly, seldom do available supply chain integration models reflect reality. Also, New Zealand value streams are significantly less integrated on the customer side compared to the supplier side. Further, every case company was found to face significant barriers to supply chain integration. Managerial, socio-cultural factors are the major obstacles to internal supply chain integration resulting in functional silos. Similarly, power and dependency issues limit the levels of integration achieved externally.

The research revealed that good top management support and favourable external dependencies offer the best setting for enhancing supply chain integration in practise. However, if a focal company lacks top management support and/or has

an unfavourable dependency structure, the focal company chooses the path of least resistance when integrating its supply chain. Also, supply chain managers and change agents address people factors and cultural change first, before addressing either internal process issues or external relationship issues; after which communication technology upgrades are addressed. Finally, this exploratory study yielded some early insights that the speed of supply chain integration development in practise follows a learning curve trajectory.

Dedicated to:

My parents, Petra and Stephan Böhme

Your love and support have encouraged me to keep pursuing challenges in my life. I could not have done it without you.

Acknowledgements

In the effort of completing this thesis over the past four years, a great many people have provided me with invaluable help along the way. I would like to thank my doctoral supervisor, A. Prof. Paul Childerhouse, for his guidance and constant encouragement throughout this research. Paul has been instrumental in developing my critical thinking ability to analyse and synthesize the subject matter. I am also grateful to A. Prof. Eric Deakins, for his counsel and support. Finally, Prof. Jim Corner who provided excellent guidance writing this thesis into a cohesive whole.

Further, I would like to thank:

- All the members of the various Quick Scans.
- Agmardt research fund for providing financial support.
- All the industrialists who provided invaluable case data.
- Cardiff University's Logistic Systems Dynamics Group (LSDG) and here especially Prof Denis Towill and Dr Andrew Potter who provided helpful feedback on my research.
- Henrike, Philipp, Katrin, and Laurenz Böhme, my grandmother Gisela Glatzel, family Thomas Glatzel, family Roswitha Horner, and family Katrin Glatzel for constant encouragement on my PhD journey.

On a more personal note, I am indebted to my partner Paula Kristina Herlin, who encouraged me to stay focused and patient in every stage of my research. I would like to thank Paula for her love, kindness and faith in me.

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1. Introduction

1.1 Background

A supply chain can be defined as: a series of companies that eventually make products and services available to customers, including all of the functions enabling the production, delivery, and recycling of materials, components, end products, and services (Wisner et al., 2005). The ultimate goal in supply chain management is to create value for the end customers as well as the organisations in the supply chain network (Christopher, 1998; Walters & Lancaster, 1999; Wisner et al., 2005). To accomplish the ultimate goal, organisations in the supply chain must integrate process activities internally and with customers and suppliers externally (Lambert et al., 1998). Yet in most organisation the situation is chaotic.

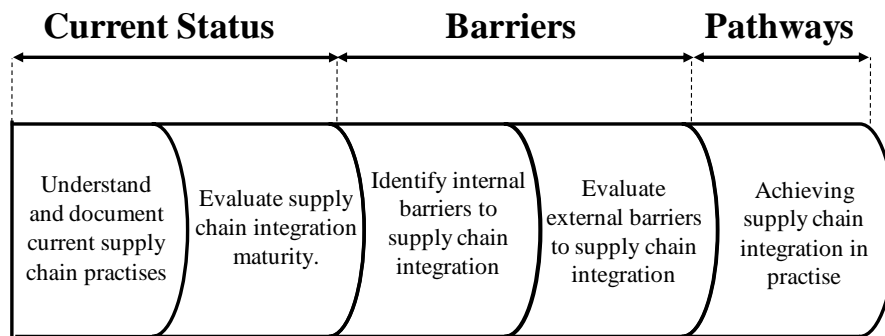
Lack of supply chain integration is expensive for companies. For example, in the USA the National Institute of Standards has estimated that inadequacies in managing inventory, scheduling and accounting information costs the automotive and electronics industries a combined total of almost \$9 billion annually, or about 1.2 percent of the value of shipments in each industry (NIST, 2004). The report also claims that almost all of these costs could be eliminated with optimally integrated systems for exchanging information throughout supply chains. The academic literature is also clear on the importance of integration. The academia continuously enhances the body of knowledge, linking supply chain integration to performance improvement (e.g. Frohlich & Westbrook, 2001; Stank et al., 1999a); but knowledge is lacking in terms of a prescribed manner by which companies can achieve integration across operations internally, and with suppliers and customers externally. Further, the actual pathway chosen by a focal company is of interest. Stevens' (1989) study proposed an integration model in which companies tend to follow a pathway to supply chain integration that progresses through separate stages; choosing to integrate internally before integrating with external supply chain members (Stevens, 1989). However, Gimenez (2004) and Potter et al. (2004) identified exemplar companies that did not follow the internal/external integration route; hence this thesis aims to investigate the actual pathways taken when companies set out to achieve supply chain integration, in order that the

company might one day select the most appropriate one for its specific supply chain situation.

1.2 Investigating supply chain integration in practise

This thesis is based around a five step approach that provides academia with a sound methodology to investigate how companies achieve supply chain integration in practise. This gives practitioners clear guidance when integrating their supply chain by providing supply chain integration assessment tools and techniques for each identified step. Figure 1.1 presents the five step procedure to investigate how companies achieve supply chain integration in practise. A more detailed description of Figure 1.1 can be found in Chapter 3.

Figure 1.1: Five step procedure to investigate supply chain integration in practise



Source: Author

Figure 1.1 proposes that before investigating pathways to supply chain integration, the current status of supply chain should be evaluated. In particular, a research methodology needs to be identified allowing the researcher to investigate in depth the current status of supply chain integration within a focal company. Further, Gimenez (2004) as well as Romano (2003) point out that a close examination of the barriers to supply chain integration is critical because the removal of barriers between and within organisations seems to be the crucial issue in integrating the supply chain. Naylor et al. (1999) also point out that the goal of an integrated supply chain is the removal of all barriers to ease the flow of material and information flow. However, academia has a better understanding of the external barriers to supply chain integration than the internal ones. Therefore,

the investigation into internal integration is rather broad, identifying and categorising common internal barriers to supply chain integration. The investigation into external integration is more specific, focusing on power and dependency. Cox (1999), and van Donk and van der Vaart (2004) identified that the key barrier to external supply chain integration is the power and dependency structure present between organisations. Once the current state is identified and the barriers to supply chain integration understood, researchers can investigate how supply chain integration is achieved including actual pathways to supply chain integration, using longitudinal case studies. Next, each chapter is briefly summarised and the specific objective of each chapter is highlighted based on the structure provided in Figure 1.1.

1.3 Potential value of research contribution

This thesis applies a qualitative (field) research methodology. The first-hand case knowledge gained coupled with a strong research focus on supply chain integration offers the potential for in-depth insights into the uptake of supply chain integration in practise. Knowledge created through observing and studying real world supply chains enables theory to be tested in the real-world setting and further refined, providing the academia with rich practical insights. In total, 239 person days were spent on-site observing, interviewing, auditing, and analysing archival data. Hence, a large amount of rich case study data has been collected predominantly by using an audit methodology termed the ‘Quick Scan Audit Methodology’. This uses three forms of triangulation when investigating real world supply chains: (1) data sources triangulation; (2) investigator triangulation; and, (3) methods triangulation.

1.4 Overview of the Thesis

This thesis comprises ten chapters. The first chapter provides an overview of the thesis by briefly introducing each individual chapter. Chapter 2 concentrates on the theory that underpins the research. The objective of the literature review is not to provide an all-inclusive review of the field of supply chain management. Rather, its aim is to provide a foundation for the thesis. Particular attention is,

therefore, paid to supply chain integration and the confusion that surrounds the topic. Current shortfalls in the literature are identified, which lead to a clear definition of the research questions raised in this thesis. The critique of literature provided in Chapter 2 concludes with a conceptual model developed, which is capable of assessing supply chain integration practises adopted by a focal company.

Chapter 3 is pivotal in that it precisely defines the research problem under investigation. This is followed by a detailed description of the five step methodology proposed to investigate the pathways to supply chain integration. The boundaries of the research are clearly defined, thereby highlighting factors that are being considered and those outside the scope of this thesis.

Chapter 4 presents different paradigms for conducting research and argues that “a one paradigm, one approach” should not be the obvious choice. The data collection technique termed Quick Scan Audit Methodology uses multiple paradigms and two ways of data triangulation: (a) investigator triangulation and (b) methodology triangulation. The contribution to theory of this chapter is manifold. First, a rigorous method has been developed to adapt the initial Quick Scan to suit longitudinal case studies. Second, a method has been developed to evaluate supplier relationships based on power and dependency. Thirdly, applying the QSAM to New Zealand supports the increase of rigour for the methodology developed. Fourthly, Quick Scan has been applied to new industry settings, especially the New Zealand process industry, which further validates the QSAM.

Chapter 5 is the first of four findings chapters and provides the basis for the remaining findings chapters. A method for evaluating a supply chain’s level of integration maturity is presented based on the Uncertainty Circle (Mason-Jones & Towill, 1998). A sample of twenty value streams is assessed and further compared to twenty value streams from the UK automotive sector. This facilitates answering the first research question on the degree of integration of New Zealand value streams. The second application of the twenty value streams is to highlight that currently available supply chain integration models (here in particular Stevens (1989) and Frohlich & Westbrook (2001)) do not always reflect reality. Resulting

from this situation, a new integration model consisting of six distinct pathways to supply chain integration is proposed.

Chapter 6 applies systems thinking to investigate why value streams are so weakly internally integrated. A conceptual model is developed based on previous research focusing on three distinct layers of barriers to internal integration. Those layers are termed environmental barriers, company barriers and value stream barriers. This model is capable of including and assessing all identified barriers to supply chain integration. Further, the research highlighted that most of the identified barriers on a company level are predominantly culture, people and relationships related.

In Chapter 7, a five step method for evaluating and measuring power and dependency in external relationships is presented. The five step method has been successfully applied to seven case companies. Chapter 7 highlights the poor relationship management practises currently applied by leading New Zealand companies. The effect of power and dependency for external integration is identified. The negative power and dependency structure (independence or supplier dominance) often limits external integration with key external entities.

The final findings chapter (8) contains four longitudinal studies to identify the routes that companies follow when integrating their value streams. The change process each case company went through is mapped out and the effects of the change process on (a) barriers to supply chain integration, (b) supply chain uncertainty and (c) the developed 'supply chain integration assessment tool' is assessed. Further, the research validates the conceptual supply chain integration model developed in Chapter 5. The findings show that companies follow different routes when integrating their supply chain. They also reveal that companies follow similar patterns when implementing change. All four case companies invested in people before addressing internal processes and/ or external relationship management issues. Changes in the current technology occurred last.

Chapter 9 is the discussion chapter. Here, the attention is focused on the meaning of the research findings for the wider academic supply chain integration

landscape. Also research areas that require further evidence are highlighted. Chapter 10 concludes the research by providing an explicit statement of each of the original contributions made by this thesis, and the relevance of this thesis for practitioners is discussed. Finally, potential research areas are identified, thus highlighting areas of potential benefit that can build on and further validate the research of this thesis.

2. Literature Review

2.1 Introduction

The purpose of this chapter is to provide a foundation for the thesis on the basis of the literature currently available. Emphasis is placed around the concept of supply chain integration and, in particular, on supply chain assessment as well as barriers/enablers and achieving supply chain integration in practise. The literature review is predominantly based on the latest publications in the key areas of supply chain management. All of the research questions analysed in this thesis are first raised in this chapter. These questions have been designed to provide solutions to topics not comprehensively addressed in the current literature, and are therefore areas that require further research and validation.

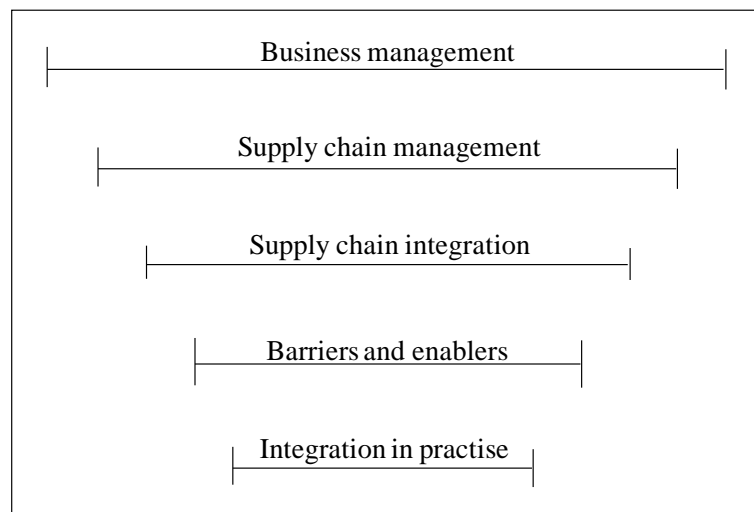
Initially, the broad field of supply chain management is discussed. The terms “supply chain” and “supply chain management” are clarified and precisely defined in the terms used in publications by renowned experts in the field. This is followed by a brief historical overview of the supply chain management concept. Further, a number of the key published methodologies for evaluating supply chain practises is reviewed. However, the main thrust of the literature review concerns itself with the major contributions that have been made over the years to the topic of supply chain integration. The key contribution of this thesis is the close and in-depth exploration of how companies actually achieve supply chain integration in practise. Hence, change management in supply chains cannot be ignored. Finally, a conceptual model is developed that enables the researcher to evaluate supply chain integration practises and investigate pathways to supply chain integration.

2.2 Research Area

One of the most significant changes in the paradigm of modern business management is that individual businesses no longer compete as solely autonomous entities, but rather as supply chains (Christopher, 1998). Business management has entered the era of supply chain competition and the ultimate success of a single company will depend on management’s ability to integrate the company internally as well as externally (Lambert et al., 1998). Lambert et al.

highlight that supply chain management is part of a wider concept termed business management. Supply chain management offers the opportunity to capture the synergy of intra- and inter-company integration and management by taking a holistic/systems perspective regarding the various activities, functions, and systems required to bring a product or service to market (Vickery et al., 2003). Figure 2.1 illustrates the scope of the research area.

Figure 2.1: Scope of research area



Source: Author

One key theme within supply chain management is the integration of customers and suppliers externally and functions internally to optimise material and information flow. Recently, academia started to investigate barriers/enablers to supply chain integration because the removal of barriers between and within organisations seems to be a critical issue along the path to supply chain integrating the supply chain (Gimenez, 2004; Romano, 2003). Finally, supply chain integration in practise is reviewed. Next, the concept of supply chain management is described, followed by the identification of a supply chain definition used for this thesis.

2.3 Supply chain management: A theoretical framework

In recent years, the area of supply chain management has become very popular. This is evidenced by marked increases in practitioner and academic publications, conferences, professional development programs, and university courses in the area (Burgess et al., 2006). However, the concept of supply chain management is not particularly well-understood and many authors have highlighted the necessity for a clear definition and conceptual frameworks of supply chain management (Cooper et al., 1997; Croom et al., 2000; New & Payne, 1995; van der Vaart & van Donk, 2007). One of the main problems is that supply chain management is such a broad notion that it can be approached from many different angles: purchasing and supply, operations management, relationship management, logistics and transportation, industrial organisation, marketing, or strategic management to name a few (Croom et al., 2000). The breadth of the concept is also the main reason why it still lacks a unitary and a widely accepted definition (Cigolini et al., 2004).

Table 2.1 provides a selection, in chronological order, of different supply chain management definitions as introduced and used by different authors. Table 2.1 is not intended to provide a comprehensive review of supply chain definitions (e.g. Cooper et al., 1997) rather the purpose here is to highlight some of the contrasting approaches to supply chain management existing in the literature. However, consistent across these definitions is the idea of coordinating and integrating a number of product-related activities among supply chain participants to improve operating efficiencies, quality, and customer service in order to gain a sustainable competitive advantage for all of the organisations involved in this collaboration.

Table 2.1: A selection of available supply chain definitions

<i>Author</i>	<i>Definition</i>
Bowersox et al. (2002)	Supply chain (sometimes called the value chain or demand chain) management consists of companies collaborating to leverage strategic positioning and to improve operating efficiency.
Van der Vorst & Beulens (2002)	Supply chain management is the integrated planning, co-ordination and control of business processes and activities in the supply chain to deliver superior consumer value at minimum cost to the end-consumer while satisfying requirements of other stakeholders.
Hugos (2003)	Supply chain management is the coordination of production, inventory, location, and transportation among the participants in a supply chain to achieve the best mix of responsiveness and efficiency for the market being served.
Benton & Maloni (2005)	Supply chain management involves the strategic process of coordination of companies within the supply chain to competitively deliver a product or service to the ultimate customer.
Li et al. (2005)	Supply chain management has been defined to explicitly recognise the strategic nature of coordination between trading partners and to explain the dual purpose of supply chain management: to improve the performance of an individual organisation, and to improve the performance of the entire supply chain. The goal of supply chain management is to create sourcing, making, and delivery processes and logistics functions seamlessly across the supply chain as an effective competitive weapon.

Source: Author

The definition by Li et al. (2005) is used throughout this thesis. This approach views the supply chain as product and information flow encompassing all parties involved, that is, the focal company and its suppliers and customers. Also Li et al. take a strong process focus when defining supply chain management. Here, a process is defined as a structured and measured set of activities designed to produce a specific output for a particular customer or market (Davenport, 1993).

Instead of the term supply chain management, some authors use similar terms such as network, supply pipeline management, demand chain management, value chain management, and value stream management (Bowersox et al., 2002; Childerhouse et al., 2002; Childerhouse et al., 2005; Childerhouse & Towill, 2006; Croom et al., 2000; Harland et al., 2001). This thesis utilises the terms supply chain and value stream. Womack and Jones (2005) popularised the term ‘value stream’ and this thesis uses the terms supply chain and value stream interchangeably; because in many respects ‘supply chain’ and ‘value stream’ are

synonymous. A practical interpretation is that a supply chain consists of a bundle of one, or more often multiple, value streams. A fuller description appears in 5.3.1. The evolution of the supply chain concept is described next, and different supply chain management schools identified.

2.4 Evolution of the supply chain management concept

Various authors cite the work of Oliver and Webber (1982), entitled “supply chain management: logistics catches up with strategy”, as the publication in which the term “Supply Chain Management” was used for the first time. The term was used with reference to management techniques which sought to reduce the stocks held in companies of the same supply chain, linked by customer-supplier relationships (Romano, 2003). However, the roots of the concept of supply chain management are initially along the lines of physical distribution and transport; using the techniques of industrial dynamics derived from the work of Forrester (1961). Another antecedent can be found in the Total Cost approach to distribution and logistics (Heckert & Miner, 1940). Both these approaches apply systems thinking and show that focusing on a single element in a chain cannot assure the effectiveness of the entire system.

Since the publication of Oliver and Webber (1982) different supply chain schools have emerged. This chapter provides a review of supply chain management related studies and classifies them into seven main schools/streams using Bechtel and Jayaram’s (1997) classification as a basis. Bechtel and Jayaram provide an extensive retrospective review of the literature and research on supply chain management, including major contributions and fundamental assumptions. While other approaches to classify the supply chain management literature have been proposed (e.g. Cooper et al., 1997; Croom et al., 2000; Halldorsson et al., 2008) the one highlighted in Table 2.2 illustrates the long and multidisciplinary evolution of supply chain management concept.

Table 2.2: Multidisciplinary evolution of the supply chain management concept

School	Key Authors	Achievement
Systems perspective	Forrester (1961); Heckert & Miner (1940); Jones & Riley (1985)	The basic premise of the systems perspective is that the policies of the optimisation of sub-systems (i.e. organisations) do not necessarily result in an optimal solution for the system as a whole
Supply chain awareness	Houlihan (1987); Jones & Riley (1985); Novack & Simco (1991); Oliver & Webber (1982)	These authors recognise that there is a continuous chain of functional areas through which materials flow and that it extends from suppliers to final distributors
Traditional logistics	Bowersox & Daugherty (1995); Scott & Westbrook (1991)	The main objective of these studies is to improve supply chain efficiency by reducing inventory levels, where little emphasis is given to supply chain effectiveness. Moreover, the analysis performed by this research stream focuses only on logistics, paying scant attention to other interface processes
Modern logistic	Christopher (1998); Fuller et al. (1993); Lee & Billington (1992);	The focus of the studies shifts from mere cost reduction to include also service and quality improvement
Integrated process redesign	Disney et al. (1997); Forrester (1961); Mason-Jones & Towill (1997); Towill (1997a)	Quantitative models are applied to a systematic vision of the supply chain, how to redesign the entire supply system in order to obtain more efficient and effective flows of materials and information
Industrial organisation	Bensaou (1999); Ellram (1991); Frohlich & Westbrook (2001); van der Vaart & van Donk (2004)	The focus is on relationships between the various actors of the same supply chain. Authors recognise that a wide variety of organisational forms exist in supply chain relationships, spanning from discrete transactional relations, through co-operative arrangements, to long-term partnerships
Intra- and inter-organisational integration	Stevens (1989); Lambert et al. (1998); Towill et al. (2002)	This school takes a systems/holistic perspective regarding supply chain management. Here, integration activity spans from internal, cross functional integration as well as external integration with key suppliers and customers

Adapted from: Bechtel & Jayaram, 1997; Cigolini et al., 2004; Halldorsson et al., 2008

The *Systems Perspective*, the *Supply Chain Awareness*, the *Traditional Logistics*, and the *Modern Logistics Schools* can be considered as linked evolutions; however, *Integrated Process Redesign*, *Industrial Organisation* and *Intra- and Inter-Organisational Integration* actually define three different, though not independent, lines of research. Despite these differences, the underlying theme of

all identified schools consider integration as a key underlying factor. The so-called “*Supply Chain Awareness School*” refers to internal and external functional integration; the “*Linkage/Logistics School*” refers to the integration of logistics activities; the “*Information School*” refers to integration of intra- and inter-company information flows; and the “integrated process design school” refers to the integration of business processes across the supply network. This thesis is situated in the *Intra-* and *Inter-Organisational* integration school by taking a holistic/systems perspective regarding supply chain integration, including internal elements as well as customer and supplier integration. Next, the wide span of the supply chain management concept is briefly introduced.

2.5 The span of the supply chain management concept

The term supply chain management has been widely used with regard to the logistics activities and the planning and control of materials and information flows. However, some authors have used it to describe strategic, inter-organisational issues (Cox, 1999), others to discuss an alternative organisational form to vertical integration (Thorelli, 1986), and others to identify and describe the relationship a company develops with its suppliers or customers (Böhme et al., 2008c; Ellram, 1991). Here, a number of subject areas are identified to be considered as core elements of supply chain management. Table 2.3 provides the principal components of the supply chain literature. The objective is to highlight how the subject literature has contributed work in supply chain management from different perspectives.

Table 2.3: Important elements of supply chain management

Supply chain element	Important issues
Strategic management	Strategic networks, strategic sourcing, vertical integration, make or buy decisions, core competency focus, supply network design, strategic alliances, strategic supplier segmentation and selection, global strategy, strategic purchasing, leanness, agility
Logistics	Integration of materials and information flows, JIT, MRP, VMI, reverse logistics, physical distribution, cross docking, logistics postponement, capacity planning, forecast information management, distribution channel management, planning and control of materials flow
Marketing	Relationship marketing, customer service management, efficient consumer response, efficient replenishment, after sales service, value stream thinking
Relationships	Relationship development, supplier development, strategic supplier selection, vertical integration, partnership sourcing, supplier involvement, supply / distribution base integration, supplier assessment (ISO), design for manufacturer, mergers acquisition, joint ventures, strategic alliances, contract view, trust, power and dependency, partnership performances, relationship marketing
Best practise	JIT, MRP (II), ERP, continuous improvement, BPR, quick response, time compression, process mapping, world class manufacturing, CPR, VMI, EDI
Organisational behaviour	Communication, human resources management, employee relationships, organisational structure, organisational learning, power in relationships, technology and knowledge transfer

Source: Adapted from Croom et al., 2000; Wisner et al., 2005

Table 2.3 is a brief and non-exhaustive list of subject areas associated with supply chain management. It should be noted that there is a partial overlapping of the subject areas. In fact, the same topic can be considered from different perspectives in more than one subject area. Next, each of the six identified elements will be briefly discussed.

2.5.1 Strategic management

Managing the supply chain means managing across traditional functional areas in the company and managing interactions externally with both suppliers and customers. This cross-boundary nature of management supports incorporating supply chain goals and capabilities in the strategic plan of the company. Hence, key contributions focus on strategic alignment of company strategy with supply chain strategy (Mejias-Scaluga & Prado-Prado, 2002; Stevens, 1989). Linking

supply chain strategy to the business strategy involves defining the key business processes involved in producing a company's product or service. Once key business processes are identified, a set of detailed objectives can be developed for each process within the supply chain (Lummus & Vokurka, 1999). A second stream focuses in detail on how to develop meaningful supply chain strategies (Gattorna & Walters, 1996; Peck & Juttner, 2000).

2.5.2 Logistics

The concept of supply chain management is strongly anchored in the logistics literature (Bowersox & Daugherty, 1995; Christopher, 1998; Jones & Riley, 1985) and logistics has continued to have a significant impact on the concept (Fuller et al., 1993). The strong influence of logistics in the process of conceptualising supply chain management seems to be due to the weight given to inventory reduction and stock availability as key objectives of supply chain management (Min & Mentzer, 2000).

Early logistics literature focused on the economic theories of a company – i.e. cost control and its contribution to the bottom line. Thus, total cost analysis was an important performance measurement (Mentzer et al., 2004). Starting in the 1980s, companies viewed time as a source of competitive advantage (Stalk et al., 1992). This gave rise to techniques like Just in Time (JIT), cross-docking and vendor managed inventory (VMI), which will be further explained in the *Best Practise* category. Nowadays, logistic capabilities also play an important role in boundary-spanning interfaces between internal functional areas and between the focal company and supply chain partners. Coordinated with the marketing function, logistics can differentiate product and service offerings to fulfil unique customer requirements (Fuller et al., 1993; Gattorna & Walters, 1996; Mentzer et al., 2004). Logistics capabilities also help the company cooperate with supply chain partners (i.e. suppliers, distributors, and other intermediaries). Thus, logistics is an integral part of the larger concept of supply chain management (Fuller et al., 1993). Recent logistics research focuses on reverse logistics (e.g. Rogers & Tibben-Lembke, 1999) and sustainability within the logistics function (e.g. Koplin et al., 2007).

2.5.3 Marketing

The objective of marketing is customer satisfaction (Walters, 1999). Supply chain management is influenced by marketing from two different angles, namely market orientation and marketing channels. The marketing concept is implemented in the form of a market orientation, which promotes the emergence of relationship marketing and the implementation of supply chain management. A market orientation helps the implementation of supply chain management by providing valuable market information on customers, competitors, potential supply chain partners, and market environments (Min & Mentzer, 2000).

Marketing channels are defined as sets of interdependent organisations involved in the process of making a product or service available (Stern & El-Ansary, 1992). Fuller et al. (1993) applied the marketing channel approach to identify multiple logistics channels. Fisher (1997) adapted the marketing channel approach and identified that the supply chains need to be tailored to customer needs. Hence, Fisher (1997) argues that a focal company consists of multiple supply chains. Further, relationship management as well as the concept of power and dependency in relationships became a crucial concept in marketing channels research (Cooper et al., 1997; Lambert et al., 1998; Min & Mentzer, 2000).

2.5.4 Relationships

Traditional relationships in the 1960s and 1970s were characterised by an adversarial, arm's length approach (Szwejczewski et al., 2005). This suited traditional purchasing, which was primarily price orientated. The pressure for change was low, but increased in the next decade so that logistics relationships were adopted. The emphasis was to make the material transfer more efficient (Da Villa & Panizzolo, 1996). At the beginning of the 1990s, relationships required an even greater degree of interaction due to the need for product innovation and co-operation in technological developments. The competitive forces in the global marketplace compelled many companies to move significantly along the continuum from arm's-length relationships with suppliers to much stronger relationships characterised by much greater interdependence (Cox, 2001).

Today, the aim of relationship management is to achieve an optimal material and information flow (Goffin et al., 1997). As a result, relationship management pursues partnerships, strategic alliances, and joint ventures (Min & Mentzer, 2000).

2.5.5 Best practise

Supply chain best practise is accepted as being “about doing things in the most effective way” (Gattorna & Walters, 1996). Therefore, best practises can take many different forms. Three main categories of best practise studies have been identified: (1) techniques, (2) technologies and (3) concepts. Many best practises set out to improve material and information flow and hence aim at reducing the bullwhip effect. Forrester (1961) identified the bullwhip effect (also termed Forrester effect), which is the amplification of demand as orders are passed on upstream in the supply chain.

Supply chain related techniques include a large number of approaches suitable for a better process design. Choices regarding material flow are carefully evaluated through the transportation fleet design, facility network design, and warehouse network design techniques using specifically developed quantitative models (Cigolini et al., 2004). Other techniques such as just-in-time (JIT), customer replenishment programs (CRP), and vendor management inventory (VMI) focus on the management of the supply system. JIT is based on the idea that no activity should take place until there is a committed customer demand. JIT principles can be extended to distribution channels under various names, e.g. continuous replenishment program (CRP). Moreover, vendor managed inventory (VMI) or consignment stock agreements have been included in external relationships (Wisner et al., 2005). Finally, the distribution requirements planning technique (DRP) tries to combine the need for lower inventory investment with improved customer service. DRP is similar to MRP (II) in that they both try to identify the requirements for finished products at the point of demand and then to produce aggregate, time-phased replenishment schedules for each echelon of the supply or distribution system (Chopra & Meindl, 2007).

Information technology (IT) is utilised to gather, transmit and share data. It creates and directs the flow of information. Researchers have paid close attention to the effects of electronic data interchange (EDI) on material and information flow as well as on the relationship itself (Larson & Lusch, 1990; Myhr & Spekman, 2005; Stefansson, 2002). EDI and internet technologies support the inter-company transfer of data and other business documents in a standard format. In logistics, research has recently focused on radio frequency tags (Angeles, 2005; Gaukler, Seifert & Hausman, 2007). Automated identification systems like bar codes and radio frequency tags are commonly used to monitor goods movement throughout the supply chain. Integrated databases regarding sell-outs, forecasts, inventories, and production orders are a means to provide each firm in the chain with information originated in the other nodes of the system (Bagchi & Skjoett-Larsen, 2002). Integrated database research has strongly focused on the application of enterprise resource planning (ERP) systems (Cagliano et al., 2006).

Other best practise studies here focused on concepts such as Motorola's Six Sigma (Wisner et al., 2005), Wal-Mart's Collaborative Planning, Forecasting and Replenishment (CPFR) (Wisner et al., 2005), Dell's Extended Enterprise (Chopra & Meindl, 2007), and Toyota's Toyota Production System (TPS) (Raisinghani et al., 2005), to name a few.

2.5.6 Organisational behaviour

Andraski (1994) has remarked that supply chains are approximately 80% people-centred and 20% technology centred. Hence, the concept of organisational behaviour is very valuable. Organisational behaviour studies are well researched within change management and here specifically within business process reengineering (BPR). BPR is based on the idea that companies should be viewed horizontally, not vertically, and should focus on business processes rather than on functional areas or departments. However, successful change involves people at every level and extensive communication throughout the organisation (Harrington, 1995). Researchers further identified that empowerment of the work force is critical to successful BPR (Randolph & Sashkin, 2002).

Organisational behaviour studies increased when applying the concept to internal and external supply chain integration. Cox (1999) for example, studied extensively the effect of power and dependency in buyer supplier relationships. Cousins and Menguc (2006) focused on socialisation tactics between buyer and supplier. Mentzner et al. (2000) studied barriers to supply chain integration and concluded that many such barriers are related to people and personal interaction rather than to technology and infrastructure.

Having identified and discussed six broad elements of supply chain management it must be reiterated that none of these elements can be viewed in isolation as they are closely interlinked. Often the same elements can be considered from different perspectives in more than one subject area. This section highlighted the academic span of the supply chain management concept. The research for this thesis investigates whether this is the same situation in New Zealand. Hence, a brief overview of the key New Zealand publications is presented next.

2.6 Supply chain management in New Zealand

New Zealand publications in the field of supply chain management are limited in number. To widen the scope of the literature, Australian publications have been researched to obtain a broader perspective from the region. Table 2.4 highlights some key publications in the field of supply chain management within the Australia/New Zealand (ANZ) context.

Table 2.4: Major Supply Chain Management Investigations within ANZ

<i>Author</i>	<i>Major findings</i>
Walters & Jones (2001)	A single case study within the New Zealand health sector revealed that value chain analysis encourages an intra- and inter-organizational review of resource application and identifies alternative methods and structures for meeting objectives.
Wilson & Sankaran (2001)	The need to distinguish between partnerships that are located in discrete-part fabrication/assembly contexts and those that are situated in a process industry context.
Basnet et al. (2003)	Companies focused on on-time delivery and quality, but low level of focus/understanding on integration or relationships.
Closs & Mollenkopf (2004)	Internal integration is not a necessary competency in ANZ. While internal integration is very important to US companies, it does not seem to be as important predictor of performance for ANZ companies.
Simatupang & Sridharan (2004a)	Empirical evidence shows that collaboration between retailers and suppliers has a significant influence on operational performance.
Mollenkopf & Dapiran (2005)	The majority of organisations focused on internal logistics integration although some organisations have world class supply chains.
Simatupang & Sridharan (2004b)	The authors introduced and validated an instrument to measure collaboration between supply chain members. The quantitative study further identified that the collaboration index was positively associated with operational performance.
Singh et al. (2005)	Presents the findings of an exploratory study that examined contemporary issues related to supply chains in the Australian automotive manufacturing industry. The authors identified many unresolved issues in the Australian automotive supply chain.
Basnet et al. (2006)	The results indicate that there has been a significant increase in the general awareness of lean manufacturing, supplier integration, and quality improvement strategies. However, good supply chain practise is still lagging behind.

Source: Author

Overall, Table 2.4 highlights that supply chain management and operations management research is still in its infancy in the ANZ region. Basnet et al. (2006) also point out that, to advance supply chain management practises in New Zealand, more research in this field needs to be undertaken.

Regarding the uptake of the supply chain management concept in practise, Wilson and Sankaran (2001) report that New Zealand's local manufacturers are lagging behind their overseas counterparts in many key areas of supply chain management. Basnet et al. (2006) conclude that there have been constant

theoretical findings and developments which have enabled organisations to improve supply chain performance internationally. However, such developments are poorly understood and matched by an equally disappointing uptake in New Zealand. However, no publication has been identified reporting on supply chain integration maturity in New Zealand. This thesis makes an early attempt to close the gap identified. Hence, the first research question is:

- Research Question 1: How integrated are New Zealand supply chains?

Next, different supply chain assessment methods are reviewed to identify the one most suitable for answering the first research question.

2.7 Supply chain assessment techniques

General supply chain performance assessment is predominantly undertaken using maturity models. Maturity models are rooted in the field of quality management (Netland et al., 2007). While numerous different types of maturity models have been developed, relatively few models for analysis of supply chains and logistics were found in the literature. Most of the reported means of diagnosing supply chains and logistics problems are based on analytical and numerical models (Chopra & Meindl, 2001). Benchmarking techniques are also frequently used. In contrast, assessment techniques encompassing the entire supply chain are scarce. The literature divides maturity assessment techniques into commercially and academically derived techniques.

2.7.1 Supply Chain Operations Reference Model (SCOR)

The SCOR model is probably the most well-known commercially available supply chain assessment technique. This model was developed in the mid-1990s by a cross-industry consortium of over 70 companies in the USA called the Supply Chain Council. The SCOR model is based around four generic supply chain management functions of: Planning, purchasing, manufacturing, and distribution (Huan et al., 2004). SCOR defines common supply chain management processes in each function and matches these with best practise,

benchmarked performance measures, and use of software. The purpose is to provide a generic framework for measuring supply chain performance and identifying areas for improvement (Power, 2005). However, Huang and Mak (2000) identified that a seemingly endless variety of supply chains exist in practise and this benchmarking approach is fraught with danger and will clearly result in errors as ‘oranges are compared with apples’. Other commercially available supply chain assessment techniques are listed and briefly explained in Appendix B.1.

2.7.2 Collaboration Index

Simatupang and Sridharan (2004b) propose an instrument to measure the extent of collaboration in a supply chain. The model incorporates collaborative practises in information sharing, decision synchronisation, and incentive alignment. The outcome of the measurement process is a collaboration index and the identification of collaborative improvement initiatives.

2.7.3 Logistics Scorecard

Yaibuathet et al. (2006) developed a self-evaluation tool termed Logistics Scorecard. The Logistics Scorecard encompasses twenty assessment items based on four fundamental areas: (1) corporate strategy and inter-organisation alignment; (2) planning and execution capability; (3) logistics performance; and (4) IT methods and implementation. Each assessment item is allocated a five-level Likert scale. Despite the generality of this scorecard an individual company can perform the self-assessment and compare its score against competitors in the same industry or across sectors.

2.7.4 Benchmarking of logistical operations

Van Landeghem and Persoons (2001) developed a causal model that relates the use of best practise to resulting performances; grouped under four main objectives: flexibility, reaction time, quality, and cost. It enables companies to obtain an idea about their rate of use of best practise and their effectiveness based

on the key metrics. This enables the researcher to benchmark the focal business against previously assessed companies. Any shortcomings give important indications of where to improve (van Landeghem & Persoons, 2001).

2.7.5 SCMAT

Netland et al. (2007) present a tool to quickly assess the maturity of a firm's supply chain activities, termed Supply Chain Maturity Assessment Test (SCMAT). SCMAT has three main objectives: It is meant as a tool to (1) map the degree of maturity of a firm's supply chain activities at the strategic and operational level; (2) communicate the degree of maturity in a logical and easy-to-understand style; and (3) identify improvement areas in a firm's development project. The aim is to take all key factors of operation management into consideration.

2.7.6 The diagnostic tool

Foggin et al. (2004) developed a qualitative diagnostic tool with which a third party logistics provider (3PL) can quickly determine the viability of engaging in service with a client. The tool consists of five classifications: inventory, customer service, organisation, systems, and product flow. These classifications follow a specific hierarchical order, hence function as a decision tree. Each classification has a set of questions. The results of using this tool not only indicate areas where the 3PL can assist the client, but also how to go about addressing the client's supply chain 'pain points' (Foggin et al., 2004).

2.7.7 Quick Scan Audit Methodology

The Logistics Systems Dynamics Group at Cardiff University began development of a supply chain audit methodology in the early 1990s (Lewis et al., 1998) termed Quick Scan Audit Methodology (QSAM). During a typical QSAM audit, material and information flows are process-mapped; key managers are interviewed; company archive information is evaluated, and attitudinal questionnaires are completed concerning supply chain interfaces. At its heart lies

an assessment of supply chain integration maturity that makes use of three (validated) measures (Böhme et al., 2008a): (1) an overarching measure of supply chain uncertainty; (2) assessment of the mindset of practising managers, both by direct observation and by assessing their adherence to twelve common-sense rules of simplified material flow; (3) measurement of the presence of 24 symptoms that are categorised into four classes: Dynamic Behaviour, Physical Situation, Operational and Organisational Characteristics. Further academically derived supply chain assessment techniques are briefly explained in Appendix B.2.

2.7.8 Cross analysis of key supply chain assessment techniques

Table 2.5 summarises all of the key supply chain assessment techniques detailed previously, focusing on assessment duration, methods used, and supply chain classification.

Table 2.5: Examples of SCM maturity models and their classification

Title	Description	Duration	Method	Classification
SCOR	Self-diagnostic tool – SCM maturity	Extensive/ unknown	Quantitative	Plan, source, make, deliver, return
Collaboration Index	Statistical diagnostic study – collaboration	2-4 hours	Quantitative	Information sharing, decision synchronisation and incentive alignment
Benchmarking of logistical operations	Diagnostic tool - logistics	Extensive/ unknown	Qualitative	HR, planning and control, production and assembly, R&D, distribution, supply and demand
Logistics Scorecard	Self-diagnostic tool - logistics	2-4 hours	Quantitative	Corporate strategy, strategic alignment, planning and execution, logistics, IT
The Diagnostic Tool	Quick time diagnostic tool – 3PL	< 2 hours	Qualitative	Inventory, customer service, organisation, systems, product flow
SCMAT	Quick time diagnostic – SC maturity	2-4 hours	Qualitative	Strategy, control, processes, resources, materials, information, organisation
Quick Scan Audit Methodology	Supply chain integration diagnostic	20 person days; 1 week	Qualitative/ Quantitative	Supply chain uncertainty; simplified material flow; complex material flow

Source: Adapted from Foggin et al., 2004; Netland et al., 2007

This thesis will apply the Quick Scan Audit Methodology to investigate supply chain integration in New Zealand. With the exception of SCMAT, all the other diagnostic methods are tailored for specific problem areas. The QSAM is capable of covering a wide range of supply chain issues in a short period of time. The Quick Scan method also specifically addresses attitudinal issues via multiple and rigorous data collection techniques when identifying the current state of supply chain integration in a focal company. Importantly one key element of the Quick Scan is a supply chain integration maturity assessment, which clearly supports answering the first research question. A detailed description and justification of the Quick Scan can be found in the Methodology Chapter 4.8.1.

The previous section identified that only minor research had been undertaken regarding supply chain integration in New Zealand. This section identified that the QSAM is an appropriate supply chain diagnostic method. Next, the supply chain integration literature is reviewed.

2.8 Supply chain integration

The integration of supply chains has been the subject of significant debate and discussion within the academia (Bagchi & Skjott-Larsen, 2002; Frohlich & Westbrook, 2001; Ota, 2001; Power, 2005; Stevens, 1989; Towill et al., 2002). Supply chain integration originates from a systems perspective, where optimisation of the whole achieves better performance than a string of optimised sub-systems (Christopher, 1998). The argument is that, via integration, trade-offs and wider ranging decisions can be made based on shared information and co-ordination. Because integration is claimed by many authors to be a supply chain Utopia synonymous with supply chain management excellence, research into supply chain integration is a fundamentally important area. Published studies have focused on power position in the supply chain (Cox, 2001), purchasing integration (Narasimham & Das, 2001), impact of simplified material flow (Childerhouse & Towill, 2003), barriers to supply chain integration (Pagell, 2004), and shared resources (van der Vaart & van Donk, 2004) to name a few.

The following section will define supply chain integration, identify the proponents and opponents of the supply chain integration concept, and discuss their arguments.

2.8.1 The three layers of supply chain integration confusion

Historically, integration of logistics management was identified as the primary challenge of the 1990s to gain and maintain customer loyalty and a competitive advantage (Bowersox et al., 2002). More recently the scope of integration has broadened considerably from a logistics perspective to a supply chain integration perspective as academia recognised the potential savings to be gained from integrating the management of the various actors in a supply chain (Vickery et al., 2003).

Nowadays, supply chain integration is perceived as the degree to which an organisation manages intra- and inter-organisation processes to achieve effective and efficient flows of products, services, information, money and decisions, with the objective of providing maximum value to its customers (Bowersox et al., 2002, Frohlich & Westbrook, 2001; Naylor et al., 1999). Hence, most supply chain literature considers supply chain integration as the collaborative effort in linking internal functions, suppliers and customers (Frohlich & Westbrook, 2001; Lambert et al., 1998; Pagell, 2004; Romano, 2003; Sabath, 1995; Spekman et al., 1998; Wong & Boon-itt, 2008). Table 2.6 presents in chronological order key findings in the field of supply chain integration.

Table 2.6: Supply chain integration findings

Author	Methodology	Key Finding
Stevens (1989)	Conceptual paper	The author identified a progressive four stage supply chain integration model starting with baseline integration, functional integration, internal integration and external integration.
Stank et al. (1999a)	Quantitative	The analyses identified that customer and internal integration are the most significant differentiators of overall firm performance.
Whipple & Frankel (2000)	Quantitative	The authors identified that the largest barrier to external integration success is organisational (e.g. culture and the need to reengineer the business process) rather than technical or financial.
Frohlich & Westbrook (2001)	Quantitative	Organisations with the greatest arch of external integration had the largest rates of supply chain performance improvements.
Towill et al. (2002)	Qualitative	The authors carried out detailed case studies on 20 supply chains from the European automotive sector. They found 80% progressing towards internal integration, with the remainder advancing further, towards external integration.
Vickery et al. (2003)	Quantitative	The study shows that the more a company has invested in integrated information technologies infrastructure, the more likely it is that the company will achieve internal and external integration.
Van Donk & van der Vaart (2004)	Qualitative	Higher complexity in business conditions requires higher levels of integration. In cases of lower complexity the authors identified lower levels of integration practises.
Cagliano et al. (2006)	Quantitative	Results show that the adoption of the lean production model has a strong influence on the integration of both information and physical flows along the supply chain, while no significant influence emerged from the adoption of ERP.
Pagell (2004)	Qualitative	The author identified that the key drivers for internal supply chain integration are company structure and culture, rewards system and communication.

Source: Author

Table 2.6 highlights that the relevance of supply chain integration has been widely discussed and supported on an empirical basis. Most of the quantitative studies presented in Table 2.6 also identified a positive relationship between the level of integration and the performance of the focal company. However, there was little consistency among the authors in the basic definitions of supply chain integration and the variables applied in carrying out the research. Van der Vaart and van

Donk (2007) came to a similar conclusion in their critical review of current supply chain integration literature.

One possible explanation for the inconsistency of the supply chain integration definition and research variables is the confusion that surrounds the supply chain integration topic. Some scholars understand supply chain integration as the integration with customers and suppliers only (Frohlich & Westbrook, 2001; van Donk & van der Vaart, 2004), while other scholars also take internal functional integration into consideration (Childerhouse & Towill, 2004; Stevens, 1989; Vickery et al., 2003). Hence, academia lacks a unified view of supply chain integration. Thus, the exclusion of internal integration creates the first layer of confusion over the concept of supply chain integration.

Supply chain practises in different industries show that integration is understood differently, and Table 2.7 presents examples of different industries showing their dominant supply chain integration practises.

Table 2.7: The meaning of integration for different industries

Industry	Author	Dominant integration practise
Food	Stank et al. (1999a); Gimenez (2006)	Transparency of information and most efforts are focused on communication and sharing of information (e.g. Point-Of-Sale data and Collaborative Planning, Forecasting, and Replenishment).
Automotive	Lamming (1993); Matson & Matson (2007)	Integration is closely linked to concepts such as JIT and lean production, as well as co-managed inventory and joint R&D. Here the focus is on linking manufacturing stages through low levels of stock and short lead times.
Retailer	Cox (1999); Burt & Sparks (2003); Towill (2005);	Supplier integration from a power and dependency perspective. Lower inventory levels due to cross-docking of materials.
Fashion, Technology	Hewitt (1994); Sabath (1995); Bruce et al. (2004)	Integration is closely linked to concepts such as quick response (efficient consumer response) and lean and agile supply chain management.

Source: Adapted from van Donk & van der Vaart, 2007

Thus, Table 2.7 highlights the second layer of confusion around the concept of supply chain integration. Apparently, the different characteristics of industry

sectors lead to different supply chain integrative practises. Van der Vaart and van Donk (2007) provide a reasonable explanation for this phenomenon by pointing out that different industry sector characteristics might deal with different barriers in their striving for optimum material and information flows. This argument is supported by Gimenez (2004) and Romano (2003) who point out that the removal of barriers between and within organisations seems to be the crucial issue in integrating the supply chain.

Finally, academia adds a third layer of confusion around the supply chain integration concept. Different scholars focus on different aspects, when studying supply chain integration, as highlighted in Table 2.8. Researchers often focus only on a small area of supply chain integration so that research findings are often constrained.

Table 2.8: Different supply chain integration research streams

Integration Stream	Key Authors	Focus
Organisation with suppliers/customers	Frohlich & Westbrook (2001)	These studies take an external view of supply chain integration only.
R&D with manufacturing	Stevens (1989); Morash & Clinton (1997); Koufteros et al. (2005)	The focus is on the processes used to create new products, often with an emphasis on moving from a traditional “functional silos” approach to a more coordinated or concurrent approach including suppliers/customers.
Marketing with manufacturing	Pagell (2004); Walters (1999)	These works tend to examine ways in which companies can increase their profitability by coordinating marketing with manufacturing. These studies often emphasis moving toward a more coordinated and less functional way of management.
Integration of IS within a company	Narasimhan & Kim (2001); Gunasekaran & Ngai (2004)	These studies often examine the ways that a common technology platform can help various functions work more closely together.
HR with manufacturing	Youndt et al. (1996)	The authors explored the relationship between human resource strategy and manufacturing strategy.
Marketing with logistics	Ellinger (2000); Stank et al. (1999a).	These works tend to examine ways in which companies can increase their profitability by coordinating marketing with logistics.

Source: Author

The conclusion that can be drawn from Tables 2.6, 2.7, and 2.8 is that integration as a concept is ill defined and not well understood (Frohlich & Westbrook, 2001), which leaves the *concept of integration* in serious scientific doubt. Van Donk and van der Vaart (2005b) are among a small group of authors who doubt the concept of supply chain integration. They argue that integrative practises should have greater exploitation in the circumstance of high demand uncertainty. The practises can then be limited to physical flow and stock management when customer demand is known to be relatively uncertain. They comment that integrative practises are hardly possible, or feasible, in circumstances of shared resources and limited capacity (van Donk, Akkerman & van der Vaart, 2008). Finally, van der Vaart & van Donk (2006) argue that integration also depends on business characteristics. Arguing along the same lines, de Teville et al. (2004) conclude from their research that demand integration is only warranted when there is sufficient demand variability. In addition, supplier and customer integration has been particularly scrutinised. Cox (2001) argues that not all relationships should be fully integrated. Indeed, the relationship type adopted should be matched to supplier and customer dependency. Swink et al. (2007) show how four different forms of strategic integration have both benefits and dis-benefits. Mann et al (2008) argue that the structures of monolithic organisations and global supply chains are similar and that, consequently:

- Wealth is being globally redistributed (e.g. changed labour wage structures across the globe as jobs shift from country to country)
- Political institutions are being affected (e.g. Wal-Mart, as a dominant and most visible face of the biggest supply chain, is more powerful than the majority of nation states)
- Life chances are being influenced (e.g. supply chains that span national borders result in lost jobs or reduced availability of jobs, loss of local culture, death of local businesses and crafts...)

It is important to emphasise that the debate in the literature is not about full integration versus zero integration. Rather, it is about how much integration is justified and under what circumstances. The answer to these questions depends very much on the nature and purpose of the supply chain. For example, it is difficult to envisage any circumstances in which internal material and information

flow optimisation will not prove essential for competitiveness. Hence, the proponents clearly outweigh the opponents. Maloni and Benton (2000) provide a list of potential benefits for supply chain integration:

- Reduced uncertainty for customers in (a) material costs, (b) quality, (c) timing and lead times, and (d) availability and responsiveness;
- Reduced uncertainty for suppliers in (a) market, (b) understanding of customer need, and (c) product/material specifications;
- Reduced uncertainty for both in (a) convergent expectations and goals, (b) reduced effects from externalities, (c) reduced opportunism, (d) increased communication, and (e) shared risk and reward;
- Cost savings from (a) decreased administration costs, (b) decreased switching costs, and (c) integration of processes and technologies;
- Enhanced responsiveness from (a) joint product and process development, (b) faster time to market, and (c) improved cycle time.

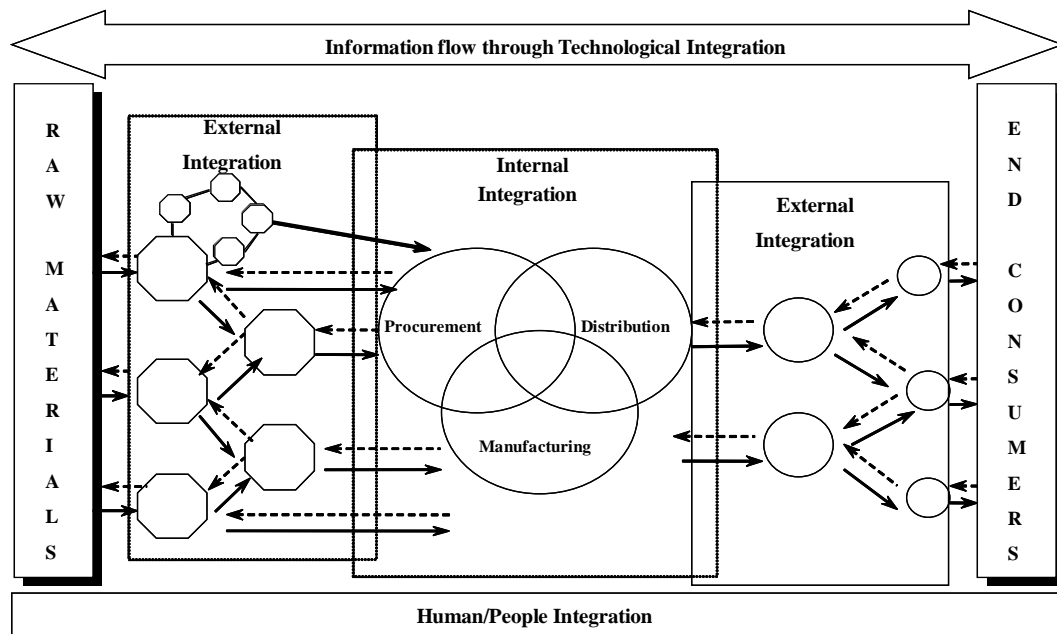
This section has examined the confusion that exists around the concept of supply chain integration. However, Ho et al (2002) point out that the development of supply chain management theory begins with the establishment of a clear conception of its meaning. Hence, it is important to clearly define the author's view regarding supply chain integration, which is presented next.

2.8.2 Author's view of supply chain integration

Not only has the supply chain integration construct been used to study a number of different organisational phenomena, it has been defined in a number of different ways. Additionally, many authors who have studied integration offer no formal definition of the construct. The end result is that this commonly researched construct does not have a single, accepted definition (Pagell, 2004). However, from the literature, it emerges that integration can support business processes at two different levels; internal and external. Internal integration aims at overcoming the functional silo boundaries. The goal is inter-departmental collaboration that brings departments together into a cohesive organisation (Kahn & Mentzer, 1998). External integration, aims at overcoming the individual company boundaries and advancing integration to an overall supply network integration. Figure 2.2 depicts

the author's view of supply chain integration. This is the perspective adopted for the remainder of this thesis, which is in line with that of many other authors (e.g. Bowersox et al., 2002; Fawcett and Magnan, 2002; Lee, 2000; Stevens, 1989).

Figure 2.2: Integrated supply chain model



Source: Adapted from Handfield and Nichols, 2002

The supply chain shown in Figure 2.2 represents a simplified supply chain network structure. The enterprise in the middle is referred to as the focal company. Figure 2.2 further highlights the information and product flows, and the key supply chain business processes penetrating functional silos within the focal company and the various corporate silos across the supply chain (Bowersox et al., 2002; Lambert et al., 1998). Figure 2.2 presents the need for internal integration of key functional areas such as engineering, sourcing, logistics, and operations. External integration with customers and suppliers (see Figure 2.2) through a distribution network is highlighted. The end consumer purchases products based on cost, quality, availability, maintainability, and reputation and a hope they satisfy requirements and expectations.

Internal and external integration aims at a more effective use of the combined resource base, together with better integrated information and material flows. However, external integration is often viewed as partnerships and strategic

alliances (e.g. Droge et al., 2004; Kim, 2006; Maloni & Benton, 1997; Spekman et al., 1998), which is somehow contradictory to the initial aim of optimising material and information flow. Therefore, Gimenez (2004) focuses solely on the maturity of vendor managed inventory (VMI) practises in a focal company to identify the level of supplier integration. Others have focused on advanced information systems such as EDI to identify the degree of external integration (Vickery et al., 2003). Frohlich and Westbrook (2001) likewise place most emphasis on information flow and communication channels when investigating “arcs of integration.” Therefore, it can be argued that partnerships and strategic alliances go beyond external integration and the pure optimisation of material and information flows.

Supply chain integration represents a promising though intricate concept that is still maturing. To support this maturation, more research is required to identify critical drivers of, and barriers to, the integration process (van der Vaart & van Donk, 2007) because the removal of barriers between and within organisations seems to be a critical issue in integrating the supply chain (Gimenez, 2004; Naylor et al., 1999; Romano, 2003). This section has presented the authors view of supply chain integration, although due to its intricate nature no single definition is provided. Next, key barriers and drivers to supply chain integration are discussed.

2.9 Barriers and enablers to supply chain integration

Many scholars acknowledge the existence of barriers to, and enablers of, achieving supply chain integration in both internal and external areas of supply chain integration (Bagchi & Skjott-Larse, 2002; van Donk & van der Vaart, 2005b; Whipple & Frankel, 2000); however, in-depth investigations are rare.

2.9.1 Internal barriers and enablers to supply chain integration

Barriers to internal integration have origins in traditional functional practises related to organisational structure, measurement and reward system, information technology, and supply chain skills (Wisner et al., 2005). However, internal barriers are not well understood. Storey et al. (2005), for example, identified that

much of the supply chain literature underestimates organisational and behavioural complexities.

The two key publications in the field of barriers to, and enablers of, internal supply chain integration are by Gimenez (2004) and Pagell (2004). Gimenez focuses on the barriers to implementing supply chain management programs by interviewing managers at 14 different businesses in the Spanish grocery sector. The key barriers identified are organisational culture and attitudes of people working in the company, functional silos, and information systems and technologies (a full list of the barriers Gimenez identified can be found in Appendix A.1). Pagell also argued that the main barriers are people in the form of the structure and culture at the plant, reward systems and the amount of formal and informal communication. Despite their contribution to knowledge, both studies have limitations. Pagell only focuses on the interfaces of three different departments within a focal company: purchasing, manufacturing and marketing; thereby ignoring interfaces with other internal departments. Gimenez only captures the management perspective on the barriers and therefore ignores barriers that management staff is unaware of. Lambert and Cooper (2000), Pagell, and Gimenez all state that further research in supply chain barriers is required. This thesis aims at contributing to knowledge in the field of internal barriers to supply chain integration by raising the following research question:

- Research Question 2: What barriers obstruct internal supply chain integration in practise?

Many key barriers, when addressed appropriately, serve as supply chain integration enablers; variables that managers can address to design and manage any key business processes internally (Romano, 2003). Table 2.9 provides a list of key internal barriers and enablers of internal supply chain integration.

Table 2.9: Barriers to supply chain integration

Barriers	Description	Enablers
Multiple independent information systems (Lee 2000; Wisner et al., 2005)	The structure and availability of information have traditionally been based on functional organisation requirements. This early practise in formatting information has resulted in what is referred to as infocratic structure. The fully integrated system instead is capable of linking and coordinating the information systems of individual parties into a cohesive whole, thereby providing information transparency.	Fully integrated information system (Fawcett & Magnan, 2002)
Defensive culture and attitude of individuals (Wisner et al., 2005)	A defensive culture is represented by people unwilling to work together or share information because of the fear that the other party will take advantage of them or use the information unethically. However, people and organisational culture are seen as a key enabler to supply chain integration. Hence, the development of a positive culture regarding change is necessary.	Willingness to change. Empowerment (Sirkin et al., 2005)
History (Pagell, 2004)	The author identified that many cultural barriers are embedded in the company's history. Hence, history influences culture and attitude in the plant.	Strategic vision that breaks with the past
Hierarchical organisational structure (Harrington, 1995)	The structure of a focal organisation has traditionally been based on functional organisation requirements. Hence, the organisational structure is hierarchical and functionally orientated, supporting a functional silo mentality. A flat organisational structure instead empowers people within the process to make decisions.	Flat organisational structure (Cooper et al., 1997; Hammer, 2001)
Functional driven reward system (Bowersox et al., 2002)	Traditional measurement and reward systems typically mirror organisation structure. Hence, most reward systems are based on functional achievement. However, cross-functional KPIs will help to overcome the silo mentality present in many companies.	Cross-functional driven reward system (Lee, 2000; Wisner et al., 2005)
Lack of supply chain skills (Walker et al., 2008)	This variable describes the lack of knowledge regarding the benefits of supply chain management among management and other employees within a focal company. Advancing supply chain skills and systems thinking within the workforce enables staff members to understand the wider trade-offs of their action.	Supply chain skills (Walker et al., 2008)
Lack of staff training (Walker et al., 2008)	Staff does not receive formal supply chain training and individual initiatives are seldom supported. Providing staff training positively impacts on the culture as staff members feel valued, and the skill level of the individual is raised.	Extensive staff training (Walker et al., 2008)
Strategic misalignment (Chopra & Meindl, 2006)	The overarching strategy sets the direction for the entire company. Misalignment of company strategy with supply chain strategy can result in different functions following different directions and hindering information and material flow optimisation. In an ideal world, companies within a supply chain are committed to a single strategy.	Strategic alignment (Peck & Juttner, 2000)
Lack of top management support (Pagell, 2004)	Changes in the process will most likely have an impact on different functions. Top management support is essential to achieve material and information flow optimisation that cuts across different functions.	Top management support (Pagell, 2004; Storey et al., 2005)
Cost of implementation (van Donk & van der Vaart, 2005b)	Cost concerns are a serious obstacle for supply chain integration, especially if companies follow a short-term budget view. Long-term investment focus is essential.	Long-term investment focus

Next, external barriers and enablers to supply chain integration are presented.

2.9.2 External barriers and enablers to supply chain integration

External barriers to supply chain integration span the whole range; from a lack of a culture of sharing information or trust (e.g. Gimenez, 2004; Whiple & Frankel, 2000) to shared resources on the supplier side (van Donk & van der Vaart, 2004). However, a number of academic studies have identified trust as the key external integration characteristic fostering collaborative behaviour (Drago, 1997; Geyskens et al., 1996; Myhr & Spekman, 2005). Trust is defined here as the degree to which companies perceive each other as credible and benevolent and it has a positive effect on the degree of supply chain integration (Myhr & Spekman, 2005). However, trust is also one of the biggest uncertainties in relationships. A high level of trust is evidenced by data sharing throughout the supply chain and, more importantly, in trust being placed in people (Drago, 1997; Ireland & Crum, 2005).

One of the greatest deterrents to trust is one's relative power (Handfield & Bechtel, 2004). Power and dependency in relationships has been studied extensively (Bensaou, 1999; Caniels & Gelderman, 2005; Cox, 2001; Kraljic, 1983). The power phenomenon can be defined as the ability of one entity in the chain to control the decision of another entity (Daparin & Hogarth-Scott, 2003). Further, the balance of power can be held by the company buying or supplying (Cox, 2001, 2004). However, power as a concept is of little analytical value since the nature of power itself is less important than the origins of power. Dependence, being the inverse of power, is the reliance of one party on the other in maintaining a relationship to achieve respective goals (Emerson, 1962). Dependence makes possible the establishment of control mechanisms over the dependent party (Farell & Schroder, 1998; Geyskens et al., 1996).

The literature draws a distinction between buyer dependency and supplier dependency. Supplier dependency typically exists when the buying company is significant for the supplier; the buying company has a high percentage of the supplier's total market (Motwani et al., 1998). Conversely, buyer dependency

can be characterised as having a high need for, but relatively low possibility of, integrative practises with suppliers (Cox, 2004). Currently, only limited attention has been given to measuring power and dependency in relationship management (Simatupang & Sridharan, 2004b). However, van der Vaart and van Donk (2007) conclude that power and dependency in external relationships should be measured since the concept is among the main factors shaping and influencing integration (a more detailed literature review of the variables influencing power and dependency is provided in Chapter 7). Due to the overall importance of power and dependency for external supply chain integration, this thesis places increased emphasis on this particular phenomenon by raising the following research questions:

- Research Question 3a: What is an appropriate technique to measure power and dependency across inter-organisational boundaries?
- Research Question 3b: How do power and dependency affect external supply chain integration?

Many initiatives within the field of supply chain management and operations management are directed toward the removal of barriers to ease the material and information flow (Naylor et al., 1999). However, the removal of barriers implies change from the current supply chain practise to a more integrated way to do business. This thesis intention is not to study change in particular. Rather, the interest is on the routes companies take to further integrate their supply chain. How is supply chain integration actually achieved? Therefore, the concept of supply chain change cannot be completely ignored when studying the pathways/routes to supply chain integration.

2.10 Supply chain change

The integration of a supply chain requires change internally and also externally with suppliers and customers. These changes target the removal of supply chain integration barriers to ease the material and information flows. Here, two distinct forms of change within supply chain management are discussed; a more gradual

change process termed continuous improvement, and radical change in the form of Business Process Reengineering.

2.10.1 Continuous Improvement

Japanese companies originally championed continuous improvement (CI) or Kaizen (Balle, 1995). Continuous improvement programs evolved from a focus on traditional manufacturing production line to reduce waste and improve product quality, into comprehensive, systematic methodologies that focus on the entire organization; from top management to the workers on the shop floor (Bessant et al., 1994). Hence, CI and quality management programs go hand in hand as they seek to achieve excellence through improvement. The best known are Kaizen, Six Sigma, Quality Circle and Total Quality Management. More recently, large organizations are developing their own CI methodologies to fit their specific needs, by encompassing the various tools and techniques of individual methodologies (Bhuiyan & Baghel, 2005). The following list is not comprehensive and captures only the CI methods most relevant for this thesis.

2.10.1.1 Kaizen

Kaizen was developed by the Japanese to overcome the inferior quality of many manufactured goods after the World War II. Kaizen is a process-oriented approach and focuses on small continuous improvements. Another key focus of Kaizen is to eliminate waste. Overproduction, scrap, unnecessary motion or tasks, excessive time setting up and breaking down processes, and moving goods too frequently and too far are examples of waste (Berger, 1997). For example, Dr Shigeo Shingo was instrumental in helping the car manufacturer Toyota overcome its quality problems. The contributions from Dr Shingo included concepts called just in time and zero quality control concepts (Raisinghani et al., 2005).

2.10.1.2 Quality Circle

In the 1950s, the Toyota Motor Company first implemented Quality Circles within the production process. Hence, Quality Circle can be seen as part of lean

manufacturing (Bhuiyan & Baghel, 2005). It is a people orientated approach to quality improvement. The approach is to take a small group of people working on related activities and empower them to make decisions and recommendations to improve their activities. Management's role is to provide a congenial atmosphere in which the group can make suggestions for improvement, even if it leads to management making adjustments to their style and culture. Organisational change due to the implementation of Quality Circles is a result of several aspects including fostering a change in employees attitude, development of individuals involved, and creating a team spirit and a positive working environment (Raisinghani et al., 2005).

2.10.1.3 Six Sigma

Six Sigma has been defined as an organised and systematic method for strategic process improvement and new product and service development (Wisner et al., 2005). The method relies on an extensive set of rigorous tools including statistical methods, mathematical modelling and the scientific method to make dramatic reductions in the customer defined defect rates (Linderman et al., 2003). To achieve this, the DMAIC model was developed; Define opportunities, Measure performance, Analyse opportunities, Improve performance, and Control performance. Six Sigma provides quality measurement that can be used throughout an organisation – not only in manufacturing but also in design, administrative, and service areas (Kwak & Anbari, 2006).

2.10.1.4 Total Quality Management

Total Quality Management (TQM) refers to a management methodology to empower organizations for self-improvement. Unlike many quality initiatives, implementation is top down starting with upper management (Wisner et al., 2005). The evolution of TQM incorporated a Japanese-style technique called Hoshin, which defines the targets and means of any project or problem. A target statement is developed involving actions, metrics, and a time period. Management's role is to provide the means to achieve the target (Chang, 2005).

2.10.1.5 Hybrid Methods

While individual CI programs help to improve organisational operations in many aspects, they are not necessarily effective at solving all issues. To overcome the weaknesses of one program or another, a number of companies have merged different CI initiatives together, resulting in a combined CI program that is more far reaching. Lean Six Sigma is a well-known hybrid methodology, a combination of Six Sigma and lean manufacturing. Another well known hybrid method is the combination of TQM with Six Sigma to gain the benefits of both methods (Raisinghani et al., 2005). A more aggressive alternative to CI is termed business process reengineering.

2.10.2 Business process reengineering

Business process reengineering (BPR) is the Western answer to continuous improvement (Balle, 1995). BPR is a radical change approach because it triggers change of many kinds, not just of the business process itself. Job designs, organisational structures, management systems, anything associated with the processes are reengineered in an integrated way. Process reengineering is founded on two key ideas:

- Business should be viewed horizontally, not vertically, and should focus on business processes rather than on functional areas, departments, etc.
- The only way to change the way the company works is to apply very aggressive change management concepts, involving people at every level, and communicate extensively throughout the organisation (Harrington, 1995).

A BPR initiative is commonly seen as a twofold challenge (Carr & Johansson, 1995; Reijers & Mansar, 2005). Firstly a technical challenge, which is due to the difficulty of developing a process design that is a radical improvement of the current design. Secondly, a socio-cultural challenge, resulting from the severe organisational effects on the people involved, which may lead them to react against those changes. Many authors identified the socio-culture challenge as the more critical one (Deetz, Tracy & Simpson, 2000; Harrington, 1995; Bainbride,

1996). Jaffe and Scott (1998) identified a number of critical factors for successful BPR and Table 2.10 provides an overview of those factors.

Table 2.10: Critical factors for successful BPR

Success Factor	Description
Critical mass	It is not easy to get people to be different. It is important to persuade people that change is necessary and not to dictate change. Employees that are persuaded by the required change will persuade others and together they become a critical mass to drive the change process.
Open to discovery and learning	Reengineering is a major risk, moving forward into uncertainty, and is not something that can be done cautiously. If a company tries to move into new territory, then this company will have to learn as it goes.
Overcoming resistance	Organisations and people are designed to resist change, not to embrace it. Hence, change is difficult to achieve. Top managers often ignore the human dimension of the process. To change, people need to shift their mind-sets, their ways of seeing the organisation, and their established roles to take on new and unfamiliar activities that may be highly threatening.
Top management support	No deep change is successful if the leaders are not fully engaged and deeply involved in the effort. Top management must visibly support the reengineering process and set the ground rules and expectations consistently and repeatedly.

Source: Adapted from Jaffe & Scott, 1998

Several well-known management philosophies exist that can scope and guide the overall course of a reengineering project, such as Total Cycle Time Compression (Schonberger, 1986; Stalk & Hout, 1990), the Lean Enterprise approach (Womack & Jones, 2005), and Constraints Management (Goldratt & Cox, 1992). However, a discussion of these various approaches is outside the scope of this thesis. More importantly, the similarities between BPR and supply chain integration are further explored here.

Supply chain integration and BPR are seen as two complementary philosophies. However, Evans et al. (1995) argue that after full and successful business process re-engineering, internal integration will be achieved. The authors undertook an in-depth literature review to identify the change areas when implementing an integrated supply chain or undertaking reengineering, which is presented in Table 2.11.

Table 2.11: Parallels between BPR and supply chain management

Area for change	BPR terminology	SCM terminology
Process	<ul style="list-style-type: none"> • Elimination of waste around the core processes • Speed up core processes • Concentration on core processes 	<ul style="list-style-type: none"> • Reduce non value add activities • Lead time reduction • SCM positions each firm to do what it does best
People	<ul style="list-style-type: none"> • Board level commitment • A management that questions • A work force that questions • Multi-skilled work force • Attitudinal changes 	<ul style="list-style-type: none"> • Board level commitment (with SCM champion at board level) • A management that questions • A work force that questions • Multi-skilled work force • Attitudinal changes
Technology	<ul style="list-style-type: none"> • Technology change • IT – a key to BPR 	<ul style="list-style-type: none"> • Technology change • IT – a key to SCM
Relationship Management/ Innovation	<ul style="list-style-type: none"> • Supplier relationship management • Customer focus • Constant innovation at the interfaces of the company • Constant product/ process innovation 	<ul style="list-style-type: none"> • ‘Partnership sourcing’ • Deep penetration into customer base • Constant innovation at the interfaces of the company • Streamline processes

Source: Adapted from Evans et al., 1995

Table 2.11 subdivides the area for change into four distinct categories: process, people, technology and innovation and identifies a remarkable overlap between BPR and supply chain management in all four change areas. Hence, Evans et al. (1995) argue that those companies which have already integrated the supply chain will have already travelled the same path as BPR. Next, each area for change is further explained.

2.10.2.1 Process

Business process re-engineering involves rooting out the real value-adding activities that can be offered to the customer through core process activities. The task is to highlight the important processes that are currently strong through the company and integrate them effectively, implementing new designs.

2.10.2.2 People

It is a widely understood requirement that the drive and vision for BPR and supply chain integration is from the top. Constant communication and commitment are management requirements for any major change. The foundation of reengineering must rest on all people changing and learning, which means that everyone in the organisation must be engaged in the process (Harrington, 1995). Reengineering is not the application of a standard technology. It requires a discovery by the people in the organisation of new ways and open systems – a sharing of full information from customers, the environment, and across boundaries (Jaffe & Scott, 1998). To change, everyone in the organisation – leaders as well as other employees – needs to shift their mind-set, their ways of seeing the organisation, and their established roles to take on new activities that are unfamiliar and sometimes highly threatening (Hammer, 1990).

2.10.2.3 Technology

Bottlenecks within the system can only be effectively dealt with through the implementation of new technology. Although the major thrust has been in the application of IT, shop floor technology is equally important. However, the technology must be able to cope with the new environment that re-engineering and integration within the supply chain bring. For an extensive list of methodologies, techniques and tools see Kettinger et al. (1997).

2.10.2.4 Innovation

Incremental process innovation ideas are linked to the make-up of personnel but the business structure dictates if these ideas are prematurely rejected or not. The concept of encouraging and then implementing good ideas from the shop floor is not a new one. This concept is well anchored in TQM programmes. Further, supplier and customer relationship management falls under this category.

A successful change process of any kind (BPR or CI) in the area of supply chain management should result in improved material and/or information flow. Hence the successful change process should result in a further integrated supply chain.

However, van der Vaart and van Donk (2007) concluded that there is little consensus on how to capture the essence of integration.

2.11 Achieving supply chain integration

2.11.1 Supply chain integration in theory and practise

Despite more than 20 years of academic publications there remains a significant gap between supply chain theory and practise. Many scholars report that few companies are actually engaged in extensive and advanced supply chain integration practises (Akkermans et al., 1999; Halldorsson et al., 2008; Harps & Hansen, 2000; Kilpatrick & Factor, 2000; Towill et al., 2002, Zailani & Rajagopal, 2005).

Fawcett and Magnan (2002) carried out a multi-method research approach involving both surveys and case study interviews in the USA. Their findings reveal that supply chain practise seldom resembles the theoretical ideal and only very few companies have truly begun to establish a supply chain management culture. These companies have begun to map their supply chain, analyse value propositions and core competencies, and evaluate the appropriateness of existing and future supply chain relationships (Fawcett & Magnan, 2002). Towill et al. (2002) carried out detailed case studies on 20 supply chains from the European automotive sector; a sector well-known for its advanced supply chain practises (e.g. Toyota Production System). They found that 80% of the sample struggle to be internally integrated, with the remainder advancing further, towards external integration. McAdam and McCormack (2001) presented a qualitative study of the relationship between managing business processes and managing supply chains. They found little evidence of companies actually exploiting the integration of business processes in their supply chains (McAdam & McCormack, 2001). Similar findings were reported by Potter et al. (2004), who concluded that, although the steel supply chain has evolved between 1990-2001 towards an integrated structure, there are currently constraints imposed by organisational boundaries.

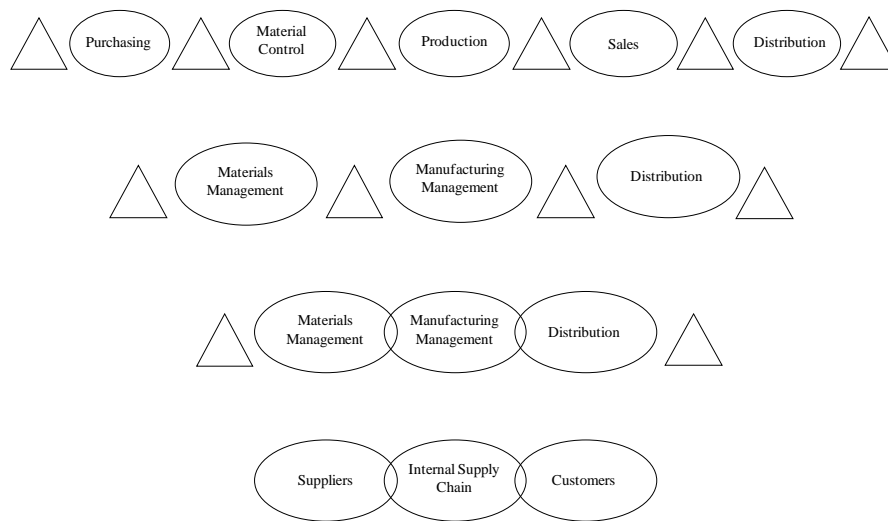
Many books reporting on customer responsive supply chain practises are using Procter & Gamble, together with Wal-Mart, as best practise examples. Storey et al. (2005) investigated Procter & Gamble's supply chain practises with key customers (retailers) and reported that while a customer responsive supply chain is technical feasible both parties lack top management support to implement the necessary change.

Recently, quantitative studies report the poor application of the supply chain management concept (Poirier & Quinn, 2003; Zailani & Rajagopal, 2005). Zailani and Rajagopal (2005) report that companies are still in their infancy stage when it comes to supply chain management and integration with customers and suppliers. Supply chain integration is a desirable concept; however, practitioners seem to struggle with its successful application. Certain barriers exist that hinder the implementation of an integrated supply chain. Poirier and Quinn (2003) report that companies within such industries as high technology manufacturing, telecommunications, and wholesale distribution, had moved into more advanced levels of supply chain management in parts of their business application areas. Overall, however, the vast majority of companies reported a poor uptake of the concept of supply chain management (Poirier & Quinn, 2003).

2.11.2 Pathways to supply chain integration

Narasimhan and Kim (2001) note that much of the research on integration has been predicated on the assumption that integration occurs in distinct stages. Possibly the most influential work regarding a stage process towards supply chain integration is by Stevens (1989), who proposed a four stage evolutionary model of supply chain integration: baseline integration, functional integration, internal integration, and external integration. Figure 2.3 represents Stevens (1989) integration model.

Figure 2.3: Supply chain integration model by Stevens (1989)



Source: Stevens, 1989

Stevens (1989) suggests that companies follow an integration process that goes through different stages by integrating internally first and then extending the integration process to other supply chain members externally. Empirical evidence (Towill et al., 2000; Koufteros et al., 2005) as well as case study research (Romano, 2003) support the evolutionary integration model developed by Stevens.

However, it has been shown that even similar companies may progress through quite different stages to achieve a fully integrated, seamless supply chain (Towill et al., 2002; Lambert et al., 1998; Lee, 2000; Stevens, 1989). Towill et al. (2002) have codified the evolutionary integration model by Stevens and applied it to 20 value streams from the automotive sector. Although none portrayed the characteristics of the traditional structure, three (15%) are shown as undergoing functional integration. However, thirteen (65%) of the value streams were in the process towards internal integration. Only four (28%) had progressed beyond this stage towards external integration. This work particularly highlights that it is unusual for supply chains to display all the characteristics of a particular stage at the same time, therefore indicating that Stevens' stepwise progression does not always reflect reality (Potter et al., 2004). Further, Gimenez' (2004) qualitative study identified one exemplar that did not follow Stevens integration model. Finally, Halldorsson et al. (2008) report that managers seem to achieve more

successful integration externally with their suppliers and customers than they do internally with their managers and departments.

Many researchers have identified a lack of understanding/knowledge regarding the path to further integrate the supply chain (Cigolini et al., 2004; Frohlich & Westbrook, 2001; van Donk & van der Vaart, 2005b). Frohlich and Westbrook (2001), in their award winning paper, raise the question of what are the necessary steps towards supply chain integration. Pagell (2004) likewise identified that there is far less research on how to achieve integration and that what research does exist tends to look at a specific factor such as the use of information technology (e.g. Narasimhan & Kim, 2001) or a single set of purchasing practises (e.g. Anasai et al., 1999). Lacking in the literature is a comprehensive study on the pathways to supply chain integration including factors that enable and inhibit integration. This thesis aims to close this research gap in understanding, and investigate what routes companies take to integrate their supply chain. Hence, the following research question is raised:

- Research question 4: What is an effective methodology to investigate supply chain integration maturity, barriers, and enhancement in practise?
- Research question 5: In what ways do companies pursue supply chain integration in practise?

Furthermore:

- Research question 6: How do companies achieve supply chain integration in practise?

In the light of the preceding discussions, existing supply chain integration models (e.g. Figure 2.3) need to be tested and also a suitable research methodology that enables the researcher to investigate pathways to supply chain integration needs to be identified or, in case of need, developed. Then, the overarching research question can be addressed.

In order to be able to answer the overarching research question, a conceptual model is needed capable of capturing all relevant characteristics of supply chain integration. Currently, there is no commonly agreed framework for the components of supply chain integration (Zhao et al., 2008). Van der Vaart and van Donk (2007) proposed one conceptual model focusing on three main categories; attitudes (e.g. attitude towards customers or suppliers), practises (e.g. EDI and VMI) and patterns (e.g. face-to-face contact with suppliers and customers). However, their model is conceptual only and externally focused. Hence, a new conceptual model capable of capturing the essence of internal and external integration is proposed next.

2.11.3 Assessing supply chain integration in practise

Stevens (1989), Towill (1997b), Kim (2006) and Das et al. (2006) concluded that advanced supply chain management practises lead to a higher level of supply chain integration. Supply chain practises are viewed as tangible activities or technologies that play an important role regarding integration. Hence, advanced supply chain integration practises have been identified in the literature (Potter et al., 2004). The authors identified 10 supply chain integration practises, which are included in the following Tables 2.12 - 2.16. An additional 12 practises have been identified (including intangible characteristics that have been reported as being critical to supply chain integration) to capture a focal company's supply chain integration status. The combined set of 22 characteristics has been grouped into five different categories termed; information generation and sharing; relationship management; technology integration; people/culture; and performance outcome. The developed conceptual model (Tables 2.12 - 2.16) enables the researcher to clearly evaluate the effect of the change process on supply chain integration. The Evans et al. (1995) categories for comparison of business process reengineering and supply chain management, set the basis for the developed conceptual model because the authors identified that companies that have already integrated the supply chain will have likely have already travelled the same path as business process reengineering. Further, a detailed literature review for each proposed category has been conducted, which resulted in 22 supply chain integration practices.

Tables 2.12 - 2.16 follow Stevens (1989) stepwise approach, each table describing the four different stages of supply chain integration; traditional supply chain, functional supply chain, reactive supply chain and seamless supply chain. The N/A column has been utilised in case a practise is not applicable. Functional supply chain integration and early reactive supply chain integration stages emphasise capabilities of cost reduction rather than balanced performance improvement, while enhanced reactive supply chain integration and seamless supply chain stages are characterised by capabilities enabling a smooth flow of material and information through full systems visibility and complete information sharing, and long-term commitment with key external entities of choice (Kim, 2006). Next, each identified supply chain practise category is discussed in detail along these supply chain stages of progression.

2.11.3.1 Information generation and sharing

Information integration makes inventory and production visible throughout the supply chain, creating a more congenial climate for collaborative planning and forecasting (Bagchi & Skjoett-Larsen, 2002). Data includes production schedules, forecasts or delivery data between different functions within a focal company and with other supply chain members like customers, suppliers or carriers (Mouritsen et al., 2003). Many improvements within supply chains are enabled by developments in the areas of information sharing (van der Vaart & van Donk, 2004). Table 2.12 highlights four information integration characteristics: operational data, visibility, communication, and performance measures.

Table 2.12: Information generation and sharing assessment

Characteristics	N/A	Traditional SC	Functional SC	Reactive SC	Seamless SC
Operational data (Mouritsen et al., 2003)		Not shared	Shared within function	Shared within organisation	Shared throughout supply chain
Visibility (Holweg et al., 2005)		No visibility	Small amount of cross-functional visibility	Complete visibility within organisation	Full supply chain visibility
Communication (Bagchi & Skjott-Larsen, 2002)		Poor communication	Improved communication within the company	Few contact points between companies in the supply chain	Multiple contact points at all management levels
Performance measures (Bagchi & Skjott-Larsen, 2002)		None	Measurement of delivery performance and inventory	Supply chain measures within company	Performance measurement across supply chain

Source: Author

In the traditional supply chain setting, operational data is not shared. However, as supply chain practises improve, the sharing of information becomes more critical and expands from sharing within a function to extensive sharing within the focal organisation. The last stage includes suppliers and customers in the data sharing activity; however, many academics argue that prior to the extensive sharing of information, trust needs to be built up between the focal company and its external entities (Wisner et al., 2005).

Holweg et al. (2005) developed a four stage integration model where visibility played a crucial part. They argue that reducing uncertainty via visibility of information flow is a major objective in supply chain integration. Unpredictable or non-transparent demand patterns have been identified as causing artificial demand amplification. This leads to poor service levels, high inventories and frequent stock-outs. In the traditional supply chain, no visibility is present. The visibility of information improves internally until full pipeline visibility is reached in the seamless supply chain stage (Holweg et al., 2005)

Pagell (2004) identified communication as one of the key enablers to supply chain integration. Bagchi and Skjoett-Larsen (2002) similarly identified that supply chain management requires various actors at all levels of hierarchy in multiple organisations to work and communicate together for achieving a common goal. The traditional supply chain value reflect poor communication practises. Communication strongly improves internally and externally until multiple contact

points at all management levels have been established (Bagchi & Skjoett-Larsen, 2002).

The final characteristic is integrated measurement systems, which are required to manage and coordinate supply chain operations. Good metrics and strong measurement systems serve to provide timely feedback that enables management to take corrective action and for superior results. These systems must track performance across the borders of internal functional areas and external supply chain partners, measuring the operations of the overall supply chain (Stank et al., 1999b). Bagchi and Skjott-Larsen (2002) developed and successfully tested a three stage performance measurement model ranging from low integration over medium to high levels of integration. Again, the traditional supply chain value reflects poor performance measurement.

2.11.3.2 Relationship management

Relationship management is concerned with the integration of key customers and suppliers. Without a foundation of effective supply chain organisational relationships, any efforts to manage the flow of information or materials across the supply chain are likely to be unsuccessful (Power, 2005). Five key integration practises have been identified and are presented in Table 2.13.

Table 2.13: Relationship management assessment

Characteristics	N/A	Traditional SC	Functional SC	Reactive SC	Seamless SC
Supplier relationship (Spekman et al., 1998)		Open market bargaining – large supplier base	Co-operation – fewer suppliers (longer contracts)	Co-ordination – information linkages	Collaboration – with supplier of choice
Customer relationship (Holweg et al., 2005)		Poor customer service	Reactive customer service	Some few major customer integration	Lasting relationships with customers of choice
Procurement (Ellram & Carr, 1994)		Reactive buying	Independent procurement	Essential business function	Internally and externally integrated function
VMI/ CPFR (Holweg et al., 2005)		Not implemented	Used only in an experimental stage	Implementation stage with a few supplier / customers	CPFR/VMI with key suppliers and customers
SC strategy (Peck & Juttner, 2000)		None	Each function individual	Company aligned	Supply chain aligned

Source: Author

Spekman et al. (1998) identified a four stage transition regarding supplier relationship management. In the first stage, supplier relationship management is immature. Companies have a strong price focus, and manage a large supplier base with predominantly adversarial relationships. As supplier relationship management practises mature, the company significantly reduces the number of suppliers and engages in longer-term contracts. The third stage is termed co-ordination. Here the focus is on information linkages with key suppliers and improvement of material and information flow. Collaboration with suppliers of choice is the final stage. Here, the focus is on optimising material and information flow with key suppliers. The terminology choice in the seamless supply chain stage points to their being no supplier dominance present in those relationships.

Holweg et al. (2005) proposed a four stage collaboration model focusing on VMI/CPFR and customer relationship management. In the traditional supply chain stage, companies purely react to customer demand; techniques like VMI and CPFR have not been implemented. The poor information flow leads to high inventory and frequent stock outs, which is associated with poor customer service. In the functional supply chain setting, customer and supplier still order independently, yet exchange demand information to overcome poor customer service. This step is frequently advertised as the first implementation of VMI and/or CPFR. In the reactive supply chain stage, key customer integration is achieved using long-term contractual agreements. VMI and CPFR practises are mature. In the seamless stage, all key customers of choice are closely linked to the focal company, with extensive information exchange and VMI/CPFR practises (Holweg et al., 2005).

Ellram and Carr (1994), propose a four stage purchasing development model. The first stage is the passive stage. Purchasing is viewed as a reactor to requests from the other departments. Many of purchasing's legitimate activities are handled by other functions outside of purchasing. In the independent stage, purchasing departments spend time to professionalise the purchasing function by introducing formalised supplier programs. In the third stage, purchasing departments are viewed by top management as essential business functions. Purchasing is expected to support and strengthen the company's competitive advantage (e.g.

providing timely information to all departments in the company about changes in price and availability of materials). In the integrative stage, the company's competitive success rests significantly on the capabilities of the purchasing department's personnel.

Mejias-Sacaluga and Prado-Prado (2002) highlight the importance of strategic alignment. To take full advantage of the supply chain approach, the supply chain strategy for key customers and suppliers need to be linked to the overall business strategy. Pagell (2004), and Peck and Juttner (2000) point out that in an ideal world, all the companies within a supply chain are committed to a single and aligned proactive strategy.

2.11.3.3 Technology integration

Ideally a company's IS system provides effective support for the functioning of the supply chain. The overall information systems architecture must be capable of linking and coordinating the information systems of the individual parties into a cohesive whole (Fawcett & Magnan, 2002). Bagchi and Skjoett-Larsen (2002) developed and successfully tested a three stage information integration model. Table 2.14 represents Bagchi and Skjoett-Larsen's model for the functional supply chain, reactive supply chain and seamless supply chain column. A fourth column (traditional supply chain) has been added reflecting a poor uptake on information systems.

Table 2.14: Technology integration assessment

Characteristics	N/A	Traditional SC	Functional SC	Reactive SC	Seamless SC
Track-and-trace system (Bagchi & Skjoett-Larsen, 2002)		No IT system being used	Bar coding of products	Increased bar-coding, automated updated with key players	Track-and-trace system throughout the supply chain
Data transfer system (Bagchi & Skjoett-Larsen, 2002)		Manual – facsimile or telephone	PC based IS (E-Mail, Internet, Extranet)	Few EDI/Internet links to customer / suppliers	Extensive use of EDI/Internet/XML links within SC
Transaction system (Bagchi & Skjoett-Larsen, 2002)		Separate independent incompatible	MRP/MRP II legacy system	ERP/DRP with MRP II / intra company / rigid interface	ERP + SC planning inter company / flexible interface

Source: Author

Track and trace systems monitor the real-time location of materials. This real-time information improves a company's response to customer questions regarding deliveries. Track and trace systems also allow those receiving goods to be prepared when materials arrive and thus to perform all the loading, unloading, and corresponding administrative work in a more efficient manner (Chopra & Meindl, 2006). The seamless supply chain has full pipeline visibility. In complete contrast, the traditional supply chain has no IT system in use (Bagchi & Skjoett-Larsen, 2002).

Electronic data interchange (EDI) technology provides suppliers with information about their production needs by giving suppliers access to production planning and control systems, vendors can then arrange deliveries without the need of any paper transaction (Gattorna & Walters, 1996). Similarly, the cash flow is optimised by timely payments using EDI. Reduction of payment delays significantly lowers the cost of doing business and makes the supply chain more efficient, and supports external integration (Bagchi & Skjoett-Larsen, 2002). The seamless supply chain makes extensive use of EDI technology, whereas the traditional supply chain typically still uses facsimile and phone.

ERP systems are primarily built on transactions-based systems, while supply chain management provides visibility, planning, collaboration, and control across and beyond the enterprise. Hence, ERP and supply chain management should be integrated to provide higher business value (Bose et al., 2008). Bose et al. further identified that the successful implementation of an ERP system resulted in a strong increase of order fulfilment as well as a considerable reduction in inventory. The seamless supply chain has a fully integrated transaction system with flexible interfaces, whereas the traditional supply chain applies separate independent and incompatible transaction systems.

2.11.3.4 People

Supply chain management requires various actors at all levels of the hierarchy in multiple organisations to work together to achieve a common goal. Managing and coordinating the human/people factor along the supply chain is therefore very

important (Trkman et al., 2007). Table 2.15 presents the six main characteristics identified in this area.

Table 2.15: People/ culture assessment

Characteristics	N/A	Traditional SC	Functional SC	Reactive SC	Seamless SC
Decision points (Towill, 1997)		Multiple decision points	Single decision point for each process	Single decision point within organisational boundary	Coordinated control from single point
Lateral organisation (Bagchi & Skjoett-Larsen, 2002)		None	Functional teams only	Cross functional teams / key account manager	Teams across the supply chain – regular interaction
Organisational structure (Harrington, 1995)		Separate almost independent departments	Discrete business functions	Less hierarchical, flat organisational structure	Process orientated organisational structure
Organisational culture (Harrington, 1995)		Defensive chief/boss watching our backs	Internal team focus. Prepared for functional trade offs	Willingness to improve. Internal trade-offs	Embrace change, understanding of external violence
Supply chain focus (Stevens, 1989)		Asset focussed / quick fix	Inbound or outbound flow / cost focus	Process flow / cost focus	Customer focus
Human resources KPI (Wisner et al., 2005)		None	Functional driven	Cross functional	Supply chain aligned

Source: Author

Towill (1997b) identified decision points as a key attribute in supply chain management. He defines decision points as points where information is brought together and acted upon. Potter et al. (2004) developed and successfully tested a four stage integration model including decision points. The traditional supply chain consists of multiple decision points. The functional supply chain has reduced these down to a single point for each process. In a reactive supply chain, a single decision point within the organisational boundary is present whereas the seamless supply chain is defined as a coordinated control from a single point (Potter et al., 2004).

Part of supply chain integration is the capability to process relevant information. One type is investment in information systems (see Table 2.14) and the other is establishment of lateral linkages. Lateral linkages could be direct contact between managers at different levels and from different functions or companies, establishing project teams (Lambert & Cooper, 2000). Those linkages provide a mechanism for decentralised general management decisions, which provides flexibility to a supply chain (Galbraith, 1994; Bagchi & Skjoett-Larsen, 2002).

Bagchi and Skjoett-Larsen developed and successfully tested a three stage lateral organisation model. Here a fourth column (traditional supply chain) has been added reflecting no lateral organisations in place.

Some researchers opine that flatter organisations work better than hierarchical ones (Cooper et al., 1997; Hammer, 2001; Harrington, 1995; Stevens, 1989). The traditional, hierarchical model of management prevalent in most enterprises drives control and efficiency by segregating business activities into standardised sub-tasks, which is represented by the traditional supply chain (Hewitt, 1994). The new principle suggests that the people who do the work should make the decisions and that the process itself can have built-in controls. Pyramidal management layers can therefore be compressed and the organisation flattened, which is represented by the seamless supply chain (Hammer, 1990).

Organisational culture also plays a role in integration. Culture is defined as the “set of values, guiding beliefs, understandings, and ways of thinking that is shared by members of an organisation and is taught to new members as correct” (Daft, 1995, p.576); it is viewed to be critical when integrating the supply chain (Christopher & Towill, 2001). A very defensive culture is present in the traditional supply chain, where individuals purely react to the given orders. In the functional supply chain, a team approach has developed, where individuals are prepared for functional trade-offs. In the reactive supply chain, individuals have developed a willingness to improve and an acceptance of change. Here, people are prepared for internal trade-offs on a company level. In the seamless supply chain, individuals embrace change and have developed an understanding for ‘external violence’ (Sirkin et al., 2005; Wisner et al., 2005).

The fifth category is supply chain focus. To achieve a high level of integration there is a need for all parties in the supply chain to change from a product and cost focus to a customer orientation (Gattorna & Walters, 1996; McAdam & McCormack, 2001). Stevens (1989) describes supply chain focus as a critical characteristic for supply chain integration. He uses a four stage supply chain integration model. In Stage 1 the supply chain has a strong asset and quick fix focus. Stage 2 is defined by an inbound or outbound flow and cost focus. Stage 3

includes the cost for the entire process, whereas Stage 4 takes a strong customer focused approach.

The final category is human resources key performance indicators (KPIs). Supply chain integration can be achieved by establishing cross-functional human resources key performance indicators (Bagchi & Skjott-Larse, 2002; Lee, 2000). Cross-functional KPIs will help to overcome the silo mentality present in many companies. Hence, it is important to align supply chain goals with the incentive system of the focal company. Performance reviews of managers should include their ability to integrate processes internally and externally and to meet overall supply chain goals (Wisner et al., 2005). In the traditional supply chain, no human resources performance indicators are present. The functional supply chain is focusing on functionally driven KPIs, whereas the reactive supply chain is represented by cross functional KPIs. Here, rewards are given to staff working successful in cross-functional teams. The seamless supply chain aligns the human resource KPIs with the overall supply chain goals (Wisner et al., 2005).

2.11.3.5 Performance Outcome

Supply chain integration is expected to improve material and information flow and hence improve the overall performance of the supply chain. Table 2.16 enables the researcher to identify the impact certain integration characteristics have on material and information flow.

Table 2.16: Outcome assessment

Characteristics	N/A	Traditional SC	Functional SC	Reactive SC	Seamless SC
Physical flow (Stevens, 1989)		Functional, uncoordinated	Fragment of coordination within company	Fully coordinated within company	Integrated across company boundaries
Inventory (Stevens, 1989)		High levels; multiple stock holding between echelons	Each company function buffered	No intermediate inventory except company boundaries	Minimal strategic inventory
Lead times (t) (Stevens, 1989)		Long storage, process and distribution	Few reduction in storage, process and distribution time	Strong reduction in storage, process and distribution time	Minimised throughout supply chain
Information flow (Bagchi & Skjoett-Larsen, 2002)		Functional, uncoordinated	Fragment of coordination within company	Fully coordinated within company	Integrated across company boundaries

Source: Author

Stevens (1989) identified four stages of supply chain integration. The traditional supply chain represents the fragmented operations within the individual company, defined by functional uncoordinated material flow, high levels and multiple stock-holding between echelons and long storage, process and distribution time. The functional supply chain is defined as having limited integration between functions. Here, a fragment of coordination within the focal company is present; inventory is buffered at each company function and a few reductions in storage, process, and distribution time are present. The reactive supply chain requires internal integration in the individual company, defined by fully coordinated material flow within the focal company, no intermediate inventory except at company boundaries and strong reduction in storage, process and distribution time. Finally, the seamless supply chain extends upstream to suppliers and downstream to customers. Material flows are integrated across company boundaries, minimal strategic inventory exists in the supply chain and the lead time is minimised (Stevens, 1989).

Bagchi and Skjoett-Larsen (2002) extended the performance outcome of supply chain integration by also focusing on integrated information flow. Here, information flows alongside the material. In Stage 1, information flows are functional and uncoordinated. Stage 2 is defined as having a fragment of coordination within the company. In Stage 3, a full coordination of information flow within the company is present. In the final stage, information flows are coordinated, even across company boundaries.

In order to verify the characteristics in Tables 2.12-2.16, the findings have been compared with Gimenez' (2004) assessment of nine manufacturers and six retailers. The results from this exercise can be seen in Appendix A.2; where the comparison highlights that there does appear to be good consistency with Gimenez's assessment.

2.12 Conclusion

The research contained in this thesis is in the field of supply chain management and, more specifically, concerns supply chain integration. The concept of supply chain management was highlighted, and an historical review of its development presented. Further, the scope of the supply chain management concept was discussed. Some different methodologies used to evaluate current supply chain practises were also presented. Here, the Quick Scan Audit Methodology has been identified as being potentially most suitable to investigate supply chain integration maturity.

The central focus of the literature review is the concept of supply chain integration. The literature identified three 'layers of confusion' regarding supply chain integration. The first layer is the range of the integration concept; some authors include internal integration, others solely focus on external integration. The second layer is introduced by the industry focusing on different supply chain integration practises. Finally, academia adds to the confusion around the concept of supply chain integration by focusing on selected small areas of supply chain integration. The three layers of confusion combined highlight that the concept of supply chain integration is ill defined and not well understood. The literature lacks a common, universal view of supply chain integration. The confusion around the supply chain integration topic also reflects the different views of supply chain management by different researchers (Mann et al., 2008). The author's view on the supply chain integration concept has been described and another definition has been added to the literature; one which the author judges to be very valuable for the understanding of supply chain integration.

Barriers to, and enablers of, supply chain integration were highlighted because academia has already identified that removal of barriers is critical for integration of the supply chain. As a consequence brief mention was made of change management within the supply chain. Finally, the conceptual model of the supply chain integration evaluation tool was presented. This tool enables the researcher to map out the current level of supply chain integration in practise and the impact of change initiatives on supply chain integration. This tool also represents the

author's understanding and scope of the concept of supply chain integration. A main purpose of this chapter was to identify the present shortfalls and thus the areas requiring further research. As a result, six research questions in the area of supply chain integration have been formulated. These are considered in further detail in the following chapter, "Research Problem Definition".

3. Research Problem Definition

3.1 Introduction

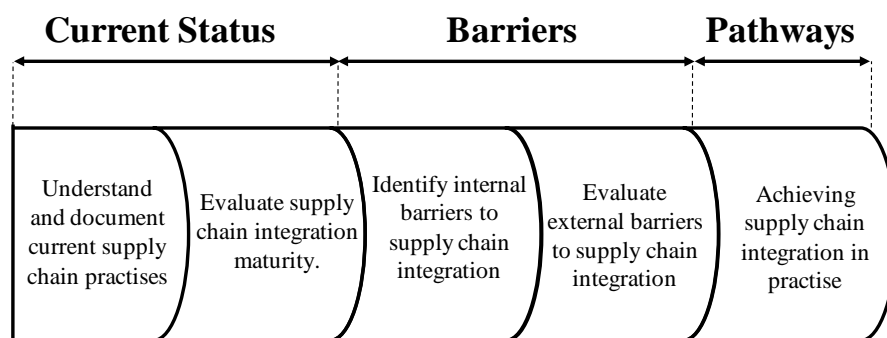
Research into supply chain integration is a fundamentally important area for current research because integration is claimed by many authors to be a supply chain Utopia synonymous with supply chain management excellence. The effective management of supply chains requires integration of business processes internally within an organisation and externally across suppliers and customers. The majority of supply chain integration research addresses the relationship between integration and performance (e.g. Frohlich & Westbrook, 2001). There is far less research on how to achieve integration internally as well as with suppliers and customers, and what research does exist tends to look at a specific factor such as the use of information technology (e.g. Narasimhan & Kim, 2001) or a single set of purchasing practises (e.g. Anasai et al., 1999). The present research is a comprehensive study on how supply chain integration is actually achieved in practise, including factors that enable and inhibit integration. This thesis aims to close this research gap in understanding, by identifying what routes and means companies take to integrate their supply chain.

However, a PhD is constrained by time and resources which means that a thesis cannot consider all factors and variables. Instead, the most influential and most relevant factors must be identified and the boundaries of the research problem specified in order to provide a manageable focus. Thus, the purpose of this chapter is to provide a clear definition of the research questions. The objective of this thesis is stated, together with a proposed procedure for investigating the identified research questions. Chapter 2.8.2 clearly expressed the author's view on supply chain integration. The research questions raised in the literature review are considered in the context of this procedure. Finally, the scope and boundaries of the thesis are defined in order to illustrate which factors are to be considered in depth and which factors are peripheral, yet may still influence any conclusions drawn from the thesis.

3.2 Procedure for investigating supply chain integration

Figure 3.1 illustrates a five step procedure for investigating pathways to supply chain integration. The objective of the first two steps is to evaluate the current status of a focal company's supply chain. This involves a thorough understanding and documentation of current practises and the resultant evaluation of supply chain integration maturity. Once the current status is identified, barriers to internal and external integration need to be investigated. This step is necessary to fully understand why the focal company chose a certain route as well as to understand which barriers are addressed to integrate the supply chain; barriers are identified as being crucial when integrating the supply chain. Once the current status and the key barriers are established, longitudinal studies allow the researcher to investigate how companies achieve supply chain integration in practise.

Figure 3.1: Five step procedure to investigate supply chain integration in practise



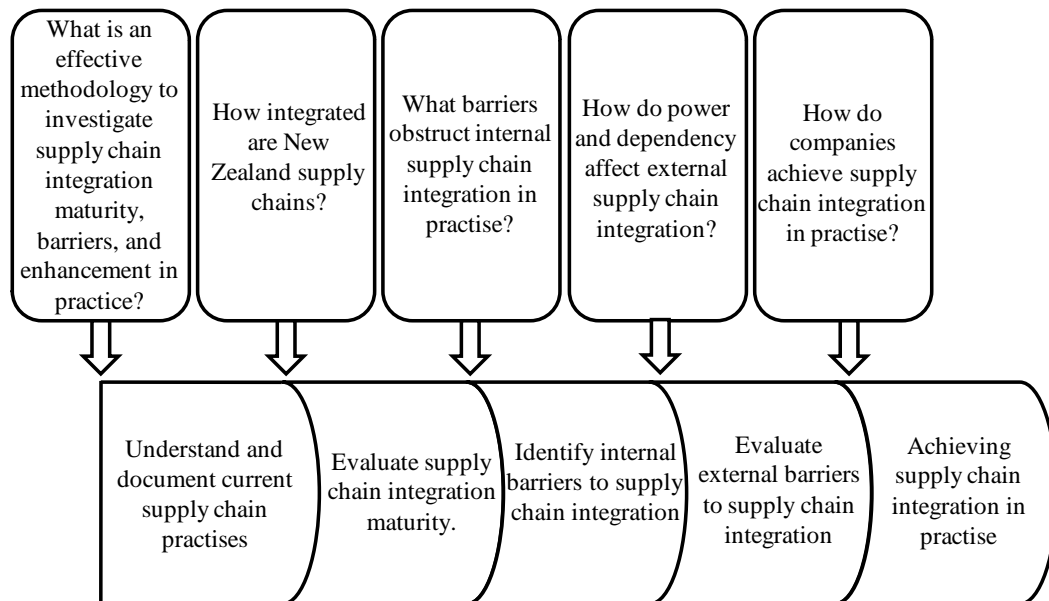
Source: Author

The five step procedure illustrated in Figure 3.1 forms the backbone of this thesis. All of the research contained within this thesis is aimed at investigating each of these five steps so as to investigate the pathways to supply chain integration. Hence, the overarching research question is: What routes do companies follow when integrating their value streams? The procedure proposed in Figure 3.1 also provides the practitioner with guidance when aiming to integrate their own supply chain, by providing unique supply chain assessment techniques for each of the five steps.

3.3 Research Questions

All of the research questions raised have been previously identified in the literature review chapter. Each one is specifically related to one of the five steps illustrated in Figure 3.1; hence Figure 3.2 presents a summary of the research questions in relations to the proposed five step procedure.

Figure 3.2: Order of research questions addressed in this thesis



Source: Author

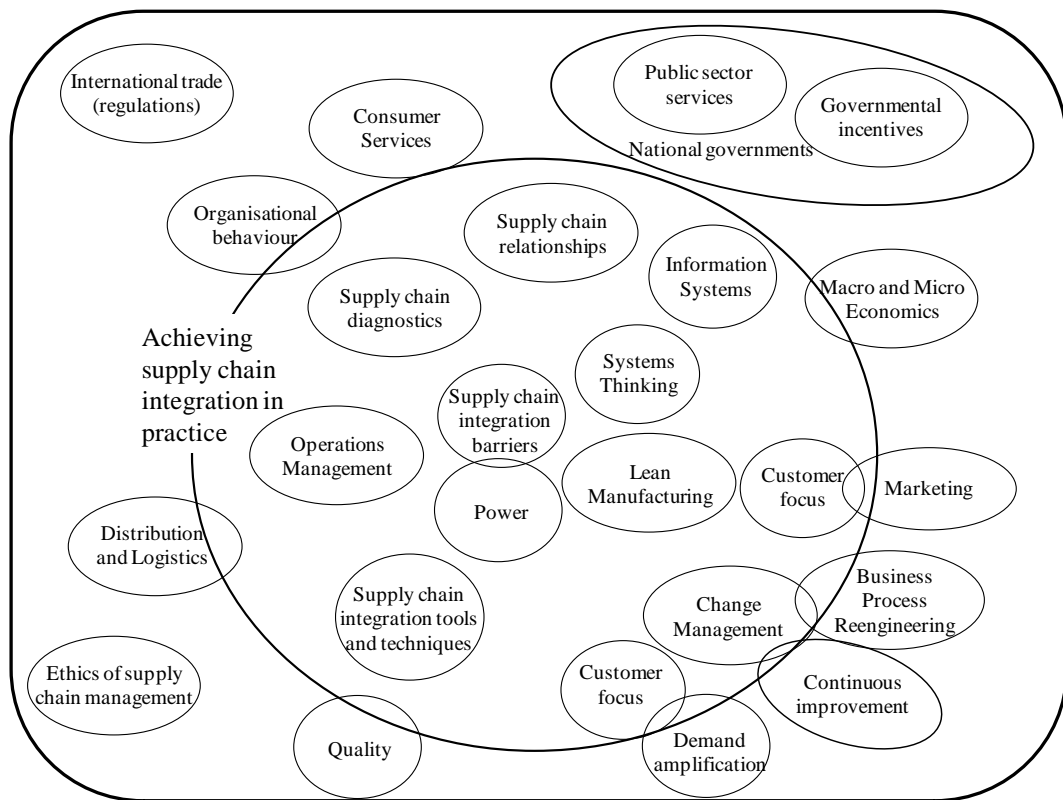
The lack of a systematic procedure for evaluating current supply chain practises and pathways to supply chain integration in the literature raises the first research question. Once the most suitable methodology to investigate this has been identified and further developed to suit longitudinal case studies, it can be applied to case companies. Here the focus is on the identification of the current status of supply chain maturity. Additionally, there is a need to investigate the barriers to supply chain integration because the removal of barriers has been identified as being of vital importance when aiming to integrate a focal supply chain. Supply chain integration barriers can occur internally and externally. Hence, two distinct research questions have been raised addressing each integration area. The research question regarding the state of internal integration is a result of the findings on the current stage of supply chain integration in New Zealand. However, Cox, (2001) and van der Vaart and van Donk (2004) both identified that the key barrier to

external integration is power and dependency. Hence, the effects of power and dependency on external integration are examined. Once the current state of supply chain integration is identified and the barriers are understood, research can address the overarching research question: What routes do companies follow when integrating their value streams? This research question was first raised by Frohlich and Westbrook (2001) in their award winning paper, ‘Arcs of integration: An international study of supply chain strategies’. Until now, there has been no clear answer on the routes companies choose. Hence, this research makes an early attempt to investigate the identified research gap. The methodological approach most suitable to answer that question involves longitudinal case studies.

3.4 Scope and boundaries of the thesis

A PhD inevitably has boundaries; it is constrained by a number of factors, including time, finances, and competencies. Therefore, there is a limit to the scope of the research undertaken. Figure 3.3 illustrates all the major factors covered by the thesis, together with some of the most influential factors that fall outside the scope of the research and which could have an effect on any conclusions drawn. There are also a number of factors that are considered but not totally covered by the thesis. These are represented in Figure 3.3 as small overlaps with the central theme of pathways to supply chain integration.

Figure 3.3: Scope and boundaries of the thesis



Source: Based on Childerhouse, 2002

This thesis views supply chain integration as involving two dimensions: internal and external integration. Internal integration is closely linked to operations management, lean manufacturing, and change management in the form of continuous improvement and business process reengineering. External integration focuses on external relationships and the concepts of power and dependency. Topics such as supply chain best practise, information systems, and barriers to supply chain integration belong to both dimensions.

Supply chain diagnostics definitely come within the scope of the thesis. One especially strong supply chain diagnostic method, the Quick Scan Audit Methodology, is outlined in Chapter 4.8.1. This method is strongly anchored within the systems thinking paradigm. Further, each findings chapter includes a model capable of assessing aspects of supply chains. Chapter 5 applies the uncertainty circle to assess supply chain maturity; Chapter 6 contains a ‘barrier to supply chain integration’ assessment model; Chapter 7 measures power and

dependency in external relationships, and finally Chapter 8 maps the potential pathways to supply chain integration.

Business process re-engineering (BPR) is not specifically covered by the thesis, although a few BPR principles in relation to change management are used. The same is true of continuous improvement. The quest for further integrating the supply chain (Towill, 1997b) lies at the heart of the research. Although demand amplification (also termed Bullwhip effect) is not covered in any great detail, it is considered in relation to optimised material and information flows.

Only a limited amount of micro- and macroeconomics is considered. Chapter 6 includes environmental factors that can create a barrier to supply chain integration, such as access to a qualified labour market, which belongs to the macroeconomics discipline. The fully integrated, seamless supply chain results in a strong customer focus. Therefore, a number of principles from the field of marketing have been used in the research. Marketing is a wide field of research, hence only particular areas have been fully considered in the research. Similarly for the field of organisational behaviour. Chapter 6 addresses barriers to supply chain integration and identifies culture and people barriers as key barriers to internal integration, which is also strongly linked to psychology and organisational behaviour studies.

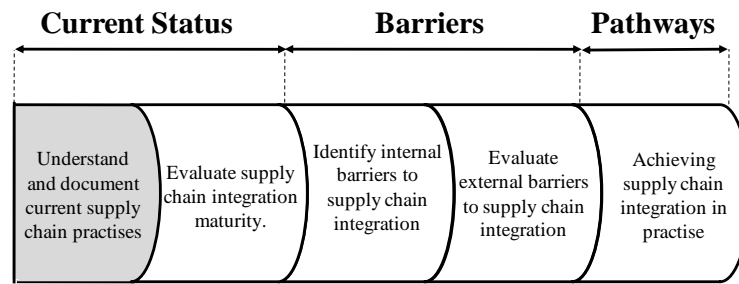
While academia acknowledges the importance of integrated distribution and logistic systems (Gattorna & Walters, 1996; Gimenez, 2006; Stank et al., 1999b), this thesis does not have any particular focus on this topic. The same holds true for quality. However, arguably one positive outcome of supply chain integration is an increase in quality (Maloni & Benton, 2000).

Three further factors that fall outside the thesis require explanation. Firstly, the ethics of supply chain management are not considered, even though they could have a major effect on any research conclusion. Secondly, national governments can have a major effect on supply chains. For instance, incentives may encourage development within a specific region or industry, which could therefore result in

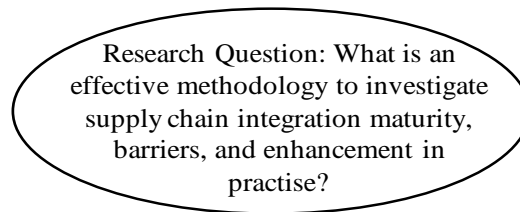
distorted perception of the supply chain integration concept. Thirdly, international trade regulations are not considered when investigating supply chain integration.

3.5 Conclusion

A five step procedure has been proposed to investigate pathways to supply chain integration. By dividing the problem into five stages, manageable problems that can be individually tested have been identified. The overarching research question regarding routes to supply chain integration was presented. Further, this chapter highlighted why the current status and barriers to supply chain integration need to be assessed prior to the investigation into how supply chain integration is actually achieved. The boundaries of the research have been clearly stated and those factors outside its scope will not be considered further. Next, the research methods chosen to investigate into the identified research questions are justified.



4. Research Methodology



4.1 Introduction

Research methods are the data collection techniques which refer to the specific, fact-finding procedures that yield information about the research phenomenon (Mentzer & Kahn, 1995; Frankel et al., 2005). The quality of research needs to be ensured by constructive critical reflection on knowledge production, its scope, and the extent of its significance (Lalle, 2003). This proceeding is known as epistemology, and is crucial to any research because a good theory is the only valid basis for practitioners (Aram & Salipante Jr., 2003).

Chapter 4 embeds the research conducted into the wider ontological, epistemological, and methodological setting and provides justification for the case study approach applied in this thesis. Further, Chapter 4 explains the data collection technique applied, specifically, the Quick Scan Audit Methodology (QSAM). The QSAM provides a consistent rigorous assessment of current supply chains practises that yields rich research data. The application of the QSAM to New Zealand supply chains has enhanced the generalisability of the method. Further, a rigorous adaptation of the QSAM has been developed to make it suitable for longitudinal case studies. A methodological approach for the investigation of power and dependency in external relationships is also presented.

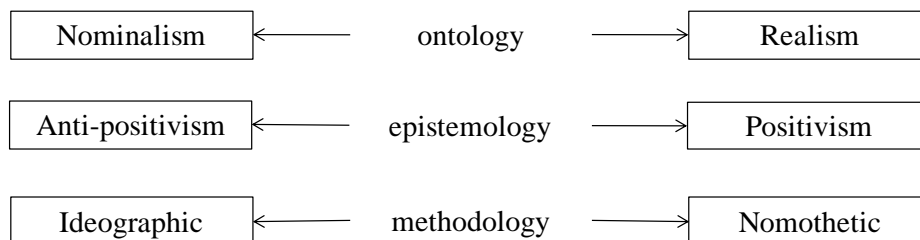
Chapter 4 begins by explaining different paradigms before matching the research question with the methodological approach. Then, a literature review of case study research is presented, followed by an in-depth explanation of the QSAM. Finally, the chapter presents the limitations of case study research and how those limitations have been addressed.

4.2 Paradigms

Different paradigms exist to generate knowledge. A paradigm is the researcher's world-view or *Weltanschauung* and includes the following three elements: epistemology, ontology, and methodology (Denzin & Lincoln, 1994). Epistemology deals with how one perceives the world, and the relationship between the researcher and the known. According to Burrell and Morgan (1985), epistemology deals with how one might understand the world and communicate this as knowledge to others. Ontology focuses on the basic questions about the nature of reality – whether an objective really exists or not (Naslung, 2002). Epistemological and ontological assumptions consequently influence methodological decisions. Basically, methodology focuses on how one gains knowledge about the world.

Figure 4.1 illustrates the difference between positivist and non-positivist paradigms in a simplistic way.

Figure 4.1: The subjective-objective dimension



Source: Burrell & Morgan, 1985

Positivists believe that an “objective” world, or an objective reality, exists. Consequently, reality can be studied using objective methods. Typically, quantitative methods such as surveys and mathematical/statistical analysis are

used. Quantitative research seeks general laws and studies tend to emphasize the measurement and the analysis of causal relationships between variables. The growth of knowledge is a cumulative process (Naslund, 2002). New knowledge is added to existing knowledge and false hypotheses are eliminated. Positivists apply four quality criteria to research (van der Vorst & Beulens, 2002):

- (1) Internal validity: The degree to which findings correctly map the phenomenon in question;
- (2) External validity: The degree to which findings can be generalised to other settings similar to the one in which the study occurred;
- (3) Reliability: The extent to which findings can be replicated, or reproduced, by another inquirer; and
- (4) Objectivity: The extent to which findings are free from bias.

Qualitative researchers, on the other hand, belong to many different paradigms (Naslund, 2002). However, a common theme amongst qualitative researchers is the rejection of positivism and its perception of objectivity. Thus, in general, qualitative researchers are more interpretive and subjective in their approach. This anti-positivist approach states that the world is essentially relativistic and thus one must understand it from the inside rather than the outside. It can only be understood from the point of view of the individuals who are directly involved in the activities which are to be studied (Denzin & Lincoln, 1994). Knowledge is created by representing the way the world actually is. Within this view of the world, the goal is to construct a theory of the stable and universal relationship between parts of the system under study. Table 4.1 summarises the main differences between Positivism and Interpretivism focusing hereby on goal, people, research finding, and self perception.

Table 4.1: Comparison of Positivism and Interpretivism

	Interpretivism	Positivism
Aim	to understand a phenomenon, but not explain or predict. To analyse the world and to understand the basis for action within such perspectives without holding the pretence that these views are objective representations of reality	to explain and predict reality, where reality is considered to be objective, tangible, and fragmentable
People	are considered to be proactive and voluntaristic	are considered to be deterministic and reactive
Research findings	are considered time-specific, contextual, and idiographic, and causality is unattainable	are considered value-free, time-free, and context independent, with the general agreement that causal relationships can be discovered
Self perception	is interactive, cooperative, and lacking a privileged point of observation	is separate from the research setting and at a privileged point of observation

Source: Adapted from Aram & Salipante Jr., 2003; Mentzer & Kahn, 1995

4.2.1 Paradigms applied in supply chain management research

Traditional logistics and supply chain management researchers tend to belong to the positivist paradigm (Eisenhardt, 1989). This approach is still very prevalent in today's management research. Mentzer and Kahn (1995), for example, reviewed the articles published in the *Journal of Business Logistics* between 1978 and 1993 and identified that 50% of all publications were survey based. Case study research accounted only for 3.2%. In 2005, Kotzab followed up on Mentzer and Kahn's study and found that 40% of all publications were still survey based. Seuring (2005) instead focused on two distinct areas of supply chain management: (1) sustainable supply chain management, and (2) supply chain performance management. The study covered the period from 1990 to 2005. The topic of supply chain performance management is also dominated by survey methods (42%) where case study research only accounts for 11%. However, the field of sustainable supply chain management is different. Case studies account for up to 40%, whereas the survey method accounts for only 25%. Finally, Carter and Ellram (2003) studied 35 years of publication in *The Journal of Supply Chain Management*. They identified that the dominant type of primary research design employed is mail survey (approximately 60%); case study research only accounted for approximately 18%. The dominance of surveys indicates that a

positivist paradigm and, thus, mainly quantitative methods, are preferred by supply chain management researchers.

However, supply chain management deals with a complex environment. Each layer and component subsystem adds complexity that makes generalisations more difficult to substantiate. This complexity creates barriers to developing well-substantiated theories (Stuart et al., 2002). Supply chain management also lacks well-developed measures and standards that would make inter-organisational comparisons easier. Hence, many authors conclude (Frankel et al., 2005; Mentzer & Kahn, 1995; New & Payne, 1995; Seuring, 2005; Westbrook, 1994) that supply chain management problems are often unstructured, even messy, real-world problems. The authors suggest that to gain relevance for supply chain researchers, “a one paradigm, one approach” perspective should not automatically be the obvious choice (Frankel et al., 2005; Mentzer & Kahn, 1995; New & Payne, 1995; Seuring, 2005; Westbrook, 1994).

In order to accurately describe, truly understand, and begin to explain these complex phenomena, supply chain scholars are calling for more research using case studies because case study research is flexible in terms of paradigms (Christensen & Raynor, 2003; Mouritsen et al., 2003; McCarthy & Golicic, 2005; Burrell & Morgan, 1985; Denzin & Lincoln, 1994). However, the process to identify the methodology that best suits the research phenomenon and achieve rigour is, amongst other things, highly dependent on the research questions (Naslund, 2002; McCarthy & Golicic, 2005; van Donk & van der Vaart, 2005a).

4.3 Research Questions

The type of research strategy used depends on the following three conditions: the type of research question posed, the extent of control an investigator has over actual behavioural events and the degree of focus on contemporary as opposed to historical events (Yin, 1994). Table 4.2 displays these three conditions and shows how each is related to the five major research strategies in social science: experiments, surveys, archival analysis, histories, and case studies (Yin, 1994).

Table 4.2: Relevant situations for different research strategies

Strategy	Form of research question	Requires control over behavioural events?	Focuses on contemporary events?
Experiment	how, why	yes	yes
Survey	who, what where, how many, how much	no	yes
Archival analysis	who, what, where, how many, how much	no	yes/no
History	how, why	no	no
Case study	how, why (key)	no	yes

Source: Yin, 1994

The overarching research question in this thesis is:

- How do companies achieve supply chain integration in practise?

Further research questions are:

- What is an effective methodology to investigate supply chain integration maturity, barriers, and enhancement in practise?
- How integrated are New Zealand supply chains?
- In what ways do companies pursue supply chain integration in practise?
- What barriers obstruct internal supply chain integration in practise?
- What is an appropriate technique to measure power and dependency across inter-organisational boundaries?
- How do power and dependency affect external supply chain integration?

The overarching research question focuses on the change processes that occur in a focal company to further integrate the supply chain. Naslund (2002) clearly points out that if research attempts to study change in organisations, surveys is not the most appropriate form. Also, the objective is to explore and understand how companies achieve supply chain integration. Due to limited empirical evidence, it is too early to develop testable hypothesis; thus, this research is exploratory in nature. Further, the research questions identified are predominantly ‘how’ and ‘why’ questions. Yin (1994) suggests case study methodology is well suited to

meet the requirements of answering ‘why’ and ‘how’ questions such as the ones raised in this thesis that examine contemporary phenomena in context, and where control over behavioural events is not required. In this research, the boundaries (factors which may influence supply chain integration) are still relatively unclear.

Supply chain management is a relatively new research area that lacks well-developed measures and standards; yet exploratory research is under represented within the supply chain management literature. These factors point to case study research as being the primary candidate for the present research. Next, case study research and the form of its application are presented in detail.

4.4 Case study research

Case study research has its roots in the broader field of social sciences, in particular ethnographic studies and anthropology (Voss et al., 2002). Kurt Lewin was the developer of field theory, which, among other things, emphasizes the importance of understanding the total situation rather than abstracting a few measurable variables from a situation (Westbrook, 1994). Although case studies are typically considered to be qualitative studies, they are not necessarily only qualitative and quantitative methods may be appropriate too. Thus, case studies can be based on both qualitative and quantitative evidence (Yin, 1994; Naslund, 2002).

A case study is an objective, in-depth examination of a contemporary phenomenon where the investigator has little control over events (Yin, 1994). This definition covers several significant points. First, the study typically involves one or more researchers gathering a considerable volume of data from within an organisation, to develop the clearest possible picture of the phenomenon. The data may come from primary sources (such as direct observations or interviews of people involved) or secondary sources (documents or records, for example). It may examine a single situation or, with multiple-case studies, several related situations. Second, case study research generally focuses on current conditions, using historical data primarily to understand or substantiate the information gathered about the ongoing situation. Third, the researcher usually has little or no

capability for manipulating events (in contrast to action research, where the researcher is involved as a participant and director of events in a natural setting) (McCutcheon & Meredith, 1993). Benbasat et al. (1987) summarise case studies as having eleven characteristics:

- 1) Phenomenon is examined in a natural setting;
- 2) Data are collected by multiple means;
- 3) One or few entities (person, group or organisation) are examined;
- 4) The complexity of the unit is studied intensively;
- 5) Case studies are more suitable for exploration, classification and hypothesis development stages of the knowledge building process; the investigator should have a receptive attitude towards exploration;
- 6) No experimental controls or manipulation are involved;
- 7) The investigator may not specify the set of independent and dependent variables in advance;
- 8) The results derived depend heavily on the integrative powers of the investigator;
- 9) Changes in site selection and data collection methods could take place as the investigator develops new hypotheses;
- 10) Case study research is useful in the study of 'why' and 'how' questions because these deal with operational links to be traced over time, rather than frequency or incidence; and
- 11) The focus is on contemporary events.

Deriving from this summary, four key strengths of case study research can be identified (Meredith, 1998; Voss et al., 2002).

- The study of the phenomenon in its natural setting leads to relevant theory generated from the understanding gained through observing actual practises.
- Answering why and how questions enables the researcher to develop a relatively full understanding of the nature and complexity of the complete phenomenon.
- The case method lends itself to early, exploratory investigations where the variables are still unknown and the phenomenon not at all understood.
- The case method is flexible in terms of number of researchers and scope.

In total, four types of case study are identified in the literature: single, multiple, retrospective and longitudinal. Table 4.3 presents the advantages and disadvantages of each type.

Table 4.3: Choice of number and type of cases

Choice	Advantages	Disadvantages
Single case	Greater depth	Limits on generalisability of conclusions drawn. Biases such as misjudging the representativeness of a single event and exaggerating easily available data.
Multiple cases	Augment external validity, help guard against observer bias.	More resources needed, less depth per case.
Retrospective / historical cases	Allow collecting data on historical events	May be difficult to determine cause and effect, participants may not recall important events.
Longitudinal cases	Overcome the problems of retrospective cases	Have long elapsed time and thus may be difficult to do.

Source: Voss et al., 2002

The single case is particularly appropriate for completely new, exploratory investigations, and the multiple case study is appropriate when there is some knowledge about the phenomenon but much is still unknown (Meredith, 1998; Seuring, 2005). But while single-case studies can richly describe the existence of a phenomenon, multiple-case studies typically provide a stronger base for theory building (Yin, 1994). The theory is better grounded, more accurate, and more

generalisable when it is based on multiple case experiments. The third form of case study research is retrospective cases. This form of case study research focuses on the collection of data on historical events and is consequently not very widespread in supply chain management research. A longitudinal case study can be particularly valuable in supply chain management research. One of the most difficult but most important issues academia tries to identify in research is the relation between cause and effect. The longer the period over which phenomenon are studied, the greater the opportunity to observe at first hand the sequential relationships of events (Voss et al., 2002). The type of case study, again, is highly dependent on the purpose of the research and hence dependent on the research question(s). Table 4.4 presents multiple purposes of case study research and the related research question.

Table 4.4: When to use case study research

Purpose	Research question	Type of case
Exploration Uncover areas for research and theory development	Is there something interesting enough to justify research?	In-depth case studies Unfocused, longitudinal field study
Theory building Identify/describe key variables Identify linkages between variables Identify why these relationships exist	What are the key variables? What are the patterns? Why should these relationships exist?	A few focused case studies In-depth field studies Multi-site case studies Best-in-class case studies
Theory testing Test the theories developed Predict future outcomes	Are the theories able to survive the test of empirical data?	Experiment Multiple case studies Large scale samples
Theory extension/refinement To better structure the theories in light of observed results	How generalisable is the theory? Where does the theory apply?	Experiment Case studies Large scale sample

Source: Adapted from Handfield & Melnyk, 1998

Table 4.4 shows that case study research is not only good at investigating how and why questions, but also it is particularly suitable for developing new theory and ideas and can also be used for theory testing and refinement (Voss et al., 2002). Table 4.5 puts the identified research questions for this thesis in perspective, regarding purpose and research structure.

Table 4.5: Purpose of the identified research questions

Research Question	Purpose	Research structure
How do companies achieve supply chain integration in practise?	Exploratory	Multiple longitudinal field studies
What is an effective methodology to investigate supply chain integration maturity, barriers, and enhancement in practise?	Theory extension/ refinement	Multiple case studies
How integrated are New Zealand supply chains?	Theory testing/ refinement	Multiple case studies
In what way do companies pursue supply chain integration in practise?	Theory testing/ refinement	Multiple case studies
What barriers obstruct internal supply chain integration in practise?	Theory building	Multiple case studies
What is an appropriate technique to measure power and dependency across inter-organisational boundaries?	Theory building	Multiple case studies
How do power and dependency affect external supply chain integration?	Theory building	Multiple case studies

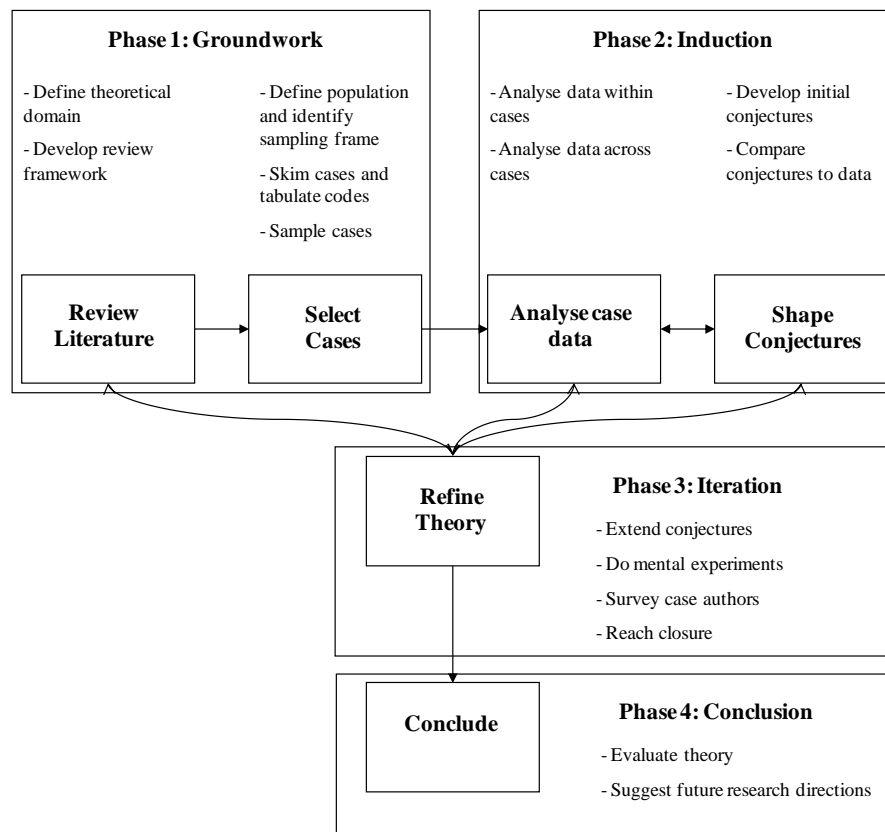
Source: Author

Table 4.5 highlights that this thesis aims for multiple purposes. The overarching research question is truly exploratory, whereas the remaining research questions predominantly focus on theory testing, building, or refinement. The research structure for each research is identical, using multiple case studies. Next, the different phases of conducting multiple case studies are described.

4.5 Methodological process within case study research

Multiple case study research constitutes a continuous cycle of interaction between theory and practise, ensuring that case study research is both rigorous and relevant (Lalle, 2003). Figure 4.2 outlines the methodological process applied in this thesis.

Figure 4.2: Applied methodological process



Source: Lewis, 1998, p.459

Figure 4.2 shows four phases within the methodological process consisting of six different steps. Next, each phase is explained in detail.

Phase 1: Groundwork

Phase 1 includes two major steps, (1) literature review and (2) case selection. A literature review is a valid approach, as it is a necessary step in structuring a research field and forms an integral part of any research. Seuring and Mueller (2007) classified literature review as an archival research method. Further, conceptual frameworks have been developed based on an in-depth literature review. The conceptual models developed for this thesis are highlighted in Chapter 2.11.3, Figure 6.1, Figure 7.1, Figure 8.1 and Figure 8.2. Phase 1 further consists of case selection, which is crucial because the population defines the set of entities from which the research sample is to be drawn.

Phase 2: Induction

The second phase also consists of two major steps, (1) analysis of case data and (2) shaping of conjectures. Case data can be analysed from two distinct angles, first the analysis of the data within cases and the cross case analysis. Once the data is analysed, propositions, hypothesis or conjectures are developed and constantly compared with the analysed data.

Phase 3: Iteration

Phase 3 focuses on the refinement of theory. The quality of research needs to be ensured by constructive critical reflection on knowledge production, its scope, and the extent of its significance. Further, the new theory needs to be anchored into the literature. If closure cannot be reached further analysis needs to be undertaken. Reaching closure is the predecessor for the conclusion phase, where the new theory is evaluated.

Phase 4: Conclusion

Phase 4 is the conclusion phase. Future research directions are also identified in this phase.

This thesis applies Lewis's (1989) framework for knowledge development. Chapter 2 presented the in-depth literature review including two conceptual models developed by the author. Next, the case selection is presented in order to complete Phase 1 of the initial research.

4.6 Case selection

The case selection is crucial because it defines the limits for generalising the findings (Eisenhardt, 1989). Stuart et al. (2002) point out that the case study method is often chosen to identify a relationship or effect, not to describe an average effect; hence cases are often not aimed at being representative, but rather exemplary. The researcher does not need to assume that what is observed is truly representative of all similar situations. Site selection should be guided more by diversity and the site's potential to help contribute to the research objectives rather than by any concern for randomness. Hence, when building theory from case

studies, case selection using replication logic, rather than sampling logic, should be used (Yin, 1994). Each case should be selected so that it either:

- Predicts similar results (a literal replication); or
- Produces contrary results but for predictable reasons (a theoretical replication) (Voss et al., 2002).

Eisenhardt (1989) further argues that a number between four and ten cases usually works well. With fewer than four cases, it is often difficult to generate theory with much complexity, and its empirical grounding is likely to be unconvincing. With more than ten cases, it quickly becomes difficult to cope with the complexity and volume of data (Eisenhardt, 1989).

4.6.1 Background of selected cases

In total, eleven different companies from a variety of industries are included in this thesis. The selected companies vary in size, industry setting, and production process.

Food 1

Food 1 is part of the process industry and has been manufacturing food products in New Zealand for more than 70 years. The New Zealand business employs around 1,900 people, of which approximately 350 are temporary or casual. Food 1 operates three production centres in New Zealand. The company processes and distributes a wide range of food and covers a total of approximately 1600 different product lines. Food 1's supplier base is strongly locally focused and produces food products for domestic and export markets. Food 1 is part of a globally operating food processor. The scope of the Food 1 research included three value streams produced at two North Island production facilities, evaluation of the supplier base, and a longitudinal study.

Food 2

Food 2 is also part of the process industry. The company is one of New Zealand's largest importers, manufacturers and marketers of nuts, dried fruits, snacks, cereals and confectionery products. The company was founded in 1984. From

small beginnings, the company now employs 180 full time and 100 part time staff. Food 2's manufacturing capabilities include nut roasting and flavouring, dry blending, oven roasting and packaging finished food products. Food 2 operates with a strong international supplier base and a domestic customer base. The scope of the Food 2 research comprised evaluation of the supplier base only.

Dairy 1.

Dairy 1 is an independent co-operative dairy company owned by its farmer shareholders. It has a history of more than 60 years of dairy production. Currently, Dairy 1 employs over 240 personnel at two different locations. Each year the company processes more than 400 million litres of milk supplied by more than 380 farms. The milk is processed into milk powder, protein, milk fat products and nutritional products. The majority of Dairy 1's manufactured goods are marketed internationally to over 40 different countries with 10-20% sold domestically. The scope of the Dairy 1 research included three major value streams, the evaluation of the supplier base, and a longitudinal study.

Dairy 2

Dairy 2 is New Zealand's largest dairy producer and one of the top six dairy companies in the world. Dairy farmers are also the main shareholders. The company operates with production sites all over the country, employing approximately 16,400 staff members. The major process steps are milk pasteurisation, separation, drying, packaging and distribution. Dairy 2's global supply chain stretches from New Zealand farms to customers and consumers in more than 140 countries. The scope of the Dairy 2 research consisted of the evaluation of the supplier base only.

Manufacturer 1

Manufacturer 1 is part of a wider group, that operates predominantly in New Zealand. The company was established over 110 years ago to provide specialist services to the dairy industry. It is privately owned and specialises in stainless steel and high alloy fabrication. Over the decades it has extended the initial core business to design, development, manufacture, installation and commissioning of stainless steel vessels and processing plant. Manufacturer 1's customer base is

predominantly within Australasia. The scope of the Manufacturer 1 research included two value streams produced at plants on the east coast of New Zealand's North Island.

Manufacturer 2

Manufacturer 2 is a medium-sized company in the central North Island and is a wholly owned subsidiary of a European-based corporation. The New Zealand-based sister company develops and produces a medium sized machine deployed in construction sites. The major process steps are sheet metal cutting, welding, machining, painting and final assembly. Approximately 90% of all products are shipped to globally established corporate owned sales offices. The key suppliers are predominantly local, medium-sized businesses. Currently, Manufacturer 2 is transforming from a project-driven production environment into a lean manufacturing batch production. The scope of the Manufacturer 2 research included two value streams, the evaluation of the supplier base, and a longitudinal study.

Steel

Steel is one of the largest and longest established engineering works in New Zealand and is wholly owned by an American investor group. The company employs approximately 130 personnel in heavy engineering. Steel operates an iron, steel and non-ferrous foundry, backed by patternmaking and laboratory facilities. The range of general engineering products manufactured by Steel covers a wide spectrum and includes the design and manufacture of special purpose machinery and components for a wide range of industries. Steel's end to end supply chain was predominantly domestic focus. Nowadays, the company attracts an increasing number of global customers. Many products are highly customised, one-off productions that are treated as individual projects. The scope of the Steel research included two value streams and evaluation of the supplier base.

Retail

Retail was introduced to New Zealand more than 30 years ago via 15 hardware retailer stores nationwide. The group is originally from Australia. Currently the group operates over 120 stores throughout New Zealand and follows the franchise

concept where each store is owned individually. The major value adding steps from a supply chain management perspective include retail display and inventory control. The scope of the Retail research comprised of an interview with one branch manager on the east coast of New Zealand's North Island.

Storage

Storage is a small medium-sized New Zealand-based company. The business is employing approximately twenty staff members at their three storage facilities, all positioned in the central North Island. Hence, Storage's end to end supply chain is locally (New Zealand North Island) focused only. Storage is a service provider that stores predominantly frozen and chilled food items. One of the key customers (approximately 50% of the revenue) hires storage to act as a buffer between market demand and supply. The scope of the Storage research comprised one value stream belonging to Storage's key customer.

Forestry

Forestry is a large pulp and paper manufacturer. Forestry is a wholly owned subsidiary of a New Zealand-based corporation. This corporation is one of New Zealand's larger manufacturers. It produces a broad range of forestry products at several manufacturing sites in New Zealand and Australia, with nearly 60 percent of revenue earned in overseas markets. Currently, the corporation is undergoing a major restructuring process. In 2004, Forestry implemented a supply chain management function to better control its production processes. Forestry is operating with a large supplier base, supplying Forestry with wood, chemicals, energy and a large group of maintenance parts. Pulp and paper are both stored at the plant and at several warehouses in New Zealand and China. The outbound logistics has been outsourced to a third party logistics provider. Paper is predominantly made to order; pulp is made to stock. The scope of the Forestry research included both value streams, the evaluation of the supplier base, and a longitudinal study.

Service

Service is part of the public sector providing healthcare. It is responsible for planning, funding, providing and monitoring health and disability services for the region. Hence, the customer base is domestic/regional only. With a budget of more than \$700 million, Service provides or buys the health and disability support services that meet the needs of the community. The major value adding processes from a supply chain management perspective include purchasing, internal transfer of material, material replenishment and inventory control. The scope of the Service research included four value streams at the major health facility in the operating region.

In summary, a large amount of primary data was extracted from eleven different case companies. The eleven case companies belong to four different industry sectors. The case companies were selected based on arguments by Yin (1994) and Voss et al (2002) that cases should be selected that either: (a) predict similar results; or, (b) produce contrary results but for predictable reasons. Food 1 was selected based on its reputation for advanced supply chain management practises. Dairy 1 and Forestry were studied to gain a greater insight into New Zealand's process industry. Manufacturer 1, Manufacturer 2, and Steel represent a part of New Zealand's manufacturing sector. This allows for comparison of two different industry sectors within New Zealand. Retail, Storage, and Service further broaden the industry sector scope. The two remaining cases: Dairy 2 and Food 2, were chosen based on their power position within the supply chain. Dairy 2 is the largest dairy company in New Zealand and was expected to have a strong power position, whereas Food 2 is a small medium-sized enterprise, predominantly sourcing from overseas and therefore was expected to have a weak power position within the supply chain. Table 4.6 provides a summary of the eleven selected cases including their contribution to this thesis. Next, the role of the researcher in case studies is determined.

Table 4.6: Summary of the cases and the contribution to the thesis

Case (Industry)	Size	Products	Value Adding	Domestic/Export	Chapter
Food 1 (process)	Large	Wide range of imperishable foods	Food processing, packing and distribution	Domestic and Export	5, 6, 7, 8
Food 2 (process)	Medium	Small range of perishable and imperishable foods	Food processing, packing and distribution	Domestic market only	7
Dairy 1 (process)	Large	Milk powder, butter and proteins	Pasteurisation, separation, drying, packaging and distribution	Predominantly Export	5, 6, 7, 8
Dairy 2 (process)	Large	Broad range of dairy products	Pasteurisation, separation, drying, packaging and distribution	Predominantly Export	7
Manufacturer 1 (manufacturing)	Medium	Large, stainless steel tanks	Machining and assembly	Domestic and Export	5
Manufacturer 2 (manufacturing)	Medium	Multi-tonne machine deployed in construction sites	Sheet cutting, machining and assembly	Predominantly Export	5, 6, 7, 8
Steel (manufacturing)	Medium	Design and manufacturer of special purpose machinery and components	Patternmaking, foundry, large scale machining and welding	Domestic and Export	5, 6, 7
Retail (retail)	Large	Hardware items	Retail display and inventory management	Domestic only	5
Storage (service)	Medium	Cool storage	Storage, chilling and retrieval	Domestic only	5
Forestry (process)	Large	Pulp and paper	Wood chipping, purification, drying and packaging	Domestic and Export	5, 6, 7, 8
Service (service)	Large	Healthcare	Purchasing, internal transfer, replenishment and inventory control	Domestic only	5, 6

Source: Author

4.7 Role of the case study researcher

The role of the researcher within qualitative research projects includes being research facilitator, research investigator, and research observer. Therefore, it is crucial that case study researchers who work with an organisation are able to analyse themselves within the process (Lalle, 2003). While doing case study research, the researcher enters a real world situation and aims both to acquire and to improve (Checkland & Holwell, 1998). Therefore, the organisation, as well as being the subject matter of the observation, is also the arena of application and of confrontation between theory and practise. The researcher's task is to bring theory and practise closer together and hence reduce the researcher - practitioner gap by being practitioner relevant as well as rigorous (Beer, 2001; Böhme et al., 2008a).

Knowledge becomes practitioner relevant when it is context specific. On the other hand, rigour conveys the academic's commitment to build general theory, and academic knowledge involves the quest for general or covering laws and principles concerning the fundamental nature of things; the more context free, the more general and the stronger the theory (Aram & Salipante Jr., 2003). The researcher-practitioner gap thus consists of the apparent tension between rigour and relevance, between the particular and the general (Aram & Salipante Jr., 2003). The challenge of narrowing the gap consists of generating knowledge that mitigates the apparent tension between these criteria (Aram & Salipante Jr., 2003). In doing so, it is important that the researcher distinguishes case study research from consultancy. A consultant shares a single common goal with the organisation whereas the case study researcher will have this goal as part of a larger primary goal, namely the discovery of new knowledge (Westbrook, 1994).

Next, the data collection and data analysis technique that aim to close the researcher-practitioner gap are presented.

4.8 Data collection and data analysis

As the case study method can be used to investigate problems within a number of research paradigms, the researcher may take an interpretive approach in understanding and explaining the data; or a more positivist approach, relying to some extent on research objective (Aram & Salipante Jr., 2003). Combining more than one approach can be especially fruitful in increasing the researcher's deductive efforts (McCutcheon & Meredith, 1993). Hence, the thesis applies a multi-method, rigorous data collection technique termed the Quick Scan Audit Methodology (QSAM) that also produces practitioner relevant outputs.

The Quick Scan is a site-based audit methodology. During a Quick Scan audit, material and information flows are process mapped and key managers are interviewed, company archival information is evaluated, and attitudinal questionnaires are completed. As a result, an in-depth understanding of a focal supply chain is obtained and comprehensively documented. The Quick Scan was applied at the beginning of the data collection process and it has proven to be a rich and time-effective method of investigation, given the resources and adequate shop floor and managerial access.

4.8.1 Quick Scan Audit Methodology (QSAM)

4.8.1.1 The development of the QSAM

To improve supply chain performance within the UK automotive industry a three year project funded by the Engineering and Physical Sciences Research Council (EPSRC), was established between Lucas Varity, Computer Science Corporation, and the Logistics Systems Dynamics Group at Cardiff University (Lewis et al. 1998). Entitled 'Supply Chain 2001', the aim of the project was to develop a route map to enable a company to move from an existing functional, differentiated supply chain to a process-orientated seamless supply chain (Lewis et al., 1998). Since the late 1990s, the QSAM has continued to be refined by the original members with assistance from other academics around the world. The methodology was designed from the start to be both practitioner relevant and supportive of academic need, by yielding rigorous supply chain data with which

to develop new theory and refine the QSAM method itself. Although originally a collaborative effort with the UK automotive industry, QSAM has since been applied in organisations of varying sizes and different business sectors in Germany, New Zealand, and Thailand, as outlined in Table 4.7.

Table 4.7: Number of QSAM applications in different countries

Country	Number	Sector
Germany	2	Automotive component and system supplier
New Zealand	7	FMCG, consumer foods Engineering service provider Dairy producer Service provider, health sector Pulp and paper mill Steel foundry
Thailand	9	Small manufacturer Cable manufacturer Steel fabricator Service provider, scanning Concrete producer
UK	16	Automotive component and system supplier OEM, non-automotive Lighting product manufacturer FMCG producer Automotive heat treatment subcontractor Steel fabricator Service provider, utility and logistics

Source: Author

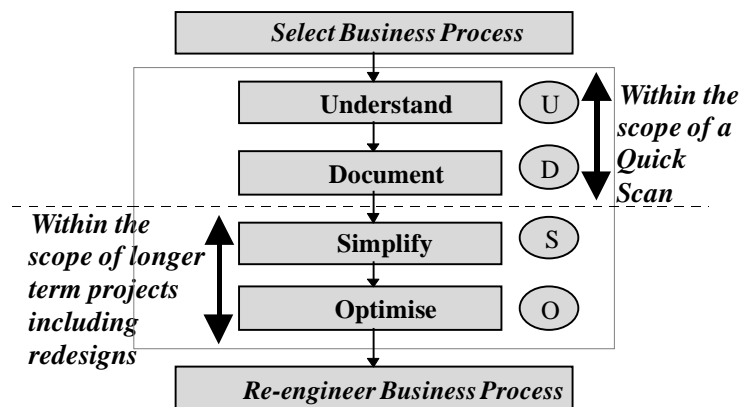
Currently, 34 Quick Scans have been undertaken in four different countries in many different sectors and in three different organisation sizes: large organisations, medium-sized, and family-owned businesses (Banomyong et al., 2005; Böhme et al., 2007b; Potter & Bowles, 2006). Applying the QSAM to different countries, sectors, and company sizes helped to develop the methodology into a robust supply chain diagnostic tool. Further, the QSAM enables the generation of comparable data needed to transfer best practises, maturity benchmarking and longitudinal reengineering programmes across different countries and industry sectors. Next, the scope of the QSAM is presented.

4.8.1.2 Scope of the QSAM

Figure 4.3 identifies the scope of a QSAM within the overall reengineering process. It can be seen to be primarily focused on the first two (Understand and Document) stages. Although any identified high impact, quick-hit opportunities

tend to be tackled early in the Simplification stage, in order to demonstrate in-house capability and an early return on the QSAM investment, the ultimate aim of QSAM is to identify the types of soundly underpinned and customised supply chain integration recommendations that tend to require persistent implementation effort and longer-term company commitment. QSAM team members frequently take on a steering group role for such endeavours.

Figure 4.3: The UDSO business process re-engineering procedure



Source: Watson, 1994

By closing the gap between researcher and subject, QSAM yields consistent results and provides close, customised supply chain integration support to practising supply chain professionals. In essence, it helps managers to identify the root causes of the ‘major pain’ that is being felt by the organisation, and provides guidance on which elements of errant supply chain processes need to be reengineered.

4.8.1.3 The QSAM process

The audit process is conducted by experienced supply chain academics in a structured approach designed to fit around the limited time availability of busy managers and employees. To this end, typically four researchers will spend three days actually on site, assisted by an in-house business champion.

The six major process steps involved in conducting the QSAM, the associated key objectives, and the reasoning for each are provided in Table 4.8. Once an

organisation has agreed to being audited, the first key step is the preliminary presentation. The objective here is mainly to obtain buy-in from the key managers and hence overcome any fear of the audit. During this presentation, the QSAM process is explained and the advantages to the organisation highlighted. To save time during the very busy data collection days, specific requirements are requested at this point and the questionnaires (both attitudinal and quantitative) are distributed to appropriate managers.

The second process step highlighted in Table 4.8 comprise a very intensive day on-site, involving the overall evaluation of the value streams status via the collection of three data sources. The use of questionnaires, process mapping of material and information flows and multiple interviews of a cross-section of managers facilitates methodological triangulation and hence increases internal validity. During the next day, this data is analysed off-line in a brainstorming session aimed at preliminary identification of good and bad practises. The output of this stage is a list of hypothesised reasons for the bad practises and a resultant list of further data requirements to validate the initial evaluation.

The second day on-site, and the fourth step illustrated in Table 4.8, is the collection of specific data to investigate the hypotheses. Probing interviews are conducted to investigate why poor practise is present. Often archival data from the organisation's information systems is available to be collected to verify the bad practises and establish causes. However, this data is often incomplete and new data is generated via live observation of key processes. This frequently exploits the use of activity sampling. During the following day, the team of researchers analyse all the data via a systematic process centred around cause and effect analysis (detailed in Chapter 6). The output of this penultimate step is a ranked list of improvement opportunities to enhance the performance of the value streams.

Table 4.8: The QSAM process

QS Process	Location/ Duration	Key Objectives	Reasoning
Preliminary presentation	On-site 2 hours	<ul style="list-style-type: none"> • Identify value stream(s) • Issue data request • Obtain buy-in 	<p>The selection of value stream(s) allows focus & detailed investigation within the limited QS duration.</p> <p>Pre-emptive requests for archival data & the issuing of questionnaires minimises wasted time during intensive on-site data collection.</p> <p>Successful buy-in is key for access to data & to avoid political game-playing via the distortion and withholding of information.</p>
Evaluate supply chain status	On-site 1 day	<ul style="list-style-type: none"> • Collect questionnaires • Conduct interviews • Process map 	<p>Methodological triangulation significantly reduces the errors of each individual data collection approach. Different researchers collect each of the data types hence reducing bias via investigator triangulation.</p>
Brainstorm supply chain barriers	Off-line 1 day	<ul style="list-style-type: none"> • Identify good & bad practises • Develop hypotheses • Identify further data requirements 	<p>Initial impressions are first discussed between the team members.</p> <p>The inter-relationships & possible causes of the bad practises are hypothesised and the data required to validate each is identified.</p>
Hypothesis investigation	On-site 1 day	<ul style="list-style-type: none"> • Collect archival data • Conduct probing interviews • Observe current practise 	<p>Specific historical data such as time series or inventory levels are collected to test each hypothesis.</p> <p>Further interviews are conducted that delve into why current practises are deficient.</p> <p>The material flow process is observed and documented, especially when there is a lack of archival data.</p>
Analyse the findings	Off-line 1 day	<ul style="list-style-type: none"> • Identify major pain(s) • Cause and effect analysis • Develop improvement opportunities 	<p>The over-riding problem(s) is(are) first identified.</p> <p>The heart of the analysis is the development of a cause and effect diagram based around the major pain that inter-relates all the bad practises and identifies root causes.</p> <p>Improvement opportunities for the root causes are identified and ranked by benefit, time and cost to implement.</p>
Feedback presentation	On-site 3 hours	<ul style="list-style-type: none"> • Present findings to management • Initiate round table discussion • Agree upon an action plan 	<p>This is the most important stage for the target company, as the objective is a group understanding of the key shortcomings of the supply chain and the agreement to an action plan to rectify the most significant poor practises.</p>

Source: Adapted from Naim et al., 2002

The final step of the QSAM is the most important for the target organisation and involves a half day presentation and discussion of findings with management. The objective of this meeting is not just to feed back the audit team findings but also for management to obtain a more holistic perspective of their supply chain. This includes understanding the ramifications of their individual decisions on the actors up and down the value stream. The ideal output of this step is an action plan for change. The focal company is further provided with a brief summary report of the Quick Scan. A selection of summary reports is provided in Appendix D.

In summary, the key QSAM elements that result in a successful supply chain audits are:

- A team of four researchers can ensure investigator triangulation
- The use of four data collection methods provides methodology triangulation
- The application of a refined, systematic and hence holistic methodology
- The considerable skills and knowledge of the QSAM team
- The buy-in obtained during the preliminary presentation based around the win-win situation of the provision of improvement opportunities and gathering of rigorous research data.

Next, the data collection methods are explained in detail.

4.8.1.4 Data collection techniques utilised during a Quick Scan

Supply chain management spans the organisational boundaries, making the identification and collection of useful practise and performance data difficult. The supply chain perspective implies that an organisation's success is due not only to its own internal practises, but also those of its suppliers and downstream customers. This means that the unit of analysis for considering practise is an inter-organisational operation, where valid measures of success may be difficult to identify exactly (New & Payne, 1995). The combination of data types can be highly synergistic (Eisenhardt, 1989), while the data collection from various sources helps to give validity, and any misunderstanding or wrong assumptions

have multiple opportunities of exposure and correction (Westbrook, 1994). The goal of the different data collection techniques is to understand as fully as possible the phenomena being studied through triangulation, with the accumulation of multiple entities as supporting sources of evidence, to assure that the facts being collected are indeed correct (Meredith, 1998). Hence, the QSAM combines qualitative with quantitative evidence.

The Quick Scan procedure uses four data collection techniques: attitudinal and quantitative questionnaires, process maps, structured interviews, and archival information. The questionnaires have a number of purposes. The preliminary questionnaire is used to gain initial knowledge of the focal organisation being analysed, including information such as key customers, suppliers, production volumes, product variants, and company structure (Böhme et al., 2008a). The second format of data collection is process mapping, which provides a detailed understanding of the material and information flows for the business processes. The third type of data collection during the Quick Scan is semi-structured interviews. These are conducted with a cross-section of senior and middle management from all functions and include coverage similar of all the questionnaires as well as the process mapping. The final type of data collection during the Quick Scan is archival data. Archival data is relevant as it is perceived as being unbiased and being able to provide historical factual data from respondents (Flynn et al., 1990).

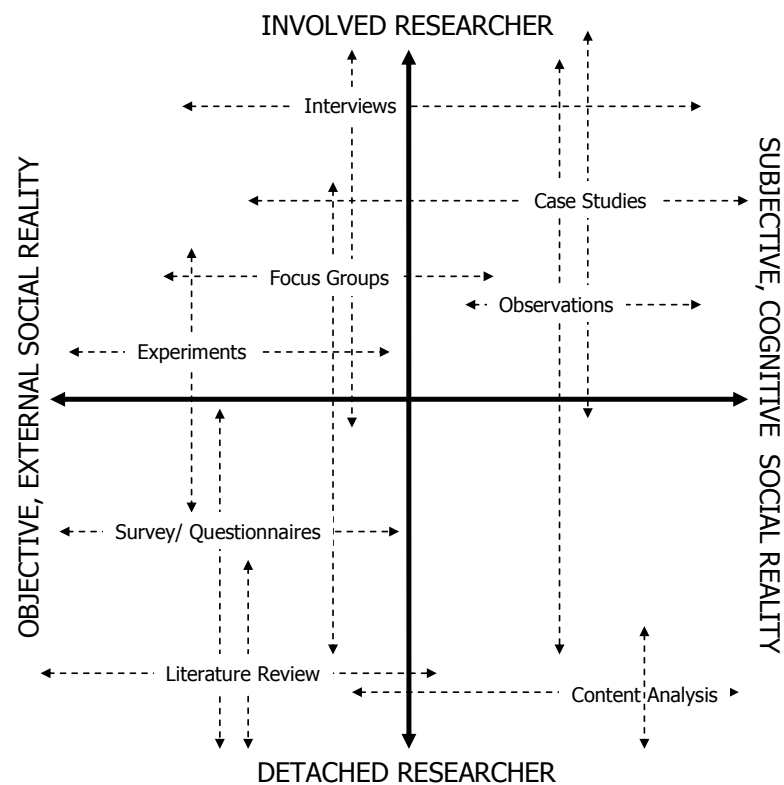
The mix of quantitative and qualitative data enables the research team to obtain a good understanding of the supply chain, while also enabling triangulation (Potter & Bowles, 2006). Two means are identified to achieve triangulation. The first is by multiple data collection methods that provide stronger substantiation of constructs and hypotheses (Eisenhardt, 1989); the second is by employing multiple investigators to visit the case study sites. This allows the case to be viewed from the different perspectives of multiple observers. Multiple investigators have two key advantages. First, they enhance the creative potential of the study as team members often have complementary insights which add to the richness of the data (Eisenhardt, 1989). Secondly, the use of more investigators builds confidence in the findings and increases the likelihood of

surprising findings. Overall, by providing several sources of verification, triangulation improves the researcher’s judgment accuracy (Flynn et al., 1990).

4.8.1.5 QSAM’s position within research paradigms

Here, the QSAM is anchored into the wider epistemological setting. In Figure 4.4, Frankel et al. (2005) provide a very insightful review of method usage in the field of logistics and supply chain management and categorise the eight most common methods based on epistemology; the focus here is on researcher involvement and on social reality.

Figure 4.4: Mapping out eight research methods



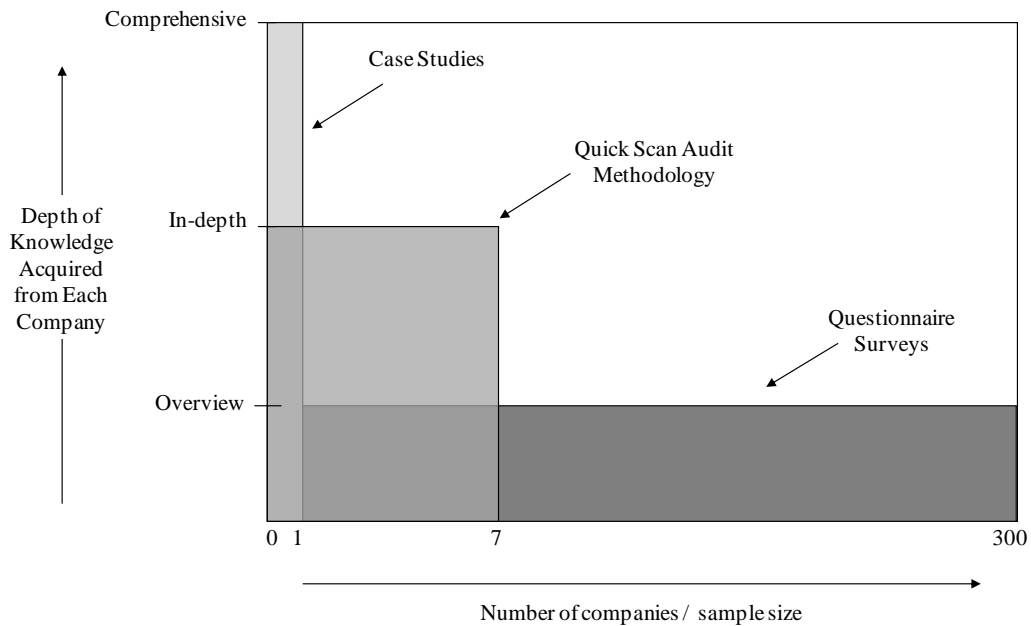
Source: Frankel et al., 2005

While surveys and questionnaires are rather objective and the researcher is detached from the research setting, case studies are more subjective and require the involvement of the researcher. There is a substantial ‘white space’ in logistics research in the top right hand corner of Figure 4.4, where very little research is

being carried out. The QSAM, being a form of case study research, attempts to fill that gap with high researcher involvement and a tendency towards subjectivity.

Figure 4.5 compares the QSAM to alternative research methods regarding depth of knowledge and sample size.

Figure 4.5: Scope and depth of understanding gained via QS analysis



Source: Towill et al., 2002

The depth of knowledge obtained from each Quick Scan reflects the large investment in time by the researchers conducting the analysis, although the understanding is not as great as the comprehensive knowledge obtained via case study analysis, for example by Burbridge and Halsall (1994). However, a far greater in-depth understanding is gained via a Quick Scan than either telephone or postal surveys, see, for example, Schmenner and Swink (1998). The QSAM leads to specific knowledge creation. These research outputs are presented next.

4.8.1.6 Research outputs generated by the QSAM

QSAM adopts the most common supply chain perspective: that of a focal organisation and its integration into the wider supply chain. By capturing

organisational data related to theory, tools use, and people a validated in-depth understanding is obtained and documented. This holistic view of the supply chain is both unbiased and based on non-historical information, and provides a valuable and rich source of research data.

Table 4.9 provides a list of the most significant original contributions to-date enabled via analysis of the empirical QSAM case data.

Table 4.9: Original contribution enabled through the QSAM application

Original contribution	Publication(s)	Key findings
Supply chain integration evaluation	Towill et al. (2000)	Despite much rhetoric, supply chain integration is the exception not the norm in practise
Validation of Stevens' (1990) integration model	Towill et al. (2000)	Stevens' (1990) model provides an effective route to improve supply chain integration
Supply chain integration beaten path	Towill et al. (2000)	Most companies proceed through the three phases when advancing their supply chain integration
Construction supply chain assessment	Barker et al. (2000)	It is feasible to audit project based construction supply chains via the QSAM
Benefits of reducing supply chain uncertainties	Geary et al. (2002)	Reductions in demand, control, supply and process uncertainties significantly affect the company bottom line
Seamless supply chain objective	Towill et al. (2002)	The seamless supply chain (Towill, 1997b) can be effectively used as a re-engineering guide
Factors that affect real world supply chain performance	Childerhouse & Towill (2002)	There is a limited set of factors that statistically affect supply chain integration
12 rule toolkit validation	Childerhouse & Towill (2003)	Empirical validation of the operation advantages of Towill's (1999b) 12 rule tool kit
The criticality of simplicity	Childerhouse & Towill (2003)	Statistical analysis highlighting the correlation between supply chain simplicity and integration
VMI and transport	Potter et al. (2005)	Empirical investigation into the impact of VMI on transport and its tradeoffs with other supply chain metrics
Steel supply chain assessment	Potter & Bowles (2006)	It is feasible to audit process-based steel supply chains via the QSAM
Usefulness of bullwhip	Potter et al. (2008)	Customer pressure can lead to businesses inducing bullwhip in order to maintain customer service levels to all customers

Source: Author

The understanding gained from the multiple Quick Scans has manifestly enabled the development of new management theory and the validation and, more often than not, further refinement of research ideas. Next the value of the Quick Scan to practitioners is presented.

4.8.1.7 Value to practitioners

The QSAM provides practitioners with an unbiased and rigorously researched set of recommendations for improving the state of their supply chain. Such recommendations are underpinned by validated theory, plus a cause-effect diagram that provides clear pointers to high leverage change initiatives, since the diagram clearly identifies the root causes of a company's major pains. Only when managers begin to appreciate the nature of the various root causes, and how specific problems being experienced are interlinked, can they begin to identify high-leverage actions for effective change (Böhme et al., 2008b). Managers frequently report that the QSAM process was a very positive experience for them:

The process provided what we thought was a very accurate representation of our supply chain and provided a number of very useful solutions to the problem areas identified. (Ian Hill, Distribution Director, Nestle Ltd, UK)

The audit had tremendous value for us. The interaction between our staff and the research team was outstanding and stimulated some healthy debate as you would expect between 'Academics' and 'Supply Chain professionals.' The formal review process followed by an executive summary and documented, detailed findings from the review was the perfect route map for us to change our behaviour and address major shortcomings. We are confident that from what we have seen of our performance in a relatively short time we will continue to deliver the desired improvements in our end-to-end supply chain. (Supply Chain Manager, Food 1)

QSAM was a worthwhile investment giving us actionable results. What I liked was being able to get some of the best supply chain minds in NZ

working on our business while helping the university in their data collections.
Totally win/win. (Managing Director, Manufacturer 2)

The statements highlight some of the particular strengths of the QSAM. However, a SWOT (strengths, weaknesses, opportunities, threats) analysis, presented next, also focuses on the weaknesses and threats of the QSAM.

4.8.1.8 SWOT analysis of the QSAM

The SWOT analysis is embedded in the strategic management literature and aims to strategically position a focal company against its competitors (Thompson & Strickland, 2003). Here, the analysis is used as a reflection technique since applying a SWOT analysis to the QSAM enables the researcher to develop a perceptive understanding of QSAM capabilities, and the deficiencies, methodological opportunities and threats for future applications. Table 4.10 presents the outcome of the SWOT analysis.

Table 4.10: QSAM SWOT analysis

Strengths	Weaknesses
<ul style="list-style-type: none"> • Holistic view of the supply chain • Provides a good depth of insight • Independence of the research team • Triangulation of data sources • Provides focus on key issues and root causes • Flexible in terms of the tools used and research focus • Quick and efficient process • Flexible in terms of researchers involved (min 2, max 5) • Researcher support by business champion 	<ul style="list-style-type: none"> • Training required in data collection techniques, and data analysis • Data analysis complicated by broadening product variety funnel as a broad product variety adds complexity.
Opportunities	Threats
<ul style="list-style-type: none"> • Develop diagnostic expertise within industrial partner • Complementarities with wider business process reengineering initiatives • Education tool to teach upcoming academics real supply chain management • Opportunity to develop long-term research partnerships within the industry • Establishment of longitudinal data sources • Development of an industry network and best practise database 	<ul style="list-style-type: none"> • Getting buy in and managing expectations of participating companies • Vague aims and objectives • Collecting too much data which increases analysis time • Experienced researchers take on leadership • Are findings for a certain product really reflecting all products of that particular value stream? • Large production areas become time consuming

Source: Adapted from Potter & Bowles, 2006

The strengths of the QSAM have already been highlighted in this chapter. In contrast the major weakness of the QSAM is the time required to train new researchers on the method. Hand in hand with the major weakness comes one of the major threats; often when training inexperienced researchers, the experienced researchers take on a leadership role, which weakens investigator triangulation. Further threats arise when the objective of the QSAM is not clearly stated. However, the QSAM provides many opportunities. First, it can possibly be a catalyst to develop long-term research partnerships, which ultimately lead to further research funding. Second, the QSAM focal companies can develop into an industry network, which brings people from different companies together to discuss and exchange supply chain best practises (focus groups). Finally the Quick Scan provides the opportunity to collect longitudinal research data. This thesis makes a first rigorous attempt to adapt the QSAM to longitudinal case data. The adaptation of the QSAM to longitudinal case data is presented next.

4.8.1.9 QSAM adaption to longitudinal case data

This thesis aims at identifying pathways to supply chain integration, hence longitudinal data is required. The initial Quick Scan provides the researcher with in-depth company and supply chain knowledge and raises awareness for a second round of data collection. Familiarity with the site and the previously gained in-depth plant knowledge enable the researcher to conduct follow up case study within a shortened timeframe that depends on the changes implemented by the focal company. A structured approach has been developed for the follow up case study. Table 4.11 outlines the time requirements and the necessary actions required for the collection of appropriately structured longitudinal qualitative and quantitative data.

Table 4.11: Longitudinal research process

QS Process	Location/ Duration	Key objective	Reasoning
Evaluate supply chain status	On-site 3 hours	Collect questionnaire	<ul style="list-style-type: none"> • Fill out the quantitative questionnaire for value stream previously investigated during the QSAM (see Appendix C)
Overview of change process	On-site 3 hours	Collect questionnaires Conduct interviews	<ul style="list-style-type: none"> • Discussions around the Cause and Effect diagram to identify which areas (root causes) have been addressed • What further barriers occurred after the QSAM • Fill out integration evaluation tool
Evaluate change process	On-site 1 day	Conduct interviews Observe “new” practise(s) Collect archival data	<ul style="list-style-type: none"> • Interview with new appointed staff members • Interview with people responsible for the implementation of change projects • Interview shop floor supervisors who experienced the change process • Collection of quantitative data that supports the success/failure of improvement projects
Consent of change process	On-site 3 hours	Present findings to management	<ul style="list-style-type: none"> • Seek consents from staff members involved in the follow up study.

Source: Author

The developed four stage follow up process combines four data collection techniques. First, the quantitative data collected during the Quick Scan is re-assessed using questionnaire (Appendix C). Second, interviews are conducted to identify the changes which have occurred within the focal company/supply chain and the experience gained from the change process. The cause and effect diagram developed initially helps to identify which root causes have been addressed. Thirdly, the developed integration evaluation tool is applied to identify which area of supply chain integration has improved most. The fourth data collection technique is collection of archival data, which is useful to identify how the change process has affected supply chain performance. Applying four different data collection techniques provides for data triangulation and hence rigour.

In summary, QSAM provides a sound investigation method that is also strongly underpinned by theory, and is well specified and communicated to practitioners. Next, the data collection technique for the evaluation of power and dependency in external relationships is described in detail.

4.8.2 External relationship evaluation method

The second major investigation area is the external power and dependency structure that helps to identify the prospects for companies to externally integrate with supply chain stakeholders. Table 4.12 presents a five step method to evaluate the power and dependency structure of the supplier base.

Table 4.12: Methodological outline of the research

Research Objective	Step	Data Collection Method
Identification of supply chain integration practise	1) QSAM	The QSAM is only an optional step and helps to understand supply chain integration practises in the country setting
Identification of current relationship management practises	2) As-is relationship management	Semi-structured interviews to identify the current relationship practises supported by performance data
Identification of key variables for external dependencies	3) Identification of key dependency variables	Structured interviews to identify the most relevant dependency variables related to the particular case study
Identification of the idealised relationship management practise	4) Evaluation of supplier / customer base (idealised relationship management)	Sample of 17-28 external relationships from the supplier base picked by experts from the focal organisation. Identification of dependency scores for each relationship
Identification of ways to overcome external dominance.	5) Identification of improvement opportunities	Feedback presentation and expert discussion with people involved in the study.

Source: Author

Olsen and Ellram (1997) suggested a three step evaluation model: analysis of the company's purchase transactions; analysis of supplier relationships; and the development of an action plan. The present study includes two additional steps which are considered important. The first is a scoping step that aims to gain insights into supply chain management within the wider national context. However, it is important to mention that the scoping is only an option and not a necessary step. The second addition is the identification of key dependency variables for consideration, since each one has different significance to different companies in different industrial settings. The developed semi-structured interview guide can be found in Appendix G.1. Next, the final data collection technique, structured interview, is presented.

4.8.3 Structured interview

In two cases an in-depth interview was conducted and in both cases, the interviewee was the supply chain manager. Interviews commenced with a brief tour around the plant and some open ended questions to clarify the business model and to gain an overview of the supply chain and its operations. Following these open-ended questions the structured interview guide that is also applied during the Quick Scan (Appendix C) was utilised. Statistical analysis has previously validated the alignment of the Quick Scan and structured interview data collection methods (Childerhouse et al., 2004). Next, the timeframe of the research is presented.

4.8.4 Timeframe

Table 4.13 shows the research timetable. Data was collected between September 2003 and May 2008. Seven Quick Scans, seven supplier evaluations, four follow up studies, and two in-depth interviews were conducted during this time. In total, 239 person days were spent in eleven New Zealand companies. Next, the theory building process is explained.

Table 4.13: Research timetable

Case	Data collection technique	Person Days	Date
Food 1	QSAM	24	June, 2006
	Supplier evaluation	4	March, 2007
	Follow up	3	May, 2008
Food 2	Supplier evaluation	4	January, 2007
Dairy 1	QSAM	30	January, 2004
	Supplier evaluation	4	December, 2006
	Follow up	4	December, 2006
Dairy 2	Supplier evaluation	2	April, 2007
Manufacturer 1	QSAM	24	September, 2003
Manufacturer 2	QSAM	36	December, 2006
	Supplier evaluation	5	December, 2006
	Follow up	5	April, 2008
Steel	QSAM	30	February, 2008
	Supplier evaluation	2	February, 2008
Retail	Interview	1	August, 2006
Storage	Interview	1	June, 2005
Forestry	QSAM	30	February, 2006
	Supplier evaluation	3	April, 2007
	Follow up	2	April, 2008
Service	QSAM	24	January, 2007.

Source: Author

4.9 Theory building from case study research

A feature of research to build theory from case studies is the frequent overlap of data analysis with data collection (Eisenhardt, 1989; Lewis, 1989). During the theory-development process, logic replaces data as the basis for evaluation (Meredith, 1989). The central idea during the theory building process is to constantly compare theory and data – iterating toward a theory which closely fits the data. To build good theory this closeness is important because it takes advantage of the new insights possible from the data and yields a valid theory (Eisenhardt, 1989).

The theory building process also includes the comparison of the emergent concepts, theory, or hypotheses with the extant literature. This involves asking,

what is this similar to? What does it contradict and why? (Lewis, 1989) Schmenner and Swink (1998) argue that the transition from data to theory requires creative imagination because theories are not derived from observed facts, but invented in order to account for them. Although sometimes seen as subjective, well-done theory building from cases is surprisingly objective, because its close adherence to the data keeps researchers “honest” (Eisenhardt & Graebner, 2007). Next, the limitations of case study research are presented.

4.10 Limitations of case study research

Qualitative research in general is commonly perceived as exhibiting a tendency for construct error, poor internal and external validation, and questionable generalisability (Meredith, 1998). Hence, the same quality criteria apply to case study research as to quantitative studies. The four areas of limitation are further discussed.

Another concern in case study research is the internal validity of the proposed relationships, that is, whether the right cause-and-effect relationships have been established (Yin, 1994). In contrast to mathematical modelling or simulations, where the number of variables is limited and their interactions are usually clearly specified, the field-based researcher may easily attribute outcomes to the wrong causes, based on spurious relationships (McCutcheon & Meredith, 1993).

Generalisability to new populations (such as other industries, other suppliers in the supply chain, etc.), also known as external validity, is problematic. The rationalists often maintain that their results are highly generalisable because they apply in any situation and timeframe where the assumptions hold, whereas the findings from case study research (interpretivist) have little generalisability because the results are only valid for that case situation. In general, external validity cannot be established without replication of research results in different contextual settings (Mentzer & Kahn, 1995). One way to overcome this difficulty is the application of multiple settings to help to extend the generalisability of the results (Meredith, 1998). Further enlargement of the scope of the investigation, particularly via literature research, drawing connections with existing theories,

making contact with other research centres, conferences, and researching other work methods and other epistemological positions; helps with this difficulty. The actor-researcher confronts his or her own hypothesis by comparing it with those of other researchers, revealing the convergences and analysing the divergences (Lalle, 2003). In this way, the results of research become a transferable generic scientific product, ensuring the cumulative dimension of academic research (Lalle, 2003).

As with any attempt to evaluate real-world conditions, the reliability of the case information (the extent to which data would be duplicated if collected at another time or through another means) is a concern. While experiments or field studies that use multi-item scales can check scale reliability through statistical means, in most situations a case researcher must find other ways to ensure measure reliability (Yin, 1994). Using a variety of data gathering methods and the involvement of more than one researcher are two possible solutions. Also, an advantage of case study is that steps can be taken midstream to verify suspicions and improve data-gathering procedures (McCutcheon & Meredith, 1993).

Another limitation is a lack of neutrality because the case study research is fully implicated in the organisation and the way it operates. Thus, the understanding that is achieved is only meaningful within the perspectives specified by the researcher. Hence the understanding is not without bias (Meredith, 1998). To optimise neutrality, multiple methods, tools, and entities for triangulation, and temporal dynamics are necessary (Meredith, 1998). Table 4.14 summarises the four key limitations and explains how those limitations are addressed during a Quick Scan.

Table 4.14: Assessment of the QSAM against research quality criteria

Dimension of research quality	Definition	How achieved within case study?	How achieved within the QSAM?
Internal validity – <i>how accurately are cause/effect relationships identified?</i>	Establishing causal relationships between research variables (certain conditions are shown to lead to other conditions)	Use of team of researchers to obtain different viewpoints (Eisenhardt, 1989)	Use of a team of researchers for data collection (Böhme et al., 2008a)
External validity – <i>can the findings be translated to other settings?</i>	Establishing the domain to which a study's findings can be generalised.	Comparison to a theoretical framework or against a database of results (Ellram, 1996)	Comparison against database of previous QSAM applications (such as in Böhme et al., 2008b; Towill et al., 2002)
Reliability – <i>can the findings be reproduced by others?</i>	Demonstrating that the operations of a study can be repeated with the same results	Documentation of the protocol (Yin, 1994) or maintenance of a database of findings (Ellram, 1996)	Process well documented in literature (Böhme et al. 2008a and 2008b; Lewis et al., 1998; Naim et al., 2002) and existence of database (Towill et al., 2002)
Objectivity – <i>are the results free from bias?</i>	Establishing correct operational measures for the concepts being studied.	Triangulation of qualitative and quantitative data sources (Jick, 1979).	Triangulation via process mapping, data analysis, interviews and questionnaires (Böhme et al., 2008a).

Adapted from: Potter & Bowles, 2006; van der Vorst & Beulens, 2002

4.11 Discussion

Supply chain management suffers from a weak theory base (Cigolini et al., 2004; Cooper et al., 1997; Croom et al., 2000; New & Payne, 1995). Most studies based on survey data suffer from lack of internal validity due to indifferent respondent question clarity and possible bias (Naslund, 2002). Also the complexity and variety of real-world supply chains make external validity difficult as it is often very hard to compare apples with oranges (Stuart et al., 2002). Hence, many academics suggest an increase of exploratory studies that apply multiple data collection methods (Frankel et al., 2005; Mentzer & Kahn, 1995; New & Payne, 1995; Seuring, 2005; Westbrook, 1994). Case study is one of the research strategies capable of combining multiple paradigms. The Quick Scan Audit

Methodology (data collection methods) match the requirements of case studies as well as applying multiple data collection tools. QSAM is further capable of closing the researcher-practitioner relevance gap, which makes it a highly valuable data collection technique when investigating messy real world supply chains. The strength of the QSAM is certainly the researcher team and data triangulation.

The multiple data collection methods provide very strong substantiation of constructs and hypotheses (Eisenhardt, 1989). The team of four researchers also enables the case to be viewed from different perspectives. This is especially so due to individuals using specific methods which increases the chances of each investigator viewing case evidence in divergent ways (Eisenhardt, 1989). The QSAM excels at this as it is constituted of multiple methods, ranging from observing and measuring processes to conducting semi-structured interviews and the completion of quantitative and attitudinal questionnaires.

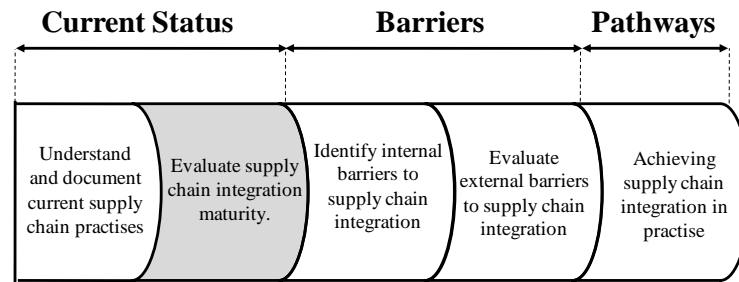
This methodology chapter has highlighted that the QSAM has been applied within New Zealand to a range of different industries as well as different company sizes. By applying the QSAM to three small medium-sized enterprises (SMEs) the research team identified that the focal organisation had only a maximum of two major value streams. Therefore, those value streams represent the focal SME's entire internal supply chain resulting in a more complete picture of the focal organisation. Further, the relatively small size of New Zealand companies has allowed the researcher to spend more time looking into supply chain-related areas such as staff development, strategic direction of the enterprise, staff turnover, and leadership. In short, applying the QSAM to SMEs expands the initial focus on value streams to an enterprise scan with a strong process focus.

Of course, the QSAM is still capable of improvement. As such, a great deal of further validating research is required. The method itself is constantly being updated, strengthened, streamlined, and may, therefore, be regarded as still evolving. One of the improvements of the QSAM presented in Chapter 4 is the adaptation of the QSAM to longitudinal case data. However, the longitudinal data collection process could be improved further by introducing a second researcher.

This would increase validity and also extend triangulation practise, from data triangulation to researcher triangulation. Even more ideal would certainly be a second Quick Scan.

4.12 Conclusion

This chapter has presented different paradigms for conducting research. Academia has clearly identified that supply chain management lacks common theory and that “a one paradigm, one approach” should not be the obvious choice. Hence, case study research is applied to the research question identified. The data collection technique termed Quick Scan Audit Methodology uses multiple paradigms and three means of data triangulation: (a) investigator triangulation, (b) data triangulation, and (c) methodology triangulation. The Quick Scan approach is the initial step in a generic, robust methodology for identifying change management opportunities in the supply chain (Naim et al., 2002). The contribution to theory of this chapter is manifold. First, a rigorous method has been developed to adapt the initial Quick Scan to suit longitudinal case studies. Second, a method has been developed to measure power and dependency in external relationships. Third, applying the QSAM to New Zealand supports the increase of rigour for the methodology developed. Fourth, Quick Scan has been applied to new industry settings, especially the New Zealand process industry, which further validates the method. In the next chapter, the QSAM application in New Zealand is presented.



5. Supply Chain Integration in New Zealand

Main Research Question: How integrated are New Zealand supply chains?

5.1 Introduction

In this chapter the nature of uncertainty is described, and is used to explain why exemplary value stream integration remains an elusive goal for most New Zealand organisations. Uncertainty levels of value streams are evaluated for a wide range of organisations, using the ‘uncertainty circle’ concept, thereby enabling benchmarking comparisons of value streams performance to be made. Twenty value streams of nine different companies were investigated, using predominantly, the Quick Scan Audit Methodology (QSAM). The uncertainty data is validated via application of the supply chain integration evaluation tool developed in Chapter 2.11.3. The NZ uncertainty data is further compared to the Towill et al. (2002) investigation results of twenty value streams in the UK automotive sector. Finally, the collected data is considered in light of Stevens (1989) integration model and also Frohlich and Westbrook’s (2001) integration model to identify whether companies follow particular distinct paths to supply chain integration. By presenting current value stream integration practises in New Zealand, this chapter becomes the basis for the following three chapters which discuss the findings. Once the current state is determined, internal and external barriers to integration are identified and, by using longitudinal studies, the pathways to value stream integration can be ascertained. Towill et al. (2002) and Böhme et al. (2008b) have provided the foundation of this findings chapter, and the relevant literature is reviewed in the following section.

5.2 Supply chain integration

The integration of supply chains has been the subject of significant debate and discussion within the academia (e.g. Bagchi & Skjott-Larsen, 2002; Frohlich & Westbrook, 2001; Ota, 2001; Power, 2005; Stevens, 1989; Towill et al., 2002). Supply chain integration originates from a systems perspective (Christopher, 1998), where optimisation of the whole achieves better performance than a string of optimised sub-systems. The argument is that via integration, trade-offs and wider ranging decisions can be made based on shared information and co-ordination (Frohlich & Westbrook, 2001; Lambert et al., 1998; Pagell, 2004; Romano, 2003; Sabath, 1995; Spekman et al., 1998; Wong & Boon-itt, 2008). Hence, research into supply chain integration is a fundamentally important area for current research. However, despite more than 20 years of academic publications there remains a significant gap between supply chain theory and practise; many scholars report that few companies are actually engaged in extensive supply chain integration practises (Akkermans et al., 1999; Böhme et al., 2008b; Kilpatrick & Factor, 2000; Towill et al., 2002). Here, the concept of supply chain integration is studied by focusing on supply chain uncertainty.

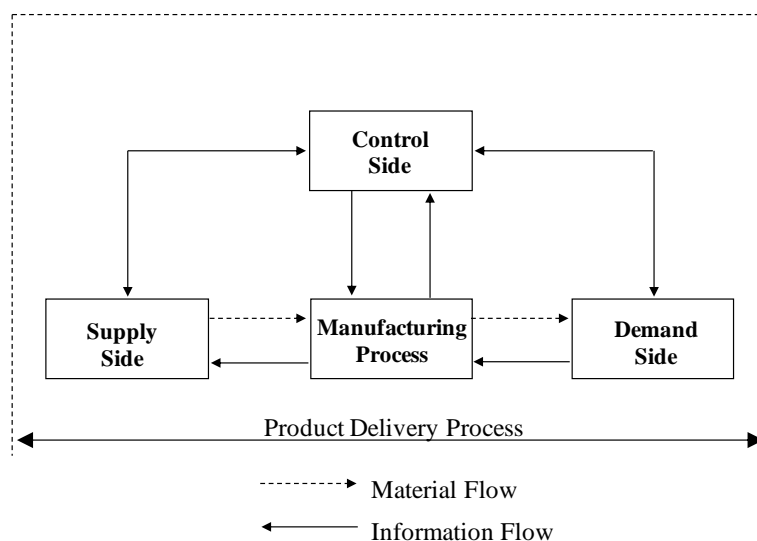
The development of comparative measures of supply chain integration maturity is complicated by the variety of supply chains encountered in practise; the operational contexts within which they operate; and the complex multi-function, multi-organisation measures required. However, a growing number of researchers have begun to use uncertainty as a comparative means for assessing and framing supply chain concepts (van der Vorst & Beulens, 2002; Vidal & Goetschalck, 2000; van Donk & van der Vaart, 2005a; Wong & Boon-itt, 2008; Lee, 2002; van der Vorst et al., 2001 and Sun et al., 2009). Numerous authors have identified the need to manage, minimise, and remove uncertainties from their business so as to increase control and co-ordination and improve the effectiveness of their decision making processes (Chopra & Meindl, 2007). This also holds true in a supply chain context as Christopher (2005) explains, “One of the main reasons why any company carries safety stock is because of uncertainty” (p. 51). This point is further emphasised by Bowersox et al., (2002) when they state, “... a basic objective of overall logistical performance is to minimise variance” (p.164).

Further, Sabri and Beamon (2000) state, “uncertainty is one of the most challenging but important problems in supply chain management” (p. 582). Finally, according to Lee (2002) “it is necessary to understand the sources of the underlying uncertainties and explore ways to reduce these uncertainties” (p. 107). The Logistics Systems Dynamics Group at Cardiff University, in collaboration with staff of the Management Systems Department at Waikato University in New Zealand have explored the issue of supply chain uncertainty in some detail. A relationship between best-in-class practise, where the supply chain is highly integrated, and levels of supply chain uncertainty has been established using the Quick Scan Audit Methodology (QSAM). During a QSAM, supply chain uncertainty is quantified using the supply chain uncertainty circle (see Figure 5.1). The uncertainty circle and the quantifying process are now further explained.

5.2.1 The supply chain uncertainty circle

Davis (1993), and later Mason-Jones and Towill (1998), segmented supply chain uncertainties into four areas termed the ‘uncertainty circle’, so that root causes and methods for minimisation can be developed (Childerhouse et al., 2007). The supply chain uncertainty circle has been applied and validated successfully (Towill et al., 2002; Childerhouse et al., 2007; Böhme et al., 2007a). Figure 5.1 illustrates the systems engineering view of supply chains.

Figure 5.1: The supply chain uncertainty circle



Source: Davis, 1993; Mason-Jones and Towill, 1998

In applying the uncertainty circle to a focal company each uncertainty area is investigated in detail. Control and manufacturing process uncertainties can be addressed predominantly internally; whereas demand and supply uncertainty areas require the involvement of the external entities. The four areas of uncertainty are summarised and evaluated in Table 5.1.

Table 5.1: Description of the four uncertainty areas

Area of Uncertainty	Explanation
Process	Process uncertainty affects an organisation's internal ability to meet a production delivery target. The amount of process uncertainty can be established by understanding each work process's yield ratios and lead time estimates for operations. Also, if the particular production delivery process is competing against other value streams for resources, the interaction must be studied and codified
Control	Control uncertainty is associated with information flow and the way an organisation transforms customer orders into production targets and supplier raw material requests. The level of control uncertainty can be determined by comparing customer requirements, supplier requests to deliver, and production targets over the same time periods. In a pure demand-pull environment the linkage between supply and demand is clear and control uncertainty is eliminated. However, companies typically use order batching and lot sizing
Supply	Supply uncertainty results from poorly performing suppliers not meeting an organisation's requirements and thereby handicapping value-added processes. It can be evaluated by looking at supplier delivery performance, time series of orders placed or call-offs, and deliveries from customers, actual lead times, supplier quality reports, and raw material stock time series
Demand	Demand uncertainty can be thought of as the difference between actual end-market-place demand and the orders placed with an organisation by its customers. Demand uncertainty can also be quantified by measuring how well companies meet customer demand. Poor on-time delivery, fill rates or high finished goods inventory are often a result of demand uncertainty.

Source: Naim et al., 2002

One common way to deal with uncertainty is by holding buffer inventory internally and at the company boundaries (Christopher, 1998), which results in a decline in operational performance. Process uncertainty results in high work-in-progress stock levels and insufficient manufacturing lead times. Supply and demand uncertainty both cause high inventory at a focal company's boundaries. Control uncertainty negatively impacts all three previously described stock levels as well as the customer satisfaction level. Next, a detailed investigation into supply chain uncertainty/integration in New Zealand is presented.

5.3 Supply chain integration in New Zealand

The research focuses on two distinct ways to investigate supply chain integration maturity in New Zealand. First, a detailed supply chain uncertainty analysis is presented using the supply chain uncertainty circle developed by Davis (1993) and Mason-Jones and Towill (1998). Second, the application of the integration evaluation tool (see Chapter 2.11.3) highlights the current stage of supply chain integration practises applied to New Zealand value streams.

5.3.1 Application of the supply chain uncertainty circle

The research question raised in this chapter was investigated via comparative analysis of twenty value streams. The term ‘value stream’ has been popularised by Womack and Jones (2005), and is defined as “the special activities required to design, order, and provide a specific product, from concept to launch, from order to delivery, and from raw materials to final end consumer” (p.68). In many respects ‘supply chain’ and ‘value stream’ are synonymous. A practical interpretation is that a supply chain consists of a bundle of one, or more often multiple, value streams. Data was collected from nine different companies consisting of twenty different value streams. Of these the Quick Scan Audit Methodology was applied to seven companies consisting of seventeen value streams. Further, three interviews with supply chain managers were conducted, applying the quantitative questionnaire presented in Appendix C. A detailed list of the primary data used for assessing uncertainty during Quick Scan investigations is listed in Table 5.2.

Table 5.2: Primary archival data sources collected during a QSAM

Uncertainty area	Primary data collection during a Quick Scan
Process side (internal uncertainty)	Scrap reports, cycle times and variability of cycle times, production targets and output, downtime reports, stock consolidation, costed bill of materials, capacity planning and asset register
Control side (internal uncertainty)	Time series of customer orders, supplier orders, demand forecasts, kanban logic, batching rules, MRP logic, call-offs, purchase orders, bill of materials number of variants, delivery frequency and number of value streams, human resource performance indicators
Supply side (external uncertainty)	Measures of performance placed on suppliers; especially schedule adherence, invoices, call-offs, bill of materials, forecasts, receipts, supplier quality reports, lead times, stock report
Demand side (external uncertainty)	Delivery frequency, echelons to end consumer, marketplace variability, stage of product lifecycle, customer ordering procedures and forecast accuracy.

Source: Naim et al., 2002

The codifying of the four uncertainty sources was undertaken by all members of the Quick Scan team. Qualitative and quantitative data related to the four types of uncertainty described above were used to assign the integration value by ranking each of the four areas of uncertainty. A 4-point Likert scale was applied to each uncertainty area, which anchors 1 = lowest uncertainty; 4 = highest uncertainty. The seamless value chain clearly exhibits low uncertainty scores for process, control, supply and demand. The choice of a 4-point Likert scale was aimed at reducing any tendency towards the mean, and instead focuses on strengths and weaknesses of individual value chains (Towill et al., 2002). Where necessary, the Likert scores were verified by cross-reference to detailed Quick Scan reports; available in Appendix E. Table 5.3 lists the uncertainty scores for the twenty value streams.

Table 5.3 Detailed uncertainty data for the 20 identified value streams

Company	Person days	Value stream	Method	Process	Control	Supply	Demand
Manufacturer 1	24	1	Quick Scan	4	4	3	3
Manufacturer 1		2	Quick Scan	3	3	3	4
Dairy 1	30	3	Quick Scan	1	4	3	4
Dairy 1		4	Quick Scan	1	4	4	4
Forestry	30	5	Quick Scan	2	3	4	3
Forestry		6	Quick Scan	2	3	4	2
Food 1	24	7	Quick Scan	1	3	1	1.5
Food 1		8	Quick Scan	2	3	1.5	3
Food 1		9	Quick Scan	1	3	1	3
Manufacturer 2	36	10	Quick Scan	2.5	3.5	2	2.5
Manufacturer 2		11	Quick Scan	3.5	3.5	2	4
Service	24	12	Quick Scan	1	3	3	1
Service		13	Quick Scan	2	3	3	3
Service		14	Quick Scan	4	4	3	2
Service		15	Quick Scan	4	4	3	3
Steel	30	16	Quick Scan	4	4	3	3.5
Steel		17	Quick Scan	3	4	3	4
Dairy 1	1	18	Interview	1.5	4	3	4
Retail	1	19	Interview	1	2	3	3
Storage	1	20	Interview	1	2	1.5	4

Source: Author

In total, 201 person days were spent investigating twenty value streams in nine different companies. Next, the detailed uncertainty analysis for all four uncertainty areas is presented.

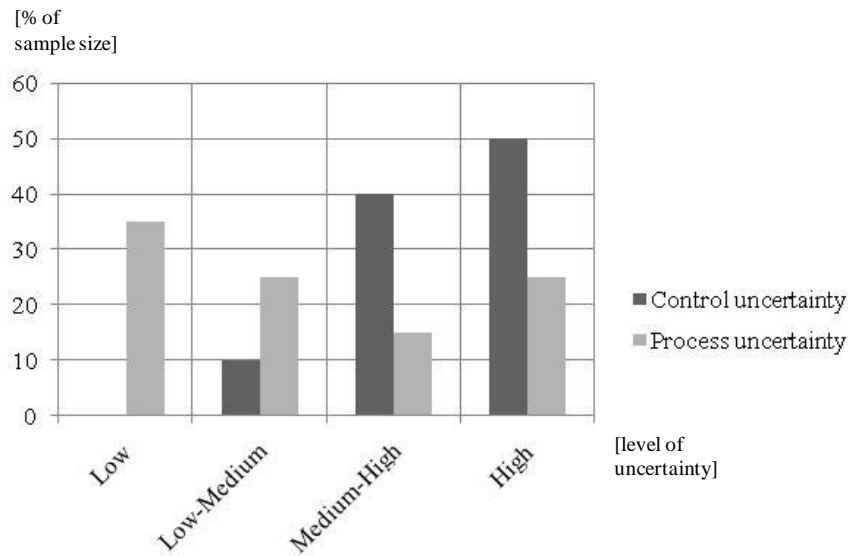
5.3.1.1 Detailed uncertainty analysis

The detailed uncertainty analysis compares two uncertainty areas. As mentioned earlier, the control and manufacturing process uncertainties can be addressed predominantly internally whereas the demand and supply uncertainty areas require the involvement of the external entities. Hence, control and process uncertainties are compared before supply and demand uncertainties.

5.3.1.1.1 Control and process uncertainty

The evaluation of control and process uncertainty is supported with industry insights from New Zealand, and Figure 5.2 shows the distribution of control and process uncertainty levels.

Figure 5.2: Comparison of control and process uncertainty



Source: Author

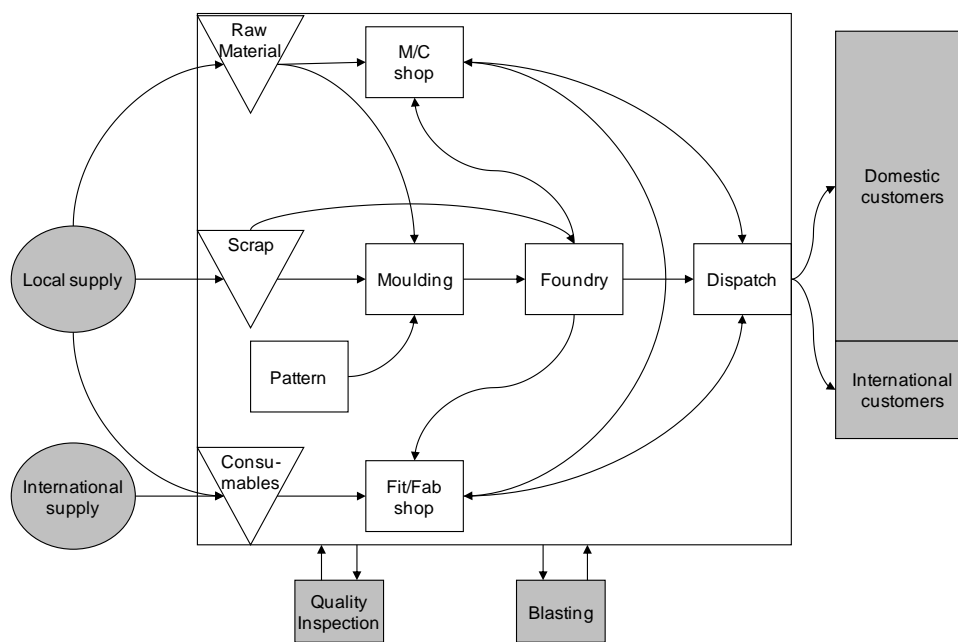
The x-axis in Figure 5.2 presents the level of uncertainty, the y-axis the percentage of value streams studied. Figure 5.2 shows that New Zealand value streams face higher uncertainty from the control side than from the process side. The mean value for control uncertainty is 3.35, which is significantly higher than the mean for process uncertainty (2.23). The t-test results in a p-value of 0.00004, which is significant at the $p \leq 0.01$ level. Further, Figure 5.2 clearly shows that no value stream was identified having minimised control uncertainty. However, 50% of the sample faces the highest control uncertainty.

The reasons for the high control uncertainty are manifold. The most common are inappropriate information systems and functional silos within the company. All the value streams suffered from inappropriate supply chain management information systems. Often the information systems are outdated and/or are designed to support a company's finance and accounting function. These information systems were not capable of capturing common supply chain management performance indicators. Hence, most of the supply chain data was analysed by individuals and shared using e-mail, which result in incomplete information flows and often inconsistent results for the same performance indicator. The lack of an integrated information system is of great concern in five of the nine cases, where sales/marketing is physically separated from the

production plant. Regular face-to-face meetings have not been set up. This poor information flow results in poor sales and operational planning procedures because relevant demand and supply information is not included in the production planning process. Hence, mismatch of supply and demand is very common.

High process uncertainty was predominantly identified within the medium-sized businesses, Steel, and Manufacturing 1 and 2. In all three cases, the factory layout was neither logical nor clear, resulting in excessive manufacturing lead times, high work-in-progress inventory, and high non-conformance in production. For example, Figure 5.2 shows the supply chain map example of Steel.

Figure 5.2: Steel's supply chain map



Source: Author

The grey shaded areas in Figure 5.2 are suppliers (left hand side and bottom) and customers (right hand side). The white shaded rectangles are internal workshops, and the triangles represent stocking points. The arrows highlight the convoluted material flow. Material needs to be handled and coordinated between six different internal workshops and two outsourced process steps. Three distinct material stocking points supply those workshops with material. In the case of Steel, the research identified that one of their core value streams currently operates with a

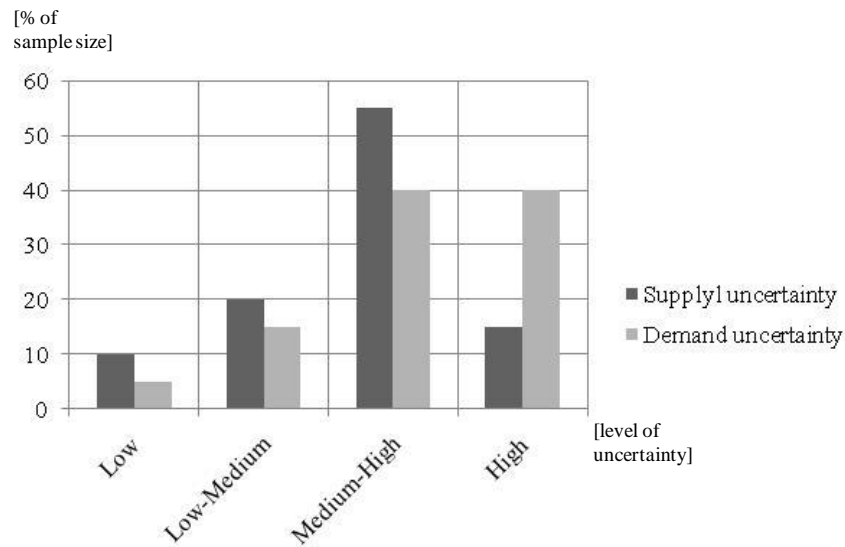
two month average manufacturing lead time, of which for only 24% of the time is valued added to the product.

The comparison of control and process uncertainty reveals a second interesting insight. Thirty five percent of all value streams face low process uncertainty and the remaining 65% are spread more or less evenly across the remaining levels of uncertainty. Hence, the standard deviation of process uncertainty (1.1863) is significantly higher than the standard deviation of control uncertainty (0.6509). The f-test results in a p-value of 0.006, which is significant at $p \leq 0.01$ level. The reason for the significantly higher standard deviation of process uncertainty is twofold. On the one hand, some value streams face low process uncertainty because of the simplicity of the process or because the value stream is highly automated. On the other hand, especially Manufacturer 1 and 2 and Steel, face high(est) process uncertainty (as described earlier). The reason for the comparably low standard deviation of control uncertainty is that 90% of the sample face medium-high or high control uncertainty; most New Zealand companies have implemented poor value stream control mechanisms. Overall, New Zealand value streams are weakly internally integrated and face high uncertainty, especially from the control side. Next the external uncertainty consisting of demand and supply uncertainty is investigated.

5.3.1.1.2 Supply and demand uncertainty

The external uncertainty category consists of demand uncertainty and supply uncertainty. The evaluation of supply and demand uncertainty is supported with industry insights from New Zealand and Figure 5.3 shows the distribution of supply and demand uncertainty.

Figure 5.3: Comparison of supply and demand uncertainty



Source: Author

The x-axis in Figure 5.3 presents the level of uncertainty, the y-axis the percentage of value streams studied. The mean for demand uncertainty (3.08) is 0.38 points higher than the mean for supply uncertainty (2.7). The t-test results in a p-value of 0.093206, which is significant at the $p \leq 0.1$ level. Hence, New Zealand value streams are significantly less integrated on the customer side than on the supplier side. The standard deviation for demand uncertainty (0.9072) is only marginally higher than the standard deviation for supply uncertainty (0.9090). The f-test results in a p-value of 0.4966, which is not significant.

On the demand side, sixteen value streams face medium-high or high demand uncertainty. On the supply side, 55% of all value streams face medium-high supply uncertainty. Fifteen percent face the highest level of uncertainty compared with only 10% of all the value streams that have minimised supply uncertainty. All exemplars facing low supply and demand uncertainty are value streams from Food 1, a company that has the most advanced relationship management practises in place compared to its New Zealand counterparts.

The reasons for the high demand uncertainty are twofold. First, in a few instances demand uncertainty is introduced by the different markets. Steel, for example, operates predominantly in a project-based environment, where future projects are

often hard to forecast. Hence, Steel can often only react to market demand fluctuations. Also, some companies produce more innovative products, which automatically lead to higher demand volatility (Christopher, 2000). The second reason for high demand uncertainty is poor customer relationship management and inaccurate forecasting procedures. In many cases, the forecasting mechanisms are immature and lack real-time market information. Manufacturer 2, for example, is part of a global operating enterprise with sales offices worldwide. However, the global enterprise has no system in place that increases warehouse visibility at the worldwide operating sales offices. The low level of visibility results in poor sales and operations planning and late and/or inefficient deliveries. A second example is provided by Food 1, which currently has one of the more advanced customer integration practises in place; including vendor managed inventory (VMI) agreements with major local retailers. However, Food 1 did not manage to implement collaborative planning, forecasting, and replenishment (CPFR) or even a VMI agreement with its own sister company in Australia; head office places both production plants under considerable internal competitive pressure.

New Zealand companies manage to better integrate with their suppliers than with their customers, hence supply uncertainty is significantly lower than demand uncertainty. Good integration practises range from VMI agreements with key suppliers; strong performance measurements; and minimised supplier bases. However, 55% of the sample still face medium-high supply uncertainty. Forestry, for example, is currently managing a very large supply base (~1200) resulting in transactional relationships with key suppliers. Other examples are provided by Dairy 1 and Steel, that have no procurement or supplier relationship management function; they both purchase on demand. Purchasing authority is given to key people in different functional areas, resulting in predominantly transactional relationships and poor supplier performance. Good indicators for demand and supply uncertainty are finished goods stock level and stock turn ratios. Table 5.4 presents four examples of companies facing high supply and demand uncertainty resulting in high inventory levels and low stock turns.

Table 5.4: Inventory levels and stock turns by value stream

Company	Value stream	Supporting data
Forestry	6	4.3 finished goods stock turn (3 months of stock). Annual stock holding cost of NZD 1.5 million (est.)
Food 1	7	1.5 months of finished goods stock resulting in NZD 9 million annual inventory carrying cost
Forestry	5, 6	NZD 22.5 million of maintenance stock. 2.5 years of inventory. NZD 3.6 million of machine clothing inventory. 1.3 years of inventory
Dairy 1	3, 4	On average, 3.1 months of raw material inventory.

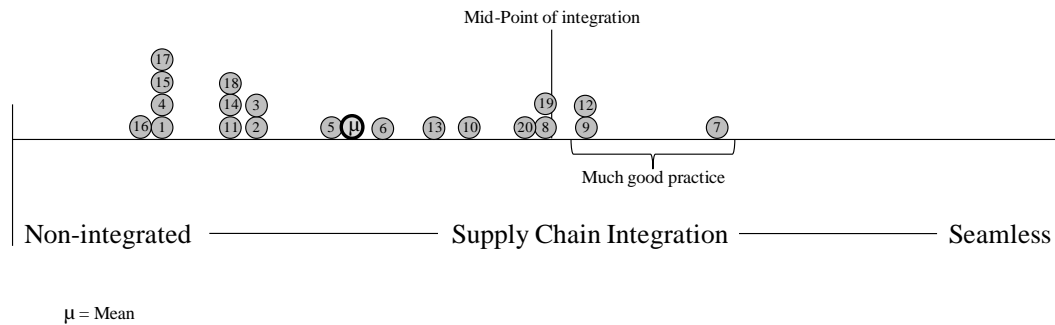
Source: Author

Table 5.4 provides inventory examples of three different companies (seven different value streams). The research identified high stock levels and low stock turns throughout the cases. In many the high stock levels function as a buffer against future uncertainty demand and unreliable suppliers. New Zealand companies face high external uncertainty due to poor relationship management and incomplete information flows with external entities. The four quantified supply chain uncertainty measures enable benchmarking of the twenty value streams; these benchmarks are presented next.

5.3.1.2 Supply chain uncertainty benchmarking

The benchmarks have been established via calculation of Euclidean Norm values. The formula for the Euclidean Norm calculation and the uncertainty score for each value stream is highlighted in Appendix E.1. The Euclidean Norm for each value stream was calculated because ‘a chain is only as strong as its weakest link’. Using this measure a non-integrated supply chain facing highest uncertainty would score 6 and the seamless supply chain facing lowest uncertainty would score 0. Figure 5.4 presents the resulting uncertainty scores for each value stream.

Figure 5.4: Uncertainty benchmark of the New Zealand sample



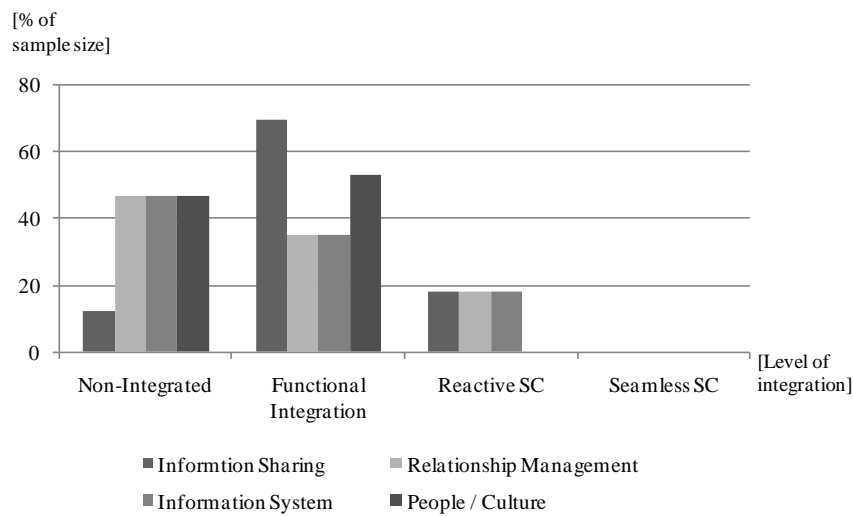
Source: Author

Figure 5.4 highlights that most value streams are positioned closer to the non-integrated supply chain side. Only three value streams were identified that were clearly beyond the mid-point of integration, i.e. progressing towards being a seamless supply chain. The research identified much good practise for value streams 7, 9 and 12. However, the value of the mean (μ) lies between the non-integrated supply chain and the mid-point. In the next section, the uncertainty data is validated via the application of the supply chain integration evaluation tool.

5.3.2 Application of the integration evaluation tool

As described earlier, the integration evaluation tool was developed with the aid of recent publications in the area of supply chain integration; hence, it is strongly anchored in the supply chain literature (see also Chapter 2.11.3). With the exception of value stream 19 and 20, the tool was applied during the Quick Scans. The data from value streams 19 and 20 were revised. Key personnel within each category were interviewed, followed by a discussion between all the researchers involved to judge if the collected data reflected reality. Finally, the average score was calculated to identify the current stage of supply chain integration for each category. The individual company scores for each identified characteristic can be found in Appendix H and Figure 5.5 presents the average level of supply chain integration for each identified category.

Figure 5.5: Outcome of the application of the integration assessment tool



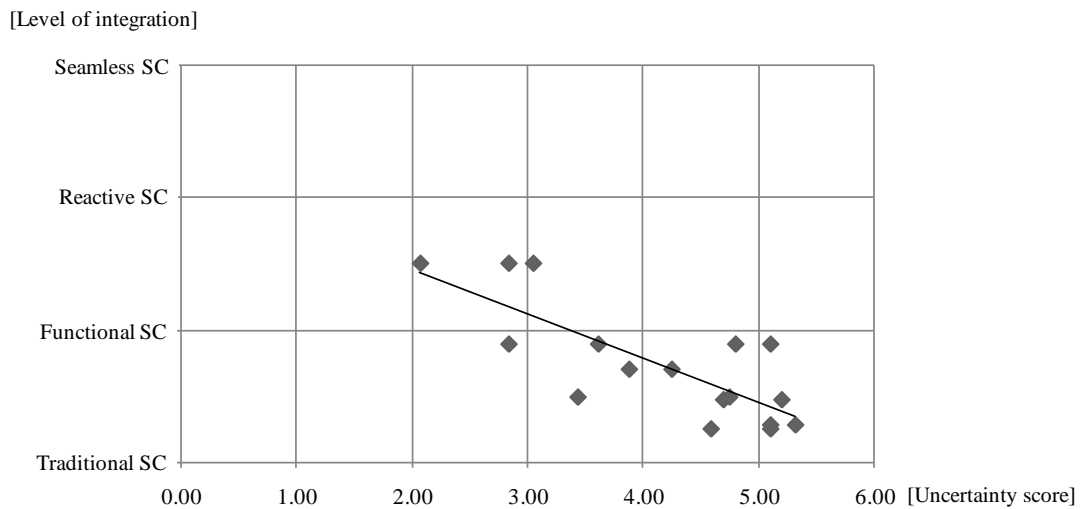
Source: Author

Figure 5.5 again highlights that good value stream integration practises are rare. No value stream was positioned in the seamless supply chain integration stage for any of the four categories. The non-integrated and functional integrated supply chain stages dominate. Only 18% of all value streams achieved the reactive stage for three of the four categories. The category that scored least is the people/culture category. Overall, 45% of all value streams fall within the non-integrated stage and the remaining 55% are in the functional integrated stage. The most advanced category is information sharing, were approximately 70% of all value streams reached the functional integration stage, 18% are in the reactive supply chain stage, and the remaining 12% are in the non-integrated supply chain stage. Overall, the assessment revealed a similar picture of current supply chain integration practises to the earlier benchmarking exercise in Figure 5.4, hence the application of the integration assessment further validates the uncertainty benchmarks.

In spite of this, further validation of the developed integration evaluation tool is desirable because of the importance of the tool to the overall thesis (the integration evaluation tool is used to assess a focal company's efforts to further integrate its supply chain). The resulting uncertainty score is then compared to the company's value stream integration practise, since it is expected that the higher the supply chain uncertainty score, the lower will be the level of supply chain

integration practises. Figure 5.6 presents the outcome of this comparison (integration evaluation was not conducted for value streams 19 and 20).

Figure 5.6: Validation of integration assessment tool using value streams 1-18



Source: Author

The x-axis in Figure 5.6 presents the uncertainty score and the y-axis the value stream integration level using the developed supply chain integration evaluation tool. As expected, Figure 5.6 highlights that higher uncertainty score values correlate with lower levels of supply chain integration, and vice versa (correlation coefficient = 0.7864). This means that a high correlation between uncertainty score and level of integration is present at a significance level of 0.0002 (significant at $p \leq 0.01$ level). Hence, Figure 5.6 verifies the legitimacy of the developed supply chain integration evaluation tool. Next, the comparison of the New Zealand uncertainty data with the UK automotive sector is presented.

5.3.3 Comparison of the UK automotive sector with NZ data set

Towill et al. (2002) carried out detailed case studies of 20 value streams from the European automotive sector between November 1997 and February 1999. They found that some 80 percent of value streams faced high uncertainties and are therefore weakly integrated. A detailed list of the UK automotive supply chain uncertainty data can be found in Appendix E.3. In Table 5.5 this data is compared

to the New Zealand sample, which was collected between September 2003 and February 2008.

Table 5.5: Comparison of NZ value streams with UK automotive

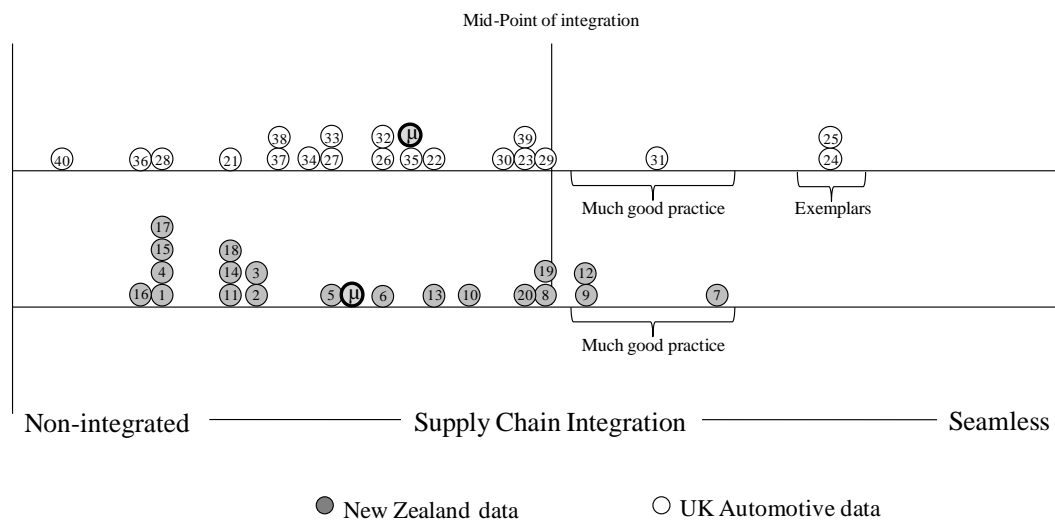
Uncertainty	NZ sample		UK sample		t-test	f-test
	Mean	Stdev	Mean	Stdev	p-value	p-value
Process	2.23	1.1863	2.30	1.0311	0.8092	0.2735
Control	3.35	0.6509	2.50	1.3179	0.0158	0.0017
Supply	2.70	0.9090	2.45	1.0990	0.4462	0.2078
Demand	3.08	0.9072	3.15	1.0400	0.8272	0.2787
Euclidean Norm	4.07	0.9951	3.78	1.401	0.0103	0.6034

Source: Author

Table 5.5 compares the mean and standard deviation of both samples. Further, a t-test and an f-test have been conducted to determine whether significant differences exist between means (t-test) and standard deviations (f-test) (significant at $p \leq 0.05$). Some insights can be drawn from the comparison. First of all, both samples follow similar patterns. The demand and process uncertainty of both samples is similar. However, one key difference between the samples is that the UK value streams face highest uncertainty from the demand side followed then by control, supply and process uncertainty. New Zealand value streams, instead, face highest uncertainty from the control side followed then by demand, supply and process uncertainty.

The difference between the mean control uncertainty scores is 0.85, and the New Zealand score is significantly higher; also the paired t-test indicates this difference is significant. New Zealand companies have significantly poorer control mechanisms in place than their UK counterparts. The f-test (p-value = 0.0017) also shows significant differences between both standard deviations (significant at p-value ≤ 0.01). These findings are supported by Closs and Mollenkopf (2004) who identified, using a quantitative comparison between Australian and New Zealand (ANZ) and the USA, that ANZ companies place less emphasis on internal integration (control and process uncertainty reduction) than their US counterparts. Finally, the mean of the Euclidean Norm between both countries is significantly different (significant at $p \leq 0.05$). Figure 5.7 presents the Euclidean Norm benchmarking comparison of the New Zealand data set and the UK automotive sector data.

Figure 5.7: Benchmark comparison between NZ and UK automotive



Source: Author

Figure 5.7 shows that the UK data is more evenly and more widely spread. Because some 50% of New Zealand value streams are located closer to the non-integrated region. On average New Zealand companies face higher uncertainty than their UK counterparts. One commonality is that both data sets have three value streams clearly positioned beyond the mid-point, and progressing towards the seamless region. However, while Towill et al. (2002) identified two exemplar value streams within their data set; the New Zealand data only revealed three value streams exhibiting much good practise. Overall, both samples highlight that value stream integration is poor in both countries and that highly integrated supply chains remain exceptional. In the next section the uncertainty data is applied to existing supply chain integration models. Here, the research aims to identify whether companies follow a distinct path to supply chain integration.

5.4 Validation of existing supply chain integration models

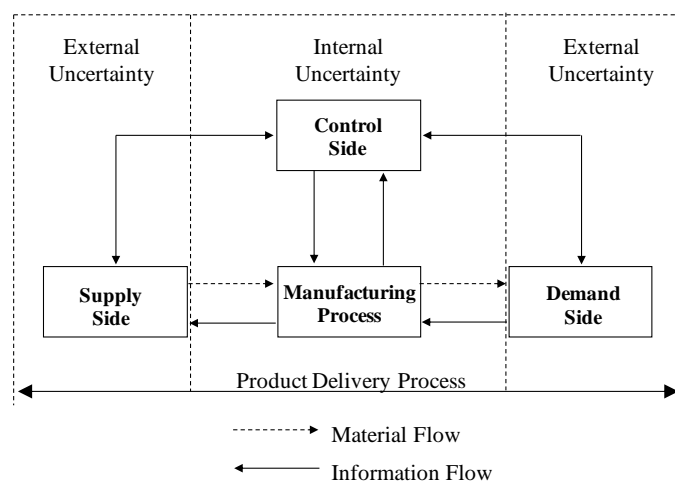
Narasimhan and Kim (2001) note that much of the research on integration has been predicated on the assumption that integration occurs in distinct sequential stages. Possibly the most influential work regarding a staged process is by Stevens (1989), who suggests that companies follow an integration process that goes through different stages; integrating internally before then extending the integration process to include other supply chain members externally (Stevens,

1989). Empirical evidence, (Towill et al., 2002; Koufteros et al., 2005) and case study research (Gimenez, 2004) support the conceptual model developed by Stevens.

Bowersox & Daugherty (1995), Hewitt (1994) and Gimenez (2004) also emphasize that the improvement of each internal function should precede the external connection with suppliers and customers in the external integration stage. However, Gimenez's (2004) highlighted that one exemplar did not follow Stevens (1989) integration model. Halldorsson et al. (1999) similarly report that managers seem to achieve more successful integration with external business partners than they do with managers and departments within their own company.

The original uncertainty circle developed by Davis (1993) and Mason and Jones (1998) (see also Figure 5.1) is adapted in order to verify the currently available supply chain integration models. This adapted version of the supply chain uncertainty circle divides the original circle into two categories: (1) internal uncertainty; and (2) external uncertainty. Internal uncertainty consists of control and process uncertainty, and external uncertainty consists of supply and demand uncertainty. The clustering of the supply chain uncertainty circle into internal and external uncertainty allows the researcher to identify the focal company's focus area for value stream integration. Figure 5.8 presents the adapted version of the uncertainty circle.

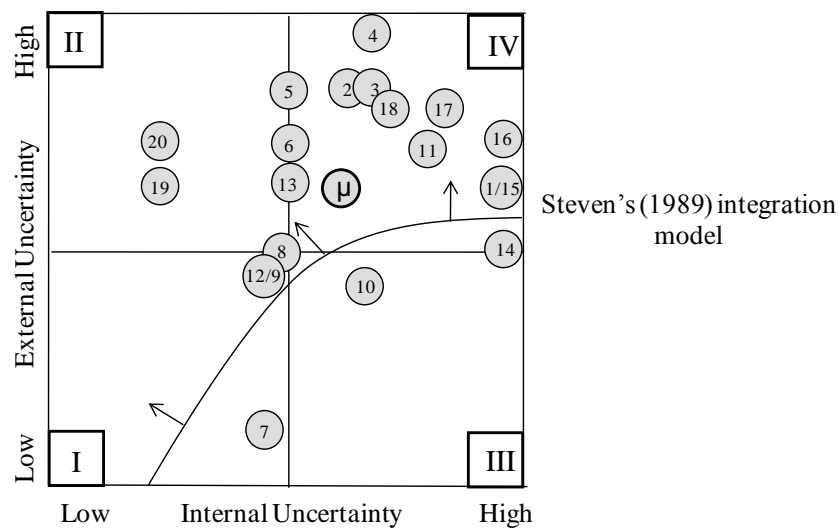
Figure 5.8: Adapted version of the supply chain uncertainty circle



Source: Adapted from Davis, 1993; Mason-Jones and Towill, 1998

The Euclidean Norm for both the internal (process and control) and external (supply and demand) uncertainty category were calculated for each of the 20 value streams. These values (Appendix E.2) are shown in the 2x2 matrix in Figure 5.9.

Figure 5.9: Validation of Stevens (1989) integration model (NZ data)



Source: Author

The matrix consists of four quadrants. The top right quadrant (IV) reflects the situation of a non-integrated value chain having high internal and external uncertainty. In contrast, the bottom left quadrant (I) represents the seamless supply chain facing minimised internal and external uncertainty. The top left quadrant (II) reflects low internal integration, where internal uncertainty is reduced, but external uncertainty remains high. Finally, quadrant (III) reflects low external integration, where external uncertainty is reduced but high internal uncertainty remains.

Figure 5.9 also identifies that, overall, New Zealand companies face slightly higher levels of internal integration than external integration (observe the position of μ in Figure 5.9). Forty five percent of the value streams are positioned in the top-right quadrant (IV) representing the non-integration area. Twenty five percent of the value streams studied are currently in a transition stage between quadrants.

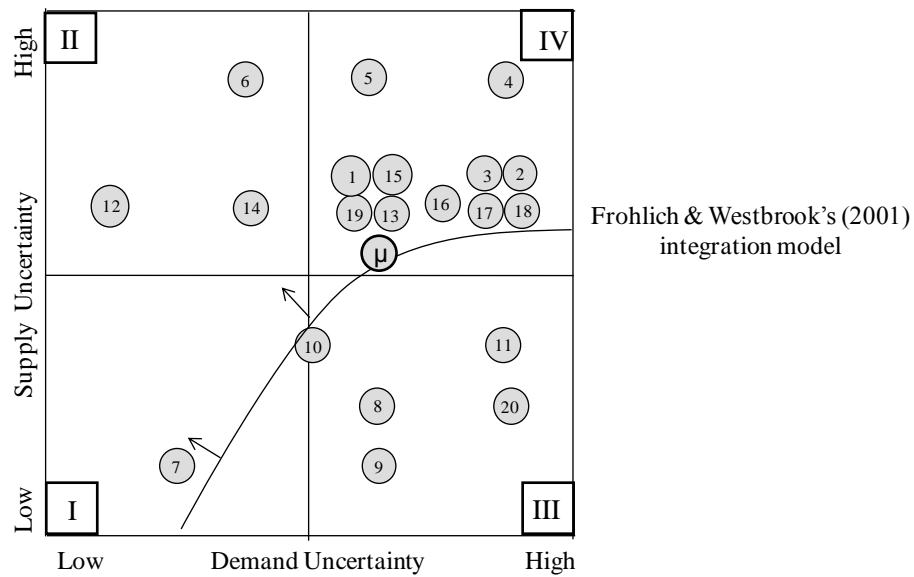
Only fifteen percent of the sample lie within quadrant (I) and are facing low uncertainty internally and externally. Ten percent of the sample have managed to reduce their internal uncertainty significantly; however, high external uncertainty remains. Only five percent (1 value stream) was assessed as being in quadrant (III). This value stream managed to considerably reduce external uncertainty; however, high internal uncertainty remains.

Figure 5.9 also shows a Stevens' integration model curve. Stevens (1989) suggests that companies follow an integration process by integrating internally first and then extending the integration process to other supply chain members externally; all the value streams should appear above Stevens integration model curve. However, three value streams (15%) have been identified that do not follow Steven's integration model, and it is important to note that these belong to three different companies.

Value stream 14 has managed to halve its external uncertainty, yet it still faces highest internal uncertainty. In contrast, value stream 10 has managed to reduce some internal uncertainty but clearly most of the company's efforts were on the external side. Finally, value stream 7 has managed to reduce external uncertainty almost to a minimum but still faces some internal uncertainty. In conclusion, this study supports the Gimenez (2004) and Potter et al. (2004) findings that companies do not always follow Stevens (1989) integration model.

In the next section, external integration is further divided into supply uncertainty and demand uncertainty. Here the intention is to identify whether the twenty value streams follow Frohlich and Westbrook's (2001) integration model. These authors identified that companies tend to integrate with customers first, before integrating with their main suppliers. Figure 5.10 maps the twenty value stream values.

Figure 5.10: Validation of Frohlich & Westbrook's (2001) integration model



Source: Author

The x-axis represents demand uncertainty, the y-axis supply uncertainty. Quadrant (IV) represents high external (supply and demand) uncertainty and quadrant (III) represents minimised external uncertainty. Some fifty five percent of the value streams studied are positioned in quadrant (IV). Only ten percent of the sample lies within quadrant (I), facing low(er) supply and demand uncertainty. Fifteen percent of the sample has managed to considerably reduce demand uncertainty; however, high supply uncertainty remains. Quadrant (III) represents those value streams that have managed to reduce supply uncertainty but demand uncertainty remains high. In total twenty percent of all value streams have been identified in this quadrant. Overall New Zealand value streams are weakly integrated on the supply and demand side, which is reflected by the position of the mean value in quadrant (IV).

Again, Figure 5.10 shows a Frohlich and Westbrook (2001) integration model curve. These authors identified that companies tend to reduce demand uncertainty before reducing supply uncertainty, hence all the value streams are expected to lie above the Frohlich and Westbrook (2001) integration model curve. However, the current research identified that twenty five percent of all value streams do not follow Frohlich & Westbrook's (2001) integration model; these studied value streams are more strongly integrated with suppliers than with customers.

Halldorsson et al.'s (2008) quantitative study reports similar findings. These authors compared the Scandinavian and North American perspectives on supply chain management and identified that companies in both countries found it easier to integrate upstream with suppliers than downstream with customers.

5.5 Discussion

The development of comparative measures of supply chain integration maturity is complicated by the variety of supply chains encountered in practise; the operational contexts within which they operate; and the complex multi-function, multi-organisation measures required. As a result, many researchers use subjective Likert scale measures (e.g. Rosenzweig et al., 2003) to assess respondents' perception of their supply chain. Chapter 5 applied the subjective measure termed uncertainty to evaluate supply chain integration maturity in practise. Measurement of uncertainty essentially enables the researcher to compare and benchmark a supply chain independent of the context within which it operates.

Both the supply chain uncertainty analysis and the supply chain integration evaluation tool highlight that New Zealand value streams are weakly integrated. New Zealand value streams face highest uncertainty from their control side, followed by demand uncertainty. However, some islands of good practise have been identified. Overall, the research into value stream integration in New Zealand reveals that a significant gap remains between value stream integration theory and practise. Hence, this research supports the existing literature regarding the lack of practitioner uptake of supply chain integration concepts. Many scholars report that few companies are actually engaged in extensive supply chain integration practises (Akkermans et al., 1999; Harps & Hansen, 2000; Kilpatrick & Factor, 2000; Towill et al., 2002; Poirier & Quinn, 2003).

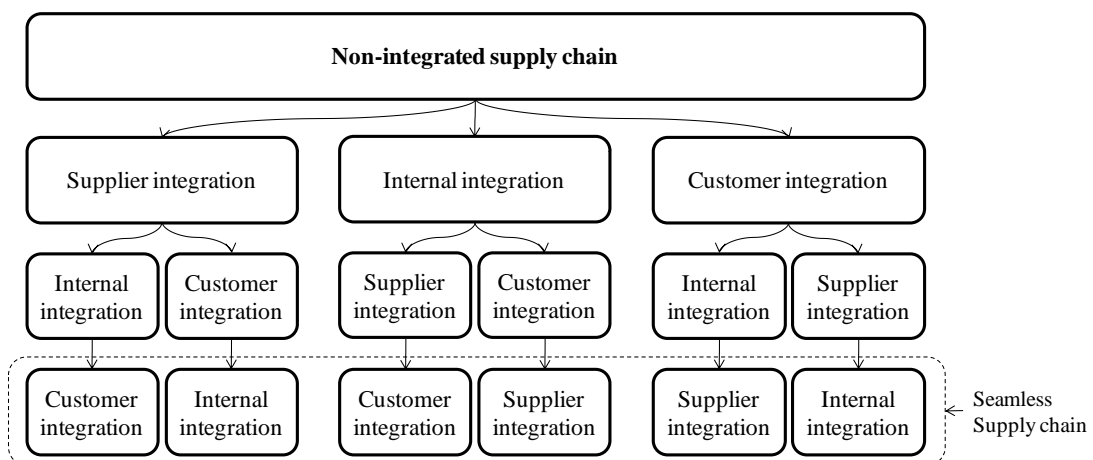
The comparison of the New Zealand data with the UK automotive sector revealed many similarities between the data sets. However, the control uncertainty paired t-test demonstrates a significant difference exists. Basnet et al. (2003) reported that New Zealand companies lack proper control mechanisms and that information

systems particularly are often outdated. Closs and Mollenkopf (2004) report that Australian and New Zealand (ANZ) companies place less emphasis on internal integration than do their US counterparts.

The uncertainty data further validates the developed integration evaluation tool (see Chapter 2.11.3). The tool is underpinned by the supply chain literature and was shown to be strongly correlates with the uncertainty scores; thus concluding that it is a useful supply chain integration audit tool.

Finally, Chapter 5 supports the latest research in supply chain integration by highlighting that Stevens' (1989) supply chain integration model does not always reflect reality (Potter et al., 2004; Gimenez & Ventura 2005). Companies do not always follow Stevens' (1989) supply chain integration model when integrating their supply chain; internal and external integration can occur simultaneously. Further, the New Zealand sample highlights that value streams face higher uncertainty from the demand side than from the supply side; a finding that contradicts the research findings of Frohlich and Westbrook (2001) who deduced that companies tend to integrate with customers first, before focusing on the supply side. It seems that there exists more than a single path to a seamless supply chain and Figure 5.11 proposes a supply chain integration model consisting of six distinct paths.

Figure 5.11: Proposed supply chain integration model



Source: Author

Narasimhan and Kim (2001) note that much of the research on integration has been predicated on the assumption that integration occurs in distinct stages. In contrast, the integration model developed in Figure 5.11 follows the findings of the present research. At the top of Figure 5.11 is the non-integrated supply chain stage. Companies that are at this non-integrated stage may choose to integrate internally or externally (with customers or suppliers) first. Once the first integration stage is achieved, the remaining integration areas are tackled until the seamless supply chain is achieved. The question remains, why does a company take a certain path to integrate its supply chain? This thesis will further explore the paths to value stream integration and seeks to validate the proposed supply chain integration model (later Chapter 8). Chapter 8 also includes a discussion around the desirability and feasibility of supply chain integration in practise.

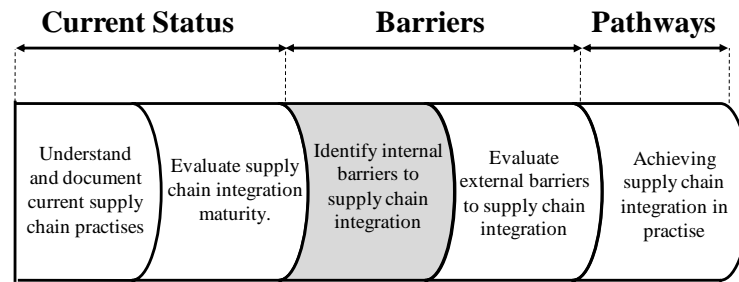
This exploratory investigation into the current stage of supply chain integration in New Zealand is not without limitations. The most obvious is that the sample cannot be used to generalise to the overall population of New Zealand value streams. The question remains whether other companies are similarly weakly integrated. Mollenkopf and Dapiran (2005), for example, report in their quantitative study that world class supply chains do exist in ANZ. However, this research has only identified that a few value streams are applying good supply chain practise. Further research is needed to explore the level of supply chain integration in New Zealand.

5.6 Conclusion

Supply chain integration in practise remains an elusive goal. This chapter evaluated and benchmarked uncertainty levels of value streams, utilising the 'uncertainty circle' developed by Davis (1993) and Mason-Jones and Towill (1998). The benchmarking revealed that New Zealand value streams are weakly integrated and face high uncertainty, especially from the control and demand sides. These findings are further validated through data triangulation by the application of the developed supply chain integration evaluation tool. This chapter also compared New Zealand findings with the UK findings by Towill et al. (2002) and concluded that differences in supply and process uncertainty are marginal; but

the UK sample faces less uncertainty on the control and demand sides than their New Zealand counterparts. The New Zealand companies even have significantly lower control mechanisms in place compared with their UK counterparts. Finally, the uncertainty scores were applied to Stevens' (1989) and Frohlich and Westbrook's (2001) staged integration models. The research identified that both models do not always reflect reality; internal and external integration can happen simultaneously. Finally and in light of these findings a new supply chain integration model was developed, which will be further validated in Chapter 8.

Chapter 5 has made two major contributions to theory. First, this research supports the current literature that a gap exists between supply chain integration theory and the actual uptake in practise. Best-in-class performance remains an elusive goal for most value streams in New Zealand and best practises adoption is patchy. Second, the research contradicts existing supply chain integration models and proposes a new supply chain integration model, which will be further explored. However, before moving to the paths to value stream integration, the question remains recording the internal and external barriers that value streams face when attempting to integrate. The following chapter provides insights into internal value stream integration barriers.



6. Barriers to Internal Supply Chain Integration

Research Question: What barriers obstruct internal supply chain integration in practise?

6.1 Introduction

The previous chapter assessed supply chain uncertainty and concluded that New Zealand value streams are weakly integrated. A gap was identified between supply chain integration theory and its uptake in practise. This chapter focuses on the barriers to internal supply chain integration. The research seeks to understand why supply chains are so weakly internally integrated and what common supply chain integration barriers exist. It enhances the understanding of the causes of certain internal supply chain integration barriers. To answer the research question, insights from six companies are presented. The chapter predominantly uses systems thinking in form of cause and effect analysis, which is one of the core analysis elements used during a Quick Scan. First, the developed conceptual model is introduced. This is capable of capturing different internal barriers to supply chain integration and categorising them into environmental barriers, company barriers, and value stream barriers. Further explanation of systems thinking and cause and effect analysis is provided, and the application of the conceptual model to six distinct cases is presented.

6.2 Barriers to internal supply chain integration

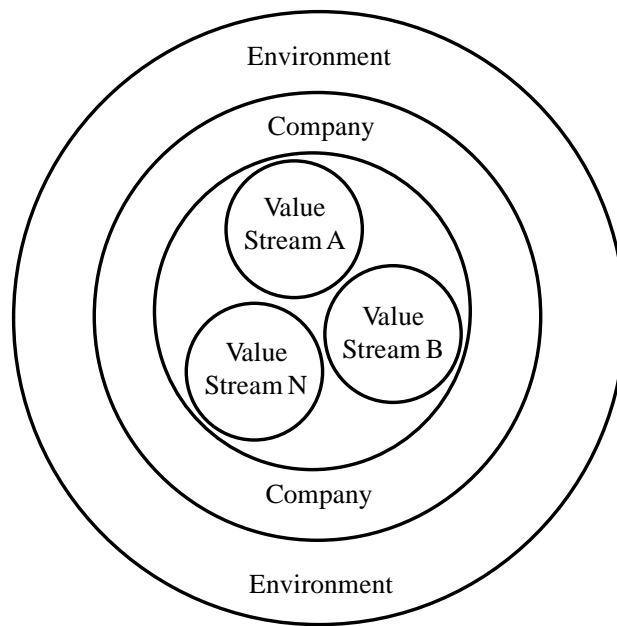
Many scholars acknowledge the existence of barriers to internal supply chain integration (Bagchi & Skjott-Larse, 2002; van Donk & van der Vaart, 2005a;

Whipple & Frankel, 2000). Frohlich (2002) goes a step further when he argues that internal barriers are the most important to address when implementing supply chain integration solutions. However, in-depth investigations into the topic are rare and barriers to supply chain integration remain not well understood (Storey et al., 2005).

Barriers to internal integration have their origins in traditional functional practises related to organisational structure, measurement and reward system, information technology, and supply chain skills (Wisner et al., 2005). The two key publications in the field of barriers to supply chain integration are by Gimenez (2004) and Pagell (2004). Gimenez's (2004) exploratory study focuses on supply chain management implementation in the Spanish grocery sector. Pagell (2004) focuses on the integration of three separate departments within a focal company, and both authors focus solely on a company level when investigating the barriers to supply chain integration. Other authors (e.g. Basnet et al., 2006; Keegan et al., 2001) investigated country specific or industry specific (e.g. Post & Altman, 1994) barriers to supply chain excellence. Towill (1999b) went beyond the company level and identified that competing value streams can inhibit integration efforts; these can create a barrier to supply chain integration when resources need to be shared amongst the different value streams.

Gimenez (2004) points out that most identified barriers to supply chain integration lack a commonly agreed structure. Consequently, Figure 6.1 proposes a supply chain barrier structure consisting of three distinct layers: environmental barriers, company barriers, and value stream barriers.

Figure 6.1: Three layers of internal supply chain integration barriers



Source: Author

The three layer structure proposed in Figure 6.1 can be viewed from outside (broad environmental context) to inside (detailed internal company context). Next, each layer is explained in detail.

6.2.1 Environment level

Here, the environmental level is related to internal integration barriers because a focal company's specific environmental aspects are assessed, which has an impact on internal integration. Previous research on the environmental barriers to supply chain integration is limited. Perhaps, the most relevant research is by Basnet et al. (2006) and Keegan et al. (2001). Whereas Keegan et al. conducted their research in the Irish grocery sector, Basnet et al. carried out in-depth case study research with two New Zealand-based companies. However, Keegan et al.'s study potentially gives some valuable insight into the New Zealand context due to the similarities between the two countries: small population size, low population density, indifferent logistical infrastructure, and a high proportion of small and medium-sized companies. Thus unsurprisingly, the research findings by Basnet et al. and by Keegan et al. are similar, Table 6.1.

Table 6.1: Similarities between Irish and NZ supply chain integration barriers

Environmental barrier	New Zealand	Ireland – grocery sector
Competition	The lack of a highly competitive domestic marketplace influences the need to adopt advanced supply chain management practises	The lack of a highly competitive domestic marketplace influences the need to adopt advanced supply chain management practises
Geographical factors	New Zealand’s geographical isolation acts as a barrier to organisations developing good supply chain management practises	Low population density restricts supply chain management use; however, economic growth and increased consumer spending increases its adoption
Infrastructure/ Logistics	The indifferent logistical infrastructure is a barrier to the adoption of leading edge supply chain practises	Physical as well as IT infrastructure can be restrictive. High logistical costs in Ireland compared to EU result from the poor infrastructure
Average company size	The high proportion of small and medium-sized organisations limits the uptake of supply chain management	Multiple small sized stores provide a challenging context to achieve supply chain economies
Country specifics	The independent/pioneer mindset of many New Zealanders is an inhibitor to the utilisation of leading supply chain management practises.	Governmental policies can restrict the uptake of SCM. Further, regulations favour independent operators and restrict the emergence of a dominant operator.

Source: Basnet et al., 2006; Keegan et al., 2001

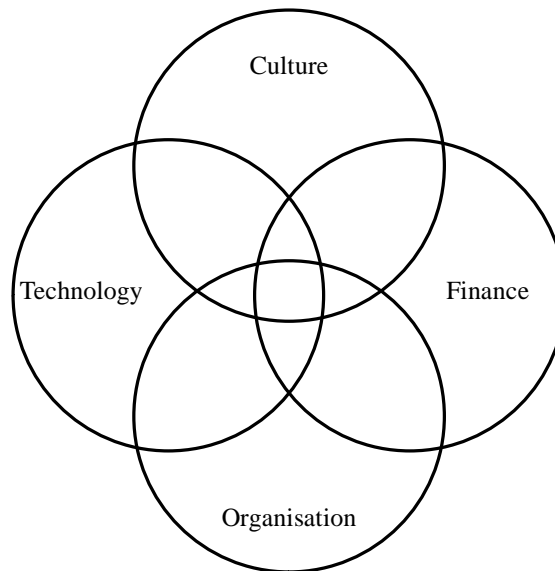
Table 6.1 highlights many similarities between the countries and because environmental factors can play an important role, they need to be assessed when investigating barriers to supply chain integration. The present research seeks to further validate the key environmental barriers identified in Table 6.1.

6.2.2 Company level

Most of the current research into barriers to supply chain integration is at the level of the company. Common barriers include functional silos, inappropriate information systems, and lack of top management support (for a more detailed list see also Table 2.9). The high number of barriers (see also (Halldorsson et al., 2008; Gimenez, 2004)) at this level calls for a more detailed structure to identify key areas that inhibit internal supply chain integration. The Cardiff business process reengineering (BPR) change model, represented in Figure 6.2, was

selected to identify and cluster the barriers to supply chain integration at a company level. Childerhouse et al. (2003) has previously successfully applied this model to 23 value streams.

Figure 6.2: Cardiff BPR change model



Source: Childerhouse et al., 2003, p.493

As Figure 6.2 indicates, the barriers are not independent, since there is often considerable overlap between them. However, it is helpful to classify them primarily as being either technology, culture, financial, or company barriers. Technology integration is predominantly concerned with linking different information systems within the organisation (Bagchi & Skjoett-Larsen, 2002). Culture assumes a strong human approach to supply chain integration, as Andraski (1994) claims that in real-world supply chains some 80% of problems are due to people and people's skills. However, people are embedded with the company structure, measurement and reward systems; hence, the organisation has a strong impact on culture and behaviour. In considering finance barriers, two factors are important; first a company's willingness to invest in supply chain integration efforts and second, the capability to invest (Halldorsson et al., 2008).

6.2.3 Value stream level

The final barriers to supply chain integration occur at the value stream level. A company can have multiple value streams (Fisher, 1997) and Towill (1999b) identified that these value streams are often not well separated and share resources in the form of labour, machines, and/or materials, which all impacts material flow optimisation. Hence, the management and planning that takes place around these value streams is (also) considered in this category. Next, the cause and effect analyses used to investigate barriers to supply chain integration is explained in detail.

6.3 Cause and effect analysis

One possible way of describing, analysing and communicating problems that deal with complex causal relationships in a supply chain is a cause and effect analysis. Cause and effect analysis is anchored within the systems thinking discipline. The idea of a system is generally expressed as encompassing inter-connected components separated from their environment by a system border. Fawcett et al. (2007) provide the following definition:

Systems thinking is the holistic process of considering both the immediate local outcomes and the longer-term system-wide ramification of decisions. Whereas traditional functional thinking seeks the local optimum – often at the expense of the overall system’s performance – systems thinking aligns efforts; getting everyone to pull in the same direction. (pp. 74-75)

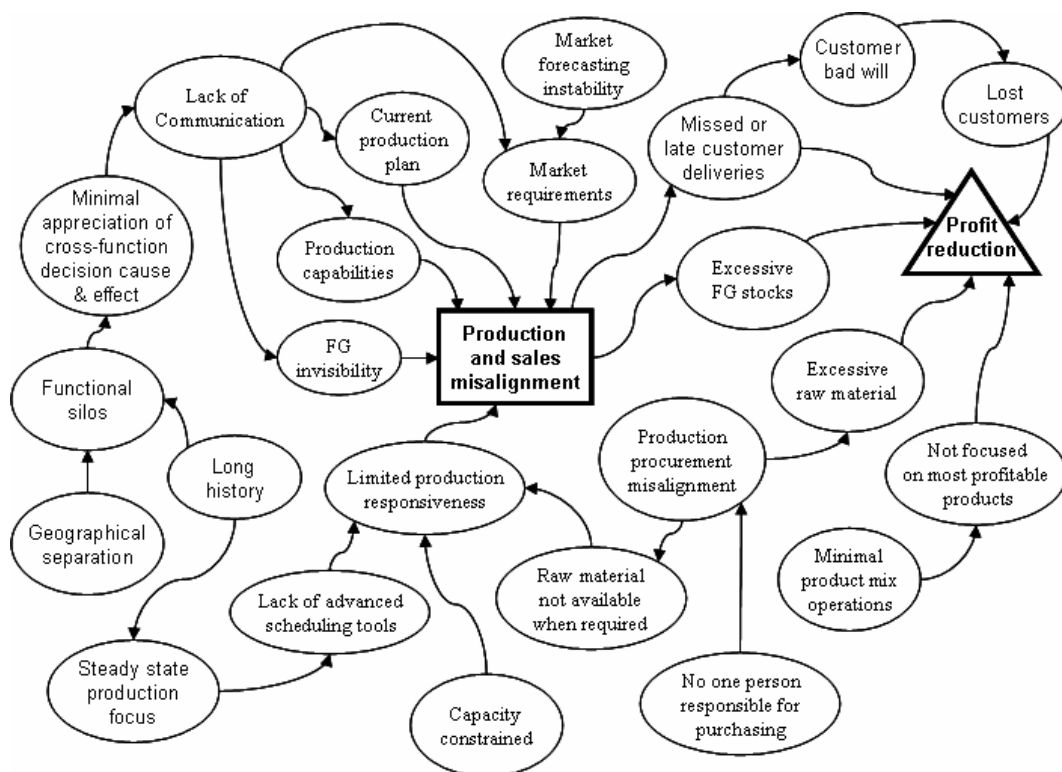
Systems thinking provides a method for describing, analysing and planning complex systems of different kinds. It offers a way of understanding problems in the present case, barriers, and communicating this understanding to others. Systems analysis helps to depict real world systems by using a structured way of building models (Holmberg, 2000).

A cause and effect analysis is one of the core elements of the Quick Scan Audit Methodology (QSAM); revealing the ‘major pain(s)’ a company is feeling as well as the root causes of the identified ‘major pain(s)’. The cause and effect diagram

is also the centre point of the feedback presentation and reflects the researcher’s holistic view of the focal company. The diagram has two main strengths: It is developed jointly by all the researchers, hence does not reflect one person’s opinion (researcher triangulation); Also, by taking a holistic/systems perspective of the focal company; supply chain specific issues are combined with the wider company and environmental issues to gain a complete ‘rich’ picture of the focal company situation.

The cause and effect analysis for Manufacturer 1 has been excluded from this Chapter because, being the first application of the methodology in New Zealand, its main purpose was to train other researchers in the method. Thus, the cause and effect analysis was predominantly developed by the leading researcher and lacks investigator triangulation. Figure 6.3 presents Dairy 1’s cause and effect diagram as an example only; the remaining diagrams are presented in Appendix F.

Figure 6.3: Cause-effect diagram: Dairy 1



Source: Author

As highlighted in Figure 6.3, the root cause for the excessive raw material is that no single person is responsible for procurement. Multiple authorisations are given to key personnel to make procurement decisions. Production and sales misalignment are being caused by two areas of major weakness: (a) limited production responsiveness, caused by capacity constraints; a lack of scheduling tools; and an historical focus on high volume production; and (b) poor communication between marketers and operations, being exacerbated by a lack of information visibility across well-entrenched functional silos. Such misalignment, in turn, causes profit reduction via missed and late customer deliveries, excessive finished goods stocks, and attendant inventory storage costs. Profits also suffer directly as the result of excessive raw materials and a lack of focus on the most profitable product mix.

The barriers to supply chain integration are extracted from the cause and effect diagram and applied to the developed conceptual model. Next, each barrier category (environment, company and value stream) is assessed using a three point Likert scale, with anchors: 1 low, 2 medium and 3 high. Next, the in-depth investigation into barriers to supply chain integration is presented.

6.4 Investigation into barriers to supply chain integration

The Quick Scan team developed six cause and effect diagrams, enabling the researcher to clearly deduce key barriers to supply chain integration. These findings are now presented.

6.4.1 Forestry: Internal barrier assessment

Forestry is a wholly owned subsidiary of a New Zealand-based corporation. Two value streams were evaluated. Quick Scan resulted in high uncertainty for both of them. Table 6.2 presents the outcome of the barrier assessment (see also the cause and effect diagram for Forestry in Appendix F.1).

Table 6.2: Supply chain integration barrier assessment: Forestry

Environment		High
Company	Culture	High
	Technology	High
	Finance	High
	Organisation	High
Value Stream		Low

Source: Author

Table 6.2 highlights that high barriers for all categories are present with the single exception of the category ‘value stream’. For this company environment factors create a high barrier to supply chain integration; corporate has been taken over by an investor creating uncertainty because the future corporate structure is unknown. Timber purchasing and transportation costs are steadily increasing due to indifferent logistical infrastructure and an increasing oil price. Finally, an unstable New Zealand dollar adds to the environmental concerns because Forestry is highly dependent on the export market.

At the company level of barriers to internal integration, Forestry’s working culture and attitude is cause for great concern. Managers throughout the company often struggle to implement improvements because of a lack of willingness to implement and to accept change, especially on the shop floor. Also, a strong union further inhibits the implementation of necessary change programmes. Further, Forestry’s information system is outdated and only loosely coupled, which results in a lack of supply chain visibility (Wisner et al., 2005). Financially, the new investor creates a high barrier to integration because policies will not allow investments with a cash-back period of more than one year. Finally, the organisation itself creates a great barrier to supply chain integration; it is set up hierarchically, resulting in independent, almost separate departments. Research further revealed a lack of top management support regarding end-to-end process optimisation (Pagell, 2004). Also, the company’s reward system is functionally driven; rewarding the optimisation of functions and discouraging cross-functional

activities such as material and information flows optimisation, and hence supports the further development of functional silos (Bowersox et al., 2002).

On the plus side, Forestry is facing no barrier to integration on an individual value stream basis. Both value streams are set up individually and do not compete for resources in form of raw materials, labour or machinery.

6.4.2 Manufacturer 2: Internal barrier assessment

Manufacturer 2 is a medium-sized, wholly owned subsidiary of a European-based corporation. The Quick Scan revealed that the main product value stream faces high uncertainty; however, uncertainty is less for the spare and wares value stream. Table 6.3 presents the outcome of the barrier assessment (see also the cause and effect diagram for Manufacturer 2 in Appendix F.4).

Table 6.3: Supply chain integration barrier assessment: Manufacturer 2

Environment		Medium
Company	Culture	High
	Technology	Medium
	Finance	Medium
	Organisation	High
Value Stream		Low

Source: Author

Table 6.3 shows that Manufacturer 2 faces predominantly medium barriers to supply chain integration. The company operates in a stable environment. Concerns mainly involve the strong New Zealand dollar as the business heavily depends on exports. However, fluctuations are less severe due to high product profit margins. The company is established in a remote part of the central North Island and thus faces problems in hiring qualified staff for its expanding business. Finally, the business feels the pressure of globalisation because new competitors are offering a cloned product at a significantly reduced price.

On a company level, the research revealed a poor culture and attitude. Functional silos exist between different shop floors, as well as between management and the shop floor. Key supply chain people often have no tertiary qualification and have gained most of their knowledge through work experience. Although current information system is modern and aligned to the corporation, it is suitable for financial accounting only and additional components are necessary to make it suitable for supply and operations management. On the finance side, Manufacturer 2 is stable and is willing to invest in supply chain improvement. In fact the only constraint identified was the larger investments needing to be signed off by head office in Europe (often a highly bureaucratic process). The major barrier at the company level is poor material flow. Manufacturer 2 operates with multiple production facilities (workshops) in one plant. The material flow is neither logical nor clear. Products move several times between the workshops resulting in double handling and excessive production lead times. Finally, the company lacks appropriate and meaningful supply chain measures.

However, Manufacturer 2 is facing no barrier to integration on an individual value stream basis. Both value streams are set up individually and do not compete for resources.

6.4.3 Dairy 1: Internal barrier assessment

Dairy 1 is an independent co-operative dairy company which is owned by its farmer shareholders. The Quick Scan revealed that both value streams face high uncertainty and hence are weakly integrated. Table 6.4 presents the outcome of the barrier assessment (see also the cause and effect diagram for Dairy 1 in Figure 6.2).

Table 6.4: Supply chain integration barrier assessment: Dairy 1

Environment		High
Company	Culture	High
	Technology	High
	Finance	Low
	Organisation	High
Value Stream		High

Source: Author

Dairy 1 faces high barriers to supply chain integration. Environmental concerns concern the strong New Zealand dollar as the business heavily depends on the export market. The company is also established in an isolated part of the South Island, hence Dairy 1 faces high logistics cost due to poor infrastructure. The geographical isolation also results in problems with hiring qualified staff. Finally, Dairy 1 is a comparably small player in a market dominated by New Zealand's leading dairy producer. Dairy 1 can often only react to the market that is dominated by the main competitor.

On a company level, the research identified a strong functional silo mentality between management and shop floor and between management functions. The information system is outdated and loosely coupled, providing only limited supply chain visibility (Wisner et al., 2005). However, Dairy 1 has a strong finance underpinning and is willing to invest in supply chain improvements. The company has a hierarchical organisational structure which supports the existence of functional silos. Further, the sales and marketing function is physically remote from the production plant; further limiting cross-functional information exchange and supporting the functional silo mentality.

Finally, the value streams create a barrier to supply chain integration. The two different value streams both depend on the same raw material supply. However, this resource (milk) is limited, seasonal and not well managed. Currently, the marketing department dictates the input of milk to each value stream.

6.4.4 Steel: Internal barrier assessment

Steel is one of the largest and longest established engineering works in New Zealand. The Quick Scan revealed that both value streams face high uncertainty and hence are weakly integrated. Table 6.5 presents the outcome of the barrier assessment (see also the cause and effect diagram for Steel in Appendix F.3).

Table 6.5: Supply chain integration barrier assessment: Steel

Environment		High
Company	Culture	High
	Technology	High
	Finance	Medium
	Organisation	High
Value Stream		High

Source: Author

Steel faces high barriers to supply chain integration in all categories except finance. The company operates in a difficult environmental setting. First, it is located in a remote part of New Zealand’s central North Island, and faces difficulties in accessing the skilled labour market. Also, Steel is a comparatively small player on the world market, hence cannot compete on price with its competitors, who continue to enter the New Zealand market. Finally, Steel operates in a project-based environment, which creates high future demand uncertainties.

On the company side, the research identified strong functional silos between the engineers, management team, and shop floor, which is exacerbated by union activity. Steel also lacks skilled staff, especially at the management level; many positions are filled by engineers lacking specific management skills. One result is an outdated and loosely coupled information system, which results in a lack of supply chain visibility. The medium barrier to supply chain integration is finance although the financial situation is stable, the research revealed an unwillingness to invest in upgrading assets and staff resources. Further, the material flow is neither

logical nor clear; products move several times between the workshops, resulting in double handling and excessive production lead times. Finally, the company lacks appropriate and meaningful supply chain measures.

The different value streams also create a serious barrier. Frequently the product flow is interrupted because multiple products require the same resources in the form of machinery and staff, which results in queuing and large increases in production lead time.

6.4.5 Service: Internal barrier assessment

Service is part of the public sector and is responsible for planning, funding, providing and monitoring health and disability services for the region. The Quick Scan revealed that most value streams face high uncertainty and hence are weakly integrated. Table 6.6 presents the outcome of the barrier assessment (see also the cause and effect diagram for Service in Appendix F.2).

Table 6.6: Supply chain integration barrier assessment: Service

Environment		Low
Company	Culture	High
	Technology	Medium
	Finance	Medium
	Organisation	High
Value Stream		Low

Source: Author

Service only faces internal barriers to supply chain integration because it operates in a stable environment. The organisation is government owned and has a strong local/regional focus.

The working culture and attitude is of great concern. Managers struggle to implement improvements because of a lack of willingness to change and there is

mistrust between the product replenishment team and the nurses, resulting in high buffer inventory. The information system is modern but is predominantly used for financial accounting and lack supply and materials management modules. The financial situation is stable; however, a strong budget focus makes the realisation of major re-engineering projects difficult. Further, Service has a functionally driven reward system, which is aligned to the hierarchical organisational structure. Hence, the organisational structure and the reward system support the existence of functional silos.

On the plus side, Service is facing no barriers to integration on an individual value stream basis. All value streams are set up individually and do not compete for resources in the form of raw materials, labour, finance or machinery.

6.4.6 Food 1: Internal barrier assessment

Food 1 is part of the process industry and has been manufacturing food products in New Zealand for more than 70 years. The Quick Scan revealed that Food 1 has managed to considerably reduce uncertainty of its value streams. Table 6.7 presents the outcome of the barrier assessment (see also the cause and effect diagram for Service in Appendix F.5).

Table 6.7: Supply chain integration barrier assessment: Food 1

Environment		Low
Company	Culture	Medium
	Technology	High
	Finance	Low
	Organisation	High
Value Stream		Medium

Source: Author

Food 1 operates in a stable environment and the company has managed to build a strong brand presence, both in New Zealand and worldwide. The research

revealed mounting environmental pressures due to changing consumer behaviour. However, the business is currently putting processes in place to meet future customer demand expectations.

Although company culture and attitude, in the guise of functional silos is a problem; this is not as severe as in the previous cases. The company has managed to retain highly qualified staff in key positions and it places strong emphasis on staff training. The current information system is outdated, which causes a high integration barrier due to the complexity of the operations (the business currently operates approximately 1600 individual production runs on two distinct production lines per year). The finance situation is stable and the company is willing to invest in supply chain improvement projects. The biggest barrier to supply chain integration has been identified at the company level; Food 1 has a hierarchical organisational structure. The reward system is aligned to this; hence, the organisational structure and reward system support the existence of functional silos. Furthermore, the sales and marketing function is physically separated from the production plant, limiting cross-functional information exchange and encouraging the functional silo mentality. Also, supply chain management is treated as a function responsible for just inbound and outbound logistics, which limits the opportunity to optimise end-to-end material and information flow. Top management support is lacking and senior managers are not willing to address the strong functional mindset.

Finally, competing value streams create an integration barrier. The two main production lines need to share resources in the form of labour and machinery. Value streams are also poorly defined and analysed.

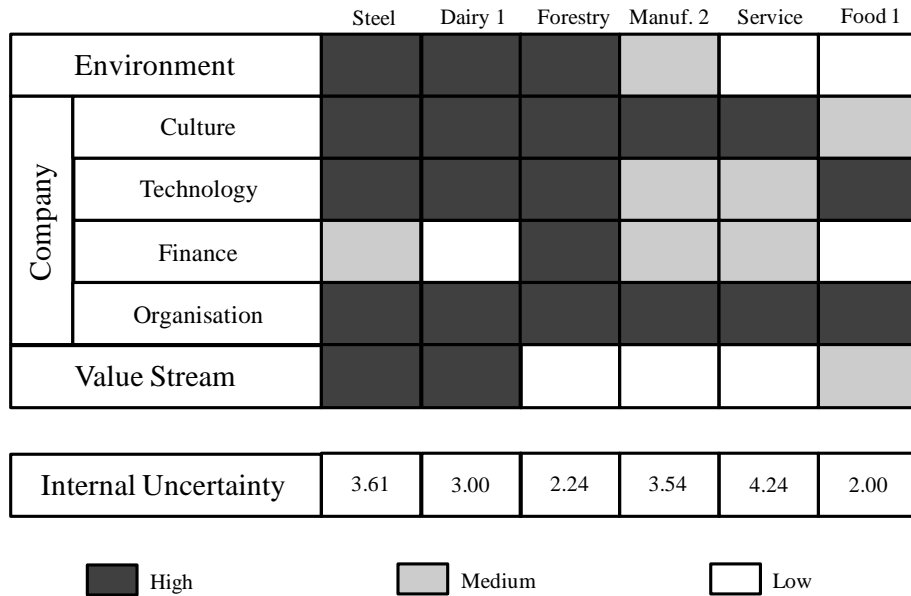
Next, a cross-case analysis of these six companies is presented.

6.5 Cross-case Analysis

The previous section revealed that all six companies face significant barriers to supply chain integration, which results in weakly integrated and poorly performing supply chains. Figure 6.4 summarises the findings, and the case

companies are arranged, left to right, in improving order of supply chain integration; the final row contains the associated internal uncertainty scores (for the most dominant value stream).

Figure 6.4: Cross-Case comparison for barriers to supply chain integration



Source: Author

The individual scores can also be found in Appendix E.2. Figure 6.4 highlights that all six companies face a variety of high organisational barriers to supply chain integration, dominated by culture and organisation categories. Halldorsson et al. (2008) report similar findings, and identified that the top barriers for companies in Scandinavia and America relate to organisational issues (e.g. organisational structures) and people issues (e.g. lack of employee skills). A further interesting insight highlighted by Figure 6.4 is that the three companies facing the highest barriers to supply chain integration have high environment scores. Arguably, the environmental barriers impact the company and value stream barriers.

The low barriers to supply chain integration are finance and value stream. Figure 6.4 shows that the company facing the lowest barriers to supply chain integration is Food 1. This company scored lowest in the environment and finance categories. However, high barriers in the technology and organisation categories remain. Not surprisingly, Food 1 is also the company facing the lowest internal uncertainty.

Surprisingly, the company facing the highest internal uncertainty (Service) is not the company facing highest barriers (Steel). Also, Forestry is facing comparatively low internal uncertainty but high internal/environmental barriers to supply chain integration. The reasons are twofold. First, internal uncertainty consists of process and control uncertainty. However, companies like Food 1, Dairy 1 and Forestry are all part of the process industry and their processes are highly automated to minimise process uncertainty, which is reflected in the internal uncertainty score. Secondly, the environmental factors are not reflected in the uncertainty score.

Figure 6.4 also highlights that all six companies experience cultural barriers in the form of functional silos, which inhibit the optimisation of material and information flows. Functional silos often result in a lack of operational ownership due to multiple decision points for a single value stream (Towill, 1997b). Further, functional silos discourage communication across functions as well as the development of cross-functional team work and relationships (Bagchi & Skjoett-Larsen, 2002). The organisational structure and reward system also contribute to the existence of functional silos. All companies are set up hierarchically. The reward system follows the organisational structure, which strongly supports the functional silo mentality. Further, in four cases, the sales and marketing function is physically separated from the production plant. This geographical dispersion causes not only high control uncertainty, it also limits cross-functional information exchange and supports the functional silo mentality.

Figure 6.4 further shows that, in many cases, the information system creates a barrier to supply chain integration. It was noted that most organisations investigated currently operate with multiple independent and loosely coupled information systems, which leads to incomplete and inadequate end-to-end information flows. Further, employees have little faith in the information being provided. The reason is twofold. First, too many employees have the ability to manipulate the data and/or, secondly, the parameters in the systems are not frequently updated. It was also noted that most of the supply chain data available is in fact financial and/or accounting data. This data represents the financial status

of a focal company but is in many cases inappropriate for supply chain or operational management decision-making.

The research revealed a stable financial situation for all six companies, where differences occur only in the willingness to invest in supply chain and/or process improvement projects and in the bureaucratic procedures involved with overseas headquarters. Forestry had implemented a policy that amortisation of investments need to be achieved within one year. Service, on the other hand, operates in a budget focused environment, which inhibits the necessary major supply chain investments.

6.6 Discussion

This chapter reported how cause and effect analysis was used to gain a holistic perspective of the barrier to internal supply chain integration a focal company faces; hereby focusing on environment, company, and value stream aspects. This categorisation is very useful as it provides supply chain managers with a barrier assessment so that they may then assign resources accordingly. Also, the developed conceptual model provides academia with a framework that integrates all the identified barriers to supply chain integration in one model. Table 6.8 presents an overview of all identified barriers to supply chain integration, which have been categorised following the conceptual model developed in Figure 6.1.

Table 6.8: Identified barriers within each category

Barrier category		Identified barriers to internal supply chain integration	Frequency (%)	Barrier identified by other authors
Environment		<ul style="list-style-type: none"> • Geographical isolation as well as isolation within the country • Indifferent logistical infrastructure • The fluctuation of exchange rates • Lack of a highly competitive domestic market 	<ul style="list-style-type: none"> • 6/6 (100) • 6/6 (100) • 5/6 (83) • 2/6 (33) 	(Basnet et al., 2006; Keegan et al., 2001; Post & Altman, 1994)
Company	Culture / People	<ul style="list-style-type: none"> • Defensive culture, internal team focus, negative attitude towards change • Lack of skilled management staff • Lack of skilled shop floor staff • Union activity creates ‘us vs them’ attitude • Poor knowledge management. Knowledge is power and not shared 	<ul style="list-style-type: none"> • 5/6 (83) • 5/6 (83) • 4/6 (67) • 2/6 (33) • 2/6 (33) 	(Gimenez, 2004; Halldorsson et al., 2008; Harrington, 1995; Pagell, 2004; Walker et al., 2008; Wisner et al., 2005)
	Technology	<ul style="list-style-type: none"> • IS system supports finance and accounting only • Multiple independent information systems 	<ul style="list-style-type: none"> • 6/6 (100) • 4/6 (67) 	(Gimenez, 2004; Lee, 2000; Wisner et al., 2005)
	Finance	<ul style="list-style-type: none"> • Lack of willingness to invest in supply chain improvement • Unable to invest in supply chain improvement 	<ul style="list-style-type: none"> • 3/6 (50) • 1/6 (17) 	(Halldorsson et al, 2008; van Donk & van der Vaart, 2005b)
	Organisation	<ul style="list-style-type: none"> • Organisational structure • Lack of staff training • Insufficient value stream measures • Reward System • Geographical dispersion • Lack of top management support • Strategic misalignment • Poor material flow 	<ul style="list-style-type: none"> • 6/6 (100) • 5/6 (83) • 5/6 (83) • 4/6 (67) • 4/6 (67) • 4/6 (67) • 4/6 (67) • 3/6 (50) • 2/6 (33) 	(Bagchi & Skjott-Larsen, 2002; Bowersox et al., 2002; Chopra & Meindl, 2006; Halldorsson et al., 2008; Stevens, 1989; Walker et al., 2008)
Value Stream		<ul style="list-style-type: none"> • Competing value streams 	<ul style="list-style-type: none"> • 3/6 (50) 	(Towill, 1999b)

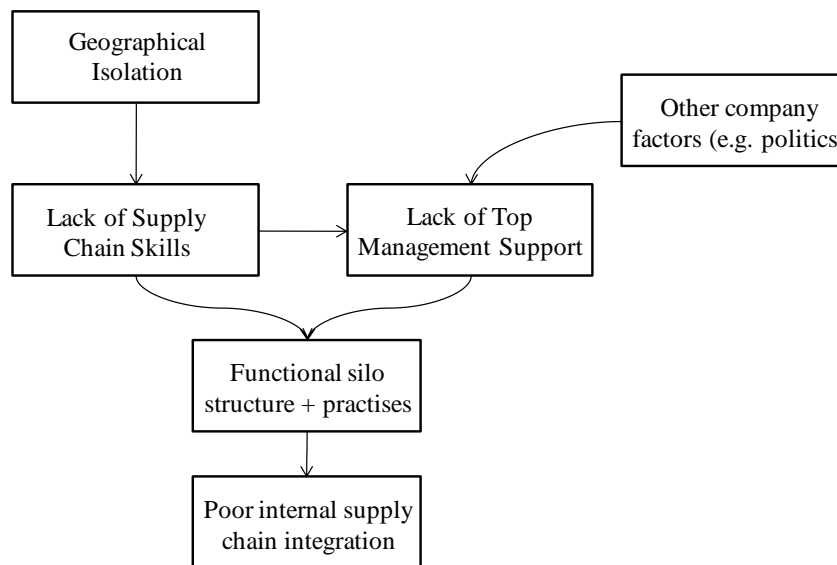
Source: Author

Most of the barriers listed in Table 6.8 have been identified by other authors and hence are strongly anchored within existing literature. The present study contributes to literature by testing and verifying barriers to supply chain integration using in-depth cross-case analysis. However, Table 6.8 highlights that the conceptual model developed in Figure 6.1 is capable of capturing barriers to supply chain integration in one cohesive model.

Table 6.8 highlights that most barriers to internal supply chain integration belong to the company level and, more precisely, to the culture and organisation categories. Arguably, barriers to supply chain integration are predominantly about people, people development and the organisational structure(s) provided by the company. As Andraski (1994) has remarked, supply chains are 80% people-centred and 20% technology-centred. A similar argument holds true for the barriers to supply chain integration. Mentzner et al. (2000) came to a similar conclusion when they learned how many barriers were related to people and personal interaction, as opposed to technology and infrastructure. Pagell (2004) likewise discussed that the company culture and structure are critical for the development of an internally integrated supply chain. Lambert and Cooper (2000), and Storey et al. (2005) point out that the importance of corporate culture and its compatibility across the internal and external supply chain cannot be underestimated. Finally, Whipple and Frankel (2000) point out that the largest barrier to integration is organisational (e.g. culture) rather than technical or financial.

Thus, the organisational culture and the organisational structure(s) are expected to be very critical regarding internal integration; the six case companies performed most poorly in the culture and organisation category. Additionally, those two categories have a strong overlap because people are embedded in the real-world structures and situations offered by the focal company (Childerhouse et al., 2003). Further, the remote geographic setting of some companies in New Zealand is expected to provide one of the most severe environmental barriers to supply chain integration. Many potential qualified employees are not willing to settle down in isolated parts of New Zealand. These critical people-related barriers are summarised in Figure 6.5.

Figure 6.5: Interrelation of key barriers to internal supply chain integration



Source: Author

The key environmental constraint is positioned at the top left of Figure 6.5. Companies face problems accessing qualified staff due to their remote setting. This has a direct impact on the supply chain skill level within a focal company. Often, the lack of supply chain skills is also reflected at the top management level, which negatively affects top management support regarding process integration and optimisation. However, other factors such as company politics are expected to result in a lack of top management support appetite for change and internal integration. A lack of top management support as well as a lack of supply chain skills is therefore expected to be the main reasons for functional silo practises and structures. Halldorsson et al. (2008) and Pagell (2004) also identified top management support and employee skills as two highly critical variables. Those practises and structures result in poor internal supply chain integration decisions which can impact on the organisational structure and reward system. These are expected to be key barriers and, if present, result in poor internal supply chain integration.

Companies need to address these issues by exploiting opportunities to overcome the barriers and top management support is expected to be very critical (Halldorsson et al., 2008; Hammer, 1990; Pagell, 2004). In many cases, top managers are in positions to positively influence the organisational structure and

reward system and hence, indirectly, make a positive impact on the culture and people working in the focal company (Bagchi & Skjott-Larse, 2002; Harrington, 1995; Lee, 2000). Top managers can increase budgets for up-skilling and staff training, and they need to identify the right incentives to persuade skilled employees to join companies located in remote parts of New Zealand.

Barriers should not be viewed in isolation as they are often uniquely interlinked and managers need to understand the resulting affects of their actions (internally as well as externally) as visualised in the cause and effect diagram (see, for example, Figure 6.2). Further, New Zealand companies not only need to tackle their identified in-house barriers, they also need to identify ways to deal with New Zealand specific environmental factors/barriers. Basnet et al. (2006), for example, identified environmental barriers (see also Table 6.1) that strongly support the findings of this chapter.

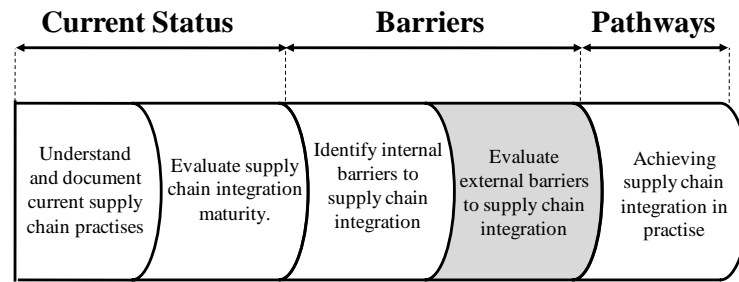
There are a multitude of further research avenues to expand this exploratory research. Firstly, the barriers identified need further validation from a larger empirical data source. Although, the environmental barriers discussed in this chapter are specific to the New Zealand context, it is expected that many of the findings can be transferred to other regions. For example, other countries with a high proportion of small and medium-sized organisations may also suffer from limited supply chain knowledge. The barriers identified at the company and value stream levels are expected to be a global phenomenon because other researchers report similar barriers to internal integration. However, further research is required to validate the conceptual model presented in Figure 6.1. Also, the list of barriers presented in Table 6.8 is not expected to be exclusive and further research is needed to identify others or even categories that create barriers to supply chain integration. Post and Altman, (1994) for example, focused on industry specific barriers rather than environmental barriers. More significantly, now that barriers have been identified, research needs to identify ways to remove or at least mitigate their effects, thereby improving the uptake of supply chain management.

6.7 Conclusion

Chapter 5 identified that supply chain integration in New Zealand remains an elusive goal. This chapter provided insights into the factors that obstruct internal supply chain integration in practise. Barriers to internal supply chain integration have been identified and categorised using the three layer conceptual model developed in this chapter. The categories are termed (a) environment barriers, (b) company barriers, and; (c) value stream barriers. The data was collected and analysed to improve understanding of the barriers organisations face that inhibit integration within a focal organisation. Furthermore, the research demonstrated that barriers identified by the literature are also common in New Zealand.

The particular strength of the research is twofold. First, using cause and effect analysis enables the researcher to take a holistic, systems perspective of supply chain integration barriers. Second, researcher triangulation ensures that the cause and effect diagram represents not just one person's opinion. Thus, the key contribution of this research is that it has furthered our understanding of a very complex phenomenon, and in a manner that is only possible using qualitative methods. The major contribution lies in the categorisation and close examination of the barriers to internal supply chain integration. Further, the research revealed that many barriers to internal integration are related to people and the structure offered to those people by the focal organisation. Top management support is expected to be very critical when companies aim to overcome internal barriers to supply chain integration.

This chapter focused predominantly on the focal company and its barriers to internal supply chain integration. Chapter 7 provides a focus study on external integration, due taking the presence of power and dependency in external relationships into consideration.



7. Barriers to External Supply Chain Integration

Main Research Question: How do power and dependency affect external supply chain integration?

7.1 Introduction

The first findings chapter, Chapter 5, identified that New Zealand value streams are weakly integrated. The previous chapter classified barriers to internal supply chain integration and concluded that many barriers to internal integration are related to people and the organisational structure offered to those people by the focal organisation. This chapter is focused on the study of supply chain relationships, which inevitably involve considerations of power and dependency. The significance of the research area has been highlighted in the literature (Cox, 2001; Maloni & Benton, 2000) (see also Chapter 2.9.2), and this chapter aims to understand how power and dependency affect supply chain integration with external entities. Furthermore, the measurement of power and dependency in external relationships is considered. First, the key variables of power and dependency in external relationships are identified. Then, a conceptual model is developed, which is capable of capturing the identified variables. Based on the conceptual model, relationships are then evaluated, to identify idealised relationship management practise. Finally, a cross-case analysis is undertaken, focusing on each company's capability to integrate externally. The discussion section details how practitioners can generally apply the results to improve supplier relationship management practises. This chapter is based on Böhme et al. (2008c).

7.2 Barriers to external integration

External integration is often viewed as comprising partnerships and strategic alliances (e.g. Droge et al., 2004; Kim, 2006; Maloni & Benton, 1997; Spekman et al., 1998). However, supply chain integration aims to achieve efficient flows of material and information (Stevens, 1989). Hence, Gimenez (2004) focus solely on the maturity of vendor managed inventory (VMI) practises in a focal company to determine the level of supplier integration. Others focus on advanced information systems such as EDI to determine the degree of external integration (Vickery et al., 2003). Frohlich and Westbrook (2001), likewise, place most emphasis on information flow and communication channels when investigating ‘arcs of integration’. Hence, it can be argued that evidence of advanced supply chain integration practise by the focal company defines the degree of external integration; and that partnerships and strategic alliances go beyond simple consideration of external integration and the pursuit of optimisation of material and information flows.

Many scholars acknowledge that a key barrier to any form of external integration with customers and/or suppliers is the power and dependency existing between the two organisations (Cox, 1999; van der Vaart & van Donk, 2004). The Quick Scans reinforced the overall importance of power and dependency as the key barrier to external integration. Much of the research on interorganisational relationships among interdependent actors has been grounded in the interrelated notions of power and control. As Pfeffer and Salancik (1978, p. 52) argued, “The concentration of power is inevitable.” They defined interdependence as a phenomenon that “exists whenever one actor does not entirely control all of the conditions necessary for the achievement of an action or for obtaining the outcome desired from the action”. By this definition, interdependence and its implications are closely identified with power and trust. This early work set the tone for subsequent research on organisational interdependence (Gulati & Sytch, 2007).

7.2.1 Trust, Power, and Dependency

Power and dependency in relationships has been studied extensively (Bensaou, 1999; Caniels & Gelderman, 2005; Cox, 2001; Kraljic, 1983). The power phenomenon can be defined as the ability of one entity in the chain to control the decision of another entity (Daparin & Hogarth-Scott, 2003). However, power as a concept is of little analytical value since the nature of power itself is less important than the origins of power. Dependence, being the inverse of power, is the reliance of one party on the other in maintaining a relationship to achieve respective goals (Emerson, 1962). The literature draws a distinction between buyer dependency and supplier dependency. Supplier dependency typically exists when the buying company is significant for the supplier; the buying company has a high percentage of the supplier's total market (Motwani et al., 1998). Conversely, buyer dependency can be characterised as having a high need for, but relatively low possibility of, integrative practises with suppliers (Cox, 2004).

7.2.2 Purchasing portfolio models

Power and dependence are generally considered important for the understanding of relationships (Caniels & Gelderman, 2005; Cox, 2001, 2004). A popular technique for capturing power and dependency in relationships occurs in the form of (2x2) purchasing portfolio models, which allow the researcher to analyse and cluster the relationships. Such portfolio models have received much attention in recent literature on strategic planning (Bensaou, 1999; Caniels & Gelderman, 2005; Cox, 2001; Kraljic, 1983). They can be used as analytical tools to organise information and create a classification framework of the variables included in the portfolio (Ellram, 1992), with the final outcome being identification of the groups of products, suppliers, customers or relationships which warrant greater resources allocation than others (Olsen & Ellram, 1997). Kraljic (1983) developed one of the first purchasing portfolio models that was used to analyse a focal organisation's supplier relationships; and other authors have since followed this approach (Bensaou, 1999; Caniels & Gelderman, 2005; Cox, 2004; Gadde & Hakansson, 2001; Spekman et al., 1998). Table 7.1 reviews five portfolio models, and includes their classification dimensions and the four resultant taxa.

Table 7.1: Review of portfolio models listed by publication date

Author	Classification Dimensions	Four taxa
Kraljic (1983)	Complexity of supply market Importance of purchase	Purchasing -, Material-, Sourcing-, and Supply Management
Spekman et al. (1998)	Strategic importance Complexity	Open market negotiations, Co- operation, Co-ordination, Collaboration
Bensaou (1999)	Supplier's specific investment Buyer's specific investment	Market Exchange, Captive- Buyer or Supplier, Strategic Partnership
Cox (2004)	Supplier- relative to buyer- power Buyer- relative to supplier- power	Independence; Buyer- or Supplier- Dominance, Interdependence
Caniels & Gelderman (2005)	Supply risk Profit impact	Non-Critical-, Leverage-, Bottleneck-, and Strategic- Items

Source: Böhme et al., 2008c

Recent adaptations and refinements of Kraljic's (1983) classification approach have produced alternative portfolio models with different classification dimensions. The underlying premise of all the models is that the need for collaboration differs from one organisation to the next (van Donk & van der Vaart, 2005b).

7.2.3 Dependency Variables

Table 7.2 is a summary of the different supplier dependency variables identified in the literature. While several authors have addressed the issue of dependence from a purchasing volume perspective, it appears that there is still a gap in the literature regarding identification of the myriad reasons for the existence of different levels of dependency in buyer-supplier relationships. Similarly, Table 7.3 provides a summary of the different buyer dependency variables identified in the literature.

Table 7.2: Supplier dependency variables

Variable	Description of supplier dependency
Purchasing volume /Profit impact	Purchasing volume is the total value of products an organisation purchases from one source, which is the basis of buyer dominance (Cox, 2004; Olsen & Ellram, 1997). Kraljic (1983) instead focuses on the percentage a special product is responsible for in terms of organisational profit.
Switching Cost	Some authors call switching cost a level of specific investment (Bensaou, 1999; Monczka et al., 1995); however, if an organisation has invested highly in a relationship then the switching costs are high and therefore the organisation is dependent.
Branding Reputation	Branding is linked to the reputation a product/organisation has. If customers demand a special brand, the buying organisation can depend on its suppliers (Cox, 2001; Olsen & Ellram, 1997).
Real time demand information	To be efficient, the manufacturer depends on EPOS data and information transparency. Having ownership of the data is a power source and makes the supplier depend on the buyer (Burt & Sparks, 2003).
Number of alternative customers	In an oligopolistic market, the number of alternative available customers is often limited. This increases the level of supplier dependency.

Source: Böhme et al., 2008c

Table 7.3: Buyer dependency variables

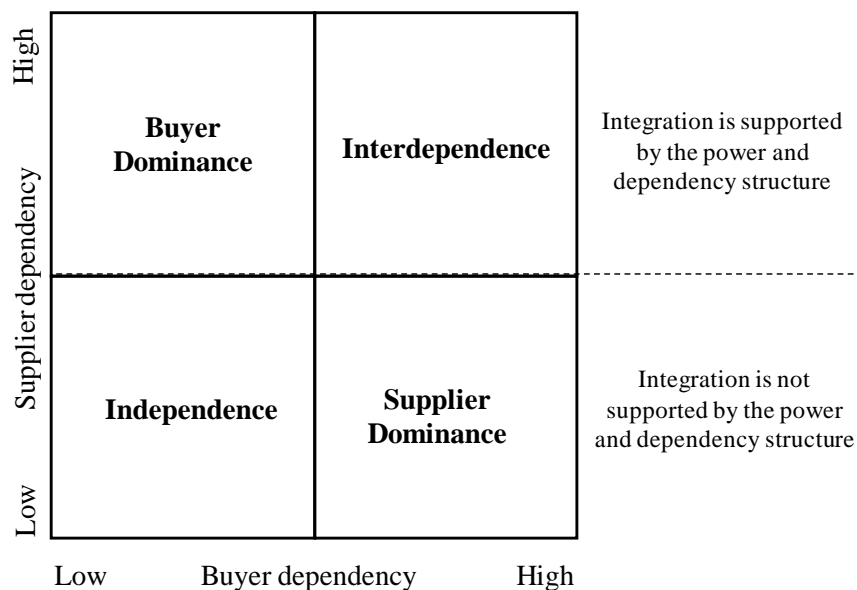
Variable	Description of supplier dependency
Capabilities / Supplier Skills	The supplier can have certain skills (Gadde & Hakansson, 2001). Those skills can be performance (Kraljic, 1983), or technically related. Technical complexity describes the equipment a supplier requires to manufacture a product (Cox, 2001) as well as the skills to produce a special product or product component.
Switching Cost	see Table 7.2
Resources available by supplier	Resource availability can be related to the final product, added value services, advertising support, and risk sharing (Gadde & Hakansson, 2001; Olsen & Ellram, 1997). Goffin et al. (2006) further identified the form of involvement in new product development as a resource a certain supplier offers.
Branding / Reputation	See Table 7.2
Number of alternative suppliers	This variable describes the number of alternative available suppliers capable of delivering the same product. Olsen and Ellram (1997) look at product substitutability; however, if the product is not substitutable, then fewer alternative suppliers are available, hence the purchasing organisation highly depends on the supplier (Geyskens et al., 1996).

Source: Böhme et al., 2008c

7.2.4 Power and Dependency Dyadic Relationship Model

The portfolio approaches by Cox (2004) and Kraljic (1983) had a major influence on the strategic supplier relationship research model used in this study. Both authors applied two dyadic power constructs that emerge from Emerson's (1962) exchange theory, which yields two distinct theoretical dimensions of resource dependence: power imbalance, or the power differential between two organisations; and mutual dependency, or the sum of their dependencies (see also Figure 7.1) (Casciaro & Piskorski, 2005). Although Cox (2004) used broad classification dimensions that covered different power and dependency variables (earlier Table 7.1), by only focusing on five variables the approach lacks completeness. In contrast, Kraljic (1983) focused on product criticality. The strategic supplier relationship research model used in the present research is shown in Figure 7.1.

Figure 7.1: Power and dependency dyadic relationship model



Source: Author

Figure 7.1 arrays the five *Supplier dependency* variables identified in Table 7.2 on the y-axis; and the five *Buyer dependency* variables in Table 7.3 on the x-axis. The various combinations of dimensions then allow the type of relationship to be categorised. Thus, if the supplier dependency and the buyer dependency in a relationship are both low (bottom left-hand quadrant), the organisations are relatively independent. If the supplier is highly dependent on the buying

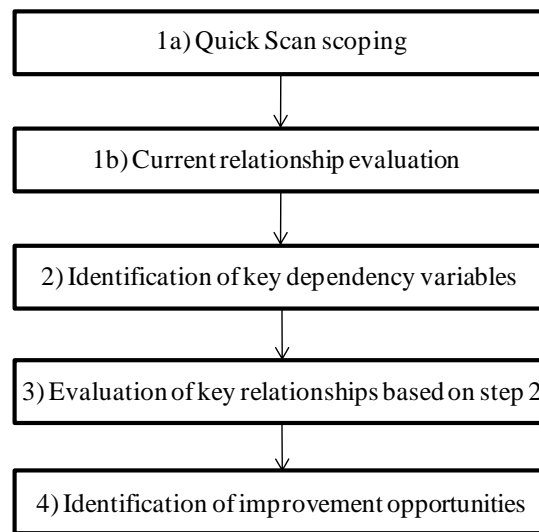
organisation, and vice versa, interdependency exists. If supplier dependency is high and buyer dependency is low, the buying organisation is dominating the relationship. Conversely, if buyer dependency is high and supplier dependency is low, the supplying organisation is dominating the relationship. Cox (2004) suggests that organisations should develop relationships appropriate to the power and dependency circumstances in which they find themselves, and Appendix G.2 provides a detailed description of such relationship management styles.

Particularly interesting is the conclusion by Cox (2001) that integrative supply chain structures are supported by buyer dominance or buyer/supplier interdependence. Therefore, the power regime in a supply chain can also be considered as a possible barrier that blocks the creation of streamlined information and material flows. On the other hand, power can be used to enforce the elimination of certain barriers (van der Vaart & van Donk, 2004); particularly in buyer dominance and interdependency situations. In the next section, the data collection process is highlighted.

7.3 Method used to investigate power and dependency

The data collection process included five crucial steps. A more detailed data collection process can be found in Chapter 4.8.1.9. and Figure 7.2 outlines the most critical steps.

Figure 7.2: Five-step process to investigate power and dependency



Source: Author

Step 1 is predominantly about gaining an overview of current supply chain and relationship management practises. In Step 2 the key dependency variables are identified, followed by the evaluation of the idealised relationships with key suppliers. In the final step, improvement opportunities are developed and discussed with the focal organisation.

Seven Quick Scan audits were conducted between 2004-2008 to gain a good understanding of New Zealand's environmental impacts, barriers, and challenges. Six further in-depth case studies were undertaken during 2006-2007. The semi-structured interview guide applied during the research can be found in Appendix G.1. During this latter period, Food 2 and Dairy 1 were included because significant differences were expected in their power structures due to their relative sizes (Food 2 is a SME and Dairy 1 is one of New Zealand's largest organisations). At this stage, the research focused only on the supplier side because the power and dependency structure on the customer side could easily be identified. For example, the company Forestry and Dairy supply commodity to the market and the relationship is transactional. In contrast, the two Food companies supply major retailers operating in the Australia and New Zealand region, hence are dominated by their customers. Finally, Manufacturer 2 supplies all its products to the wider organisation, hence interdependency is present. Case

descriptions were created principally from interviews with key managers and workers at the focal organisations, and from company brochures and company websites. Information was gathered at each site in as much rich detail as possible. While analyzing the data, similarities and differences between the sites were noted and documented. Next, scoping and the current supplier relationship management practises are presented.

7.4 Investigation into barriers to external integration

7.4.1 Findings in Steps 1 and 2: Scoping and evaluating relationships

Application of QSAM, involving interviews with 35 employees (supply chain managers and procurement managers, together with other purchasing and contracting staff) enabled the researchers to gain in-depth knowledge around the six companies studied. Table 7.4 outlines the current relationship management practises between the organisations and their suppliers.

It can be seen that all six organisations perform only relatively low level supplier integration activities, such as minor information sharing. With the exception of Food 2, every organisation had VMI agreements in place with their suppliers although these were at an experimental stage. In particular, a strong price focus in every organisation appeared to be damaging the trust between buyers and suppliers, and commensurately impacting supplier integration efforts (Burt et al., 2003). All the organisations face the problem that much procurement knowledge is tacit and the processes are not mapped; also, supplier information is seldom shared or formally recorded (in some cases the reasons for choosing a particular supplier were unclear or even appeared to defy logic). Multiple unstructured and non-transparent interfaces between suppliers and the focal organisations were commonly identified.

It was also commonly reported that the large supplier bases made it unfeasible to routinely measure supplier performance or to have every supplier signed up to a formal contractual agreement. This creates uncertainty in delivery performance, leading to buffer inventories on the inbound side of the focal organisation.

Table 7.4: Supplier relationship management practises

SRM Practises	Food 1	Food 2	Dairy 1	Dairy 2	Forestry	Manufacturer 2	Steel
Supplier base	350	120	500	300	1200	350	350
Procurement staff members	8	2	15+	3	10+	3	1
Supplier Contracts	All on contracts	All on contracts	Partly on contracts	Partly on contracts	Partly on contracts	All on contracts	Partly on contracts
Performance Measurement	Delivery on full on time, quality, Goal achievement	None	Delivery on full on time, quality	None	Delivery on full on time	Delivery on full on time, quality	Delivery on time
Main SRM Focus	Price/Cost reduction	Price/Cost reduction	Price/Cost reduction	Price/Cost reduction	Price/Cost reduction	Supplier development	None
R&D	Very little	No	Very little	No	No	Extensive	Very little
Information Sharing	Demand forecasts	No	Demand forecasts	No	No	No	No
Supplier Meetings	Quarterly	Yearly	Quarterly	Half yearly	Yearly	Half yearly	No
VMI	Few	No	Few	Few	Few	Few	Few
Supplier visits	Seldom	Frequent	No	Seldom	No	Seldom	Random
Socialisation Tactics	Yearly social supplier event	None	None	None	None	Yearly social supplier event	None
Future Direction	Global sourcing	Supplier performance measurement	Supplier base consolidation	Supplier contracts	Supplier base consolidation and supplier contracts	Supplier Development	Implementing SRM

Source: Author

Overall, although many of the participants recognised that that they should be taking a more strategic approach to sourcing, only Food 1 was actively doing so. Dairy 1 and Forestry were moving slowly toward a more strategic procurement approach although they were focusing only on their first tier suppliers.

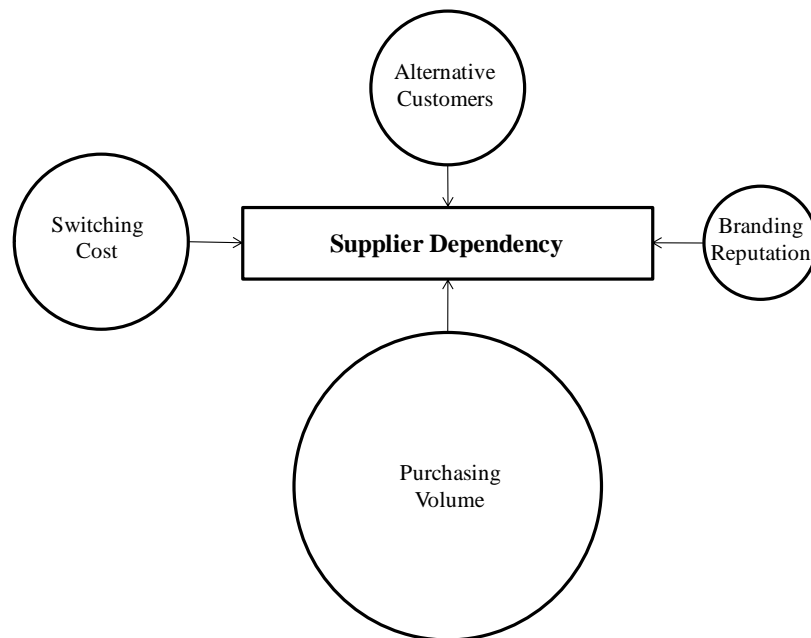
With regard to the top 17-28 suppliers (by purchasing volume), and of the 158 relationships examined, some 25% were described as being transactional, 41% were described as a close supplier, and 34% were described as a partnership. Such clustering highlights that the focal organisations perhaps do not fully comprehend all the nuances of the power/dependency situation. This finding supports an earlier study by Maloni and Benton (2000). Particularly in light of the significant spend being placed with the top suppliers, the high proportion of relationships reported as transactional was somewhat of a surprise. Also, as mentioned above, relationships reported as partnerships were frequently being managed along quite different lines to any literature description, i.e. of the six organisations:

- Suppliers on long term contracts (All suppliers on contracts: 3; Partly on contracts: 3)
- Continuous improvement
 - E.g. frequency of supplier meetings (Quarterly: 2; Half-yearly: 3; Yearly: 1)
 - E.g. frequency of supplier visits (Frequent: 1, Seldom; 3, Never: 2)
- Openness in all areas including cost, information, and accounting.
 - E.g. Information sharing. (Yes, demand forecasts: 2; Yes, part sharing of information: 1; No information sharing: 3)
- Supplier score card (Yes: 1; No: 5)
- Development of appropriate KPIs (Yes, all key measures: 1; Yes, a few key measures: 3; No key measures: 2)
- Supplier develops production skills tailored to the buyer's organisation (Yes: 1; No: 5).

7.4.2 Findings in Step 3: Identification of key variables

In this step, the key power and dependency variables are identified. Supply chain managers, procurement managers, contract managers, and procurement staff in all six organisations were interviewed to identify the key variables they considered when making purchasing decisions. This is a crucial step as these variables form the starting point for the evaluation of the supplier base and selection of appropriate future action plans. Only when the focal organisation has agreed upon the variables, and their importance to the company, should the Step 4 analysis proceed. Figure 7.3 indicates the four key supplier dependency variables, and also indicates their relative importance.

Figure 7.3: Key supplier dependency variables

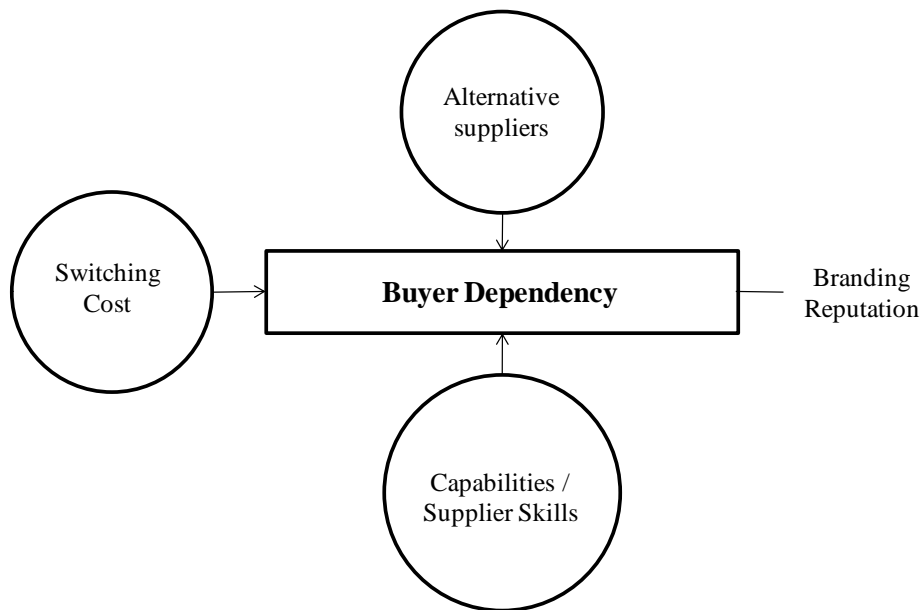


Source: Author

Figure 7.3 clearly indicates that purchasing volume (by dollar value) is by far the most important variable on the Supplier Dependency side, when the buying company has a high percentage of the supplier's total market. Purchasing volume accounts for 60% of the total supplier dependency followed by switching cost (20%), alternative customers (15%) and finally branding and reputation (5%). Interestingly, real-time demand information is not considered important by purchasing professionals within these New Zealand's companies.

Cox (2004), and Olsen and Elram (1997) likewise report that, next to switching costs, purchasing volume is one of the most important variables influencing supplier dependency. Figure 7.4 illustrates the buyer dependency variables, and also indicates their relative importance.

Figure 7.4: Key buyer dependency variables



Source: Author

The importance of the variables on the buyer dependency side is more evenly distributed. Capabilities and supplier skills account for 40% of the total buyer dependency, followed by switching cost and alternative suppliers (both 30%). Surprisingly, supply chain and procurement managers in New Zealand do not believe that branding and reputation impact buyer dependency. Although, Bensaou (1999) highlights the importance of switching cost by solely focusing on relationship-specific investments when investigating buyer-supplier relationships Gadde and Hakkanson (2001) point out the importance of capabilities and supplier skills for dependencies. However, these authors do not position these variables in relation to each other.

7.4.3 Findings in Step 4: Idealised supplier relationship

Paying particular regard to the key variables identified in Step 3, dependency on the top 17-26 suppliers by purchasing volume was objectively assessed using a 4-point Likert scale (with anchors 1=low dependency; 4=high dependency). Table 7.5 defines each anchor for each identified variable.

Table 7.5: Definition of anchor for identified variables

Variable	Low	Low - Medium	Medium – High	High
Alternative customers or suppliers	Many	Few	Duopoly	Monopoly
Switching Cost	No relationship specific investments	Few relationship specific investments	Some relationship specific investments	Heavy relationship specific investments
Branding / Reputation	Insignificant	Little significance	Some significance	Strong significance
Purchasing volume	Insignificant	Little significance	Some significance	Strong significance
Capabilities / Skills	None	Few	Some	Specific

Source: (Author)

To achieve a representative evaluation of each relationship, the weighted average score for buyer and supplier dependency was evaluated by the relevant procurement staff and by the supply chain manager. Figure 7.5 contains the results for all (158) relationships.

Figure 7.5: Supplier relationship evaluation

Supplier dependency	High	Buyer Dominance 13.9 %	Interdependence 30.4 %
	Low	Independence 28.5 %	Supplier Dominance 27.2 %
		Low	High

Buyer dependency

Source: Author

Some 28.5% of the relationships were determined to be of type *Independence*, where the focal organisation essentially needs to ensure that the lowest market price for acceptable quality and timely delivery is being achieved. A main reason for this high figure is that New Zealand organisations increasingly source large amounts of bulk products from overseas suppliers. Of the top 17-26 suppliers by volume, around 13.9% are characterised as *Buyer Dominance*, being highly dependent on the focal organisation. This was judged to be a relatively low figure considering that most of the focal organisations are large New Zealand businesses with a strong local supplier base. Conversely, some 27.2% of the top 17-26 volume relationships are characterised as *Supplier Dominance*, having focal organisations that depend highly on them. New Zealand's small market size means that, although goods are produced by multiple suppliers, often only one supplier can deliver the volume required by the larger enterprises. Finally, some 30.4% of relationships were clearly identified as being *Interdependent*, hence should be able to justify relationship integration practises. Figure 7.5 underscores that every organisation needs to manage a portfolio of different relationships based on a realistic assessment of the actual dependency situation that exists.

Evidently, power and dependency is limiting the level of integration in all of the companies studied and thus presenting a key barrier to integration. This finding

supports earlier power and dependency research that identified power as a key barrier to supply chain integration (Cox, 2001; van der Vaart & van Donk, 2004). A comparison of the current style of relationship management being practised (evaluated in Step 2), with the ideal relationships identified from objective consideration of actual power and dependency, highlights the misalignments in contemporary relationship management practise. The major misalignments are presented in Figure 7.6.

7.4.5 Comparison of current relationships with the ideal

Comparison of the current relationship with the identified idealised relationship highlights the misalignments in relationship management practises. These misalignments are highlighted in Figure 7.6

Figure 7.6: Misalignments of current and idealised relationships

Supplier dependency	High	<p>37% of all buyer dominated relationships are managed as partnerships</p>	<p>15% of all interdependence relationships are managed as transactional</p>
	Low	<p>22% of all independent relationships are managed as partnerships</p>	<p>18% of all supplier dominated relationships are managed as transactional</p>
		Low	High

Buyer dependency

Source: Author

The biggest misalignment occurs in the *Buyer Dominance* category, where it can be seen that some 37% of buyer-dominated relationships are currently being managed as a partnership, rather than as a relationship predominantly focused on achieving the best price. This is resulting in unwarranted expenditure of resources and (frequently) a suboptimal purchasing price being achieved. Similarly, for the *Independence* category, some 22% of relationships are currently being managed as partnerships even though the parties do not actually

depend on each other. Again, the result is a waste of resources and (frequently) a suboptimal purchasing price being achieved. A relatively minor misalignment occurs in the *Interdependence category*, where currently some 15% of all interdependent relationships are being managed as transactional relationships rather than as some closer style of relationship, which this situation deserves. These organisations may not be gaining all of the value that would be afforded by the recognition of their mutual dependency. Perhaps the most disconcerting situation occurs in the *Supplier Dominance category* where, even though the focal organisation is actually highly dependent on its key suppliers, 18% of those relationships are currently being managed as if the organisations are independent. These findings support those of earlier research that reported very similar misalignments (Cox, 2004).

7.4.6 Overcoming power and dependency to external integration

The current research included expert discussions with the managers contributing to this research. In identifying supplier dominance as a threat to every manager, it was stressed that the key is having the ability to reduce the power of the suppliers (Cox, 1999), even though van Donk and van der Vaart (2005b) highlighted that the power structure cannot easily be influenced. Discussions identified four strategies to overcome a disadvantageous supplier dominance situation: insourcing; volume increase; global sourcing; and socialisation.

1. **Insourcing:** The large forestry organisation (Forestry) is currently heavily dependent on the sole power supplier in its region that can meet its needs. Forestry could reduce this dependency by incinerating wood scrap from the production process to generate its own electricity. By increasing generating capacity to a level that enables alternative (smaller) providers to become eligible, the organisation will increasingly become independent of its current sole provider (Cox, 1999).
2. **Volume Increase:** Dairy 2 is planning to rationalise and consolidate its supply base by appointing one of its many suppliers to be its sole provider for farm equipment; thereby moving the remaining first tier suppliers into the second tier. Increasing the sales volume through one particular farm supplier will

increase that supplier's dependency on Dairy 2, thereby shifting the nature of the relationship more towards one of interdependence.

3. **Global Sourcing:** Food 1 is highly dependent on local ingredient suppliers and has established a project team to investigate overseas suppliers for some specific ingredients to achieve a better purchasing price. In this way, Food 1 is hoping to reduce its dependency on its local suppliers and aiming to shift the relationship more towards one of independence.
4. **Socialisation:** Socialisation helps build interpersonal relationships and trust and is argued as being an increasingly important mechanism for facilitating and enhancing supply chain integration processes (Cousins & Menguc, 2006). Through familiarity, socialisation and integration reduce the perceived risk between buyers and suppliers as they together contemplate increasing information flows and transaction-specific investments. In this way, the likelihood of opportunistic behaviour is reduced (Cousins & Menguc, 2006). While socialisation tactics do not change the dependency on a particular supplier, they help to make the situation more bearable. All of the organisations studied could usefully apply socialisation tactics.

7.5 Cross-Case Analysis

Chapter 7 began with a comparison of idealised supplier relationship management. This was followed by a brief case description, which also includes customer dependency and the identified supplier and customer uncertainty data from Chapter 5. The evaluated relationships for each sample are presented in Table 7.6.

Table 7.6: Idealised supplier relationship management

Company	Integration not supported		Integration supported	
	Independence	Supplier Dominance	Buyer Dominance	Interdependence
Food 1	19% (4)	29% (6)	9% (2)	43% (9)
Food 2	19% (5)	46% (12)	8% (2)	27% (7)
Dairy 1	15% (3)	20% (4)	20% (4)	45% (2)
Dairy 2	47% (13)	39% (11)	7% (2)	7% (9)
Forestry	0% (0)	15% (3)	5% (1)	80% (16)
Manuf. 2	42% (11)	15% (4)	31% (8)	12% (3)
Steel	52% (9)	18% (3)	18% (3)	12% (2)

Source: Author

Table 7.6 identifies that Forestry has the ‘strongest’ power and dependency structure of the seven cases. Eighty percent of their top 20 volume suppliers have been identified within the interdependence category. At the other end, Food 2 and Dairy 2 face a weak power and dependency structure. Both companies are highly dependent on their key suppliers. Further, the evaluation of the top 20 volume suppliers surprisingly resulted into a strong independence power and dependency structure for Dairy 2, Manufacturer 2 and Steel. However, focusing on supplier dominance, Table 7.6 reveals that integration is very difficult to achieve for most New Zealand businesses. Power and dependency limits the level of integration for all companies included in this study and has been identified as a key barrier to supplier integration. Each case is dominated by at least three of their Top 17-26 volume suppliers. A detailed case description for each sample organisation is presented in Appendix G.3.

In addition to the demand and supply uncertainty values identified in earlier Chapter 5, Table 7.7 broadens the scope from a purely supplier perspective by including the power and dependency structure on the customer side. This table also utilises well established symbols when describing relationship circumstances based on power and dependency (e.g. Cox, 2004; Sanderson, 2004).

Table 7.7: Summary table of individual case analysis

Supply Side		Focal Company		Customer Side	
Supply Uncertainty	Power structure	Company Name	Relationship Mngt	Power structure	Demand Uncertainty
1.5	</=	Food1	Mature	</=	2.5
N/A	>	Food 2	Immature	<	N/A
3.5	>/=	Dairy 1	Immature	0	4.0
N/A	</=	Dairy 2	Mature	0/=	N/A
4.0	</=	Forestry	Immature	0/=	2.5
2.0	</=	Manuf. 2	Mature	=	3.0
3.0	0/>	Steel	Immature	0/=	4.0

> (dominance of the supplying entity); < (dominance of the receiving entity); 0 (independence); = (interdependence)

Source: Author

Table 7.7 clearly shows that power structure has no direct influence on the supply uncertainty scores. This is highlighted by Forestry, where the power structure on the supplier side is very positive regarding integration and yet the supply uncertainty score has the highest value (4.0). The supply uncertainty score is influenced by current relationship management practises and those companies having more mature relationship management practises managed to considerably reduce supply and demand uncertainty. Also, companies producing commodities for international markets suffer from a weak power and dependency structure on the demand side.

7.6 Discussion

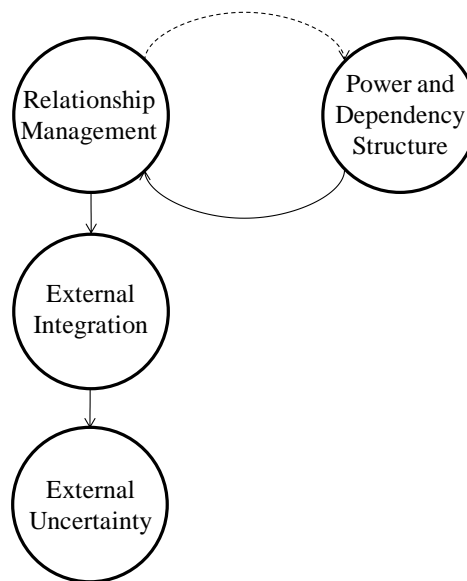
The results of this research clearly show that New Zealand organisations are only weakly integrated with their suppliers. Every company in this sample was simultaneously dominated by at least three suppliers, which considerably reduces the chances of supplier integration. The research continues that purchasing volume is the key dominant variable regarding supplier dependency (Olsen & Ellram, 1997). Further, the research showed that companies with mature supplier relationship management and procurement practises monitor relationship performance, especially with their top 20 dollar value suppliers. Also, employing managers responsible for relationship management results in a better understanding of the power and dependency structures that exist in their supply chains (Cox, 1999, 2004), and in reduced external uncertainty.

Every company in this sample identified their key suppliers prior to the evaluation. The number of suppliers lies between 17-28. Hence, it can be assumed that all businesses have a strong transactional – independence portfolio of relationships to manage. Many examples of poor and misaligned supplier relationship management practise were identified. If this is in any way representative of all New Zealand organisations, it is evident there exists a considerable gap between ‘best practise’ supplier relationship management theory and its application by New Zealand practitioners (Böhme et al., 2008c). Thus, considerable scope for improvement exists. McAdam and McCormack (2001)

presented a qualitative study of the relationship between managing business processes and managing supply chains, and found that there was little evidence of firms actually exploiting the integration of intra- and inter- company business processes in their supply chains. Also Zailini and Rafagopal (2005) report that companies are still in the infancy stage when it comes to supply chain management and the integration with customers and suppliers. Finally, Walters (2008) reports that organisations need to adapt to the new order of business relationships and seek to form alliances and partnerships both within and outwith national boundaries.

The research also identified no direct link between power and dependency structure and external integration in the form of external uncertainty. However, it is expected that the power and dependency structure indirectly influences integration practises. Figure 7.7 illustrates the interplay between these different variables.

Figure 7.7: Preconditions to external integration



Source: Author

Figure 7.7 shows that the relationship management style directly impacts external integration. Relationship managers have the possibility to implement advanced supply chain integration practises like EDI or VMI to improve material and information flow. This improvement will positively impact on the external

uncertainty measure. However, a positive power and dependency structure can actually support the implementation of certain integration practises. If a supplier or customer is highly dependent on a focal company, certain integration practises can be forced onto the external entity. However, if interdependency is present, win-win situations need to be created that enhance material and information flow. The link between relationship management and power and dependency structure is shown dotted because ways have been identified to influence the power and dependency structure. However, a shift in the relationship might not always be feasible. The critical power and dependency variables identified in this chapter give good guidance to the variables having the greatest leverage, when influencing the power and dependency structure. Hence, the power and dependency structure is viewed as a precondition for external integration. Power (2005) and Romano (2003) also identified the importance of dependency by stating that the recognition of the interdependence of all partners in a supply network appears to be an important precursor to effective integration.

The power and dependency structure of key suppliers and customers needs to be closely monitored. Movements in the market (new entrants, joint ventures, etc.) need to be integrated in the power and dependency measure. Also, the company's own purchasing behaviours (e.g. annual volume levels) need to be reviewed. Finally, the uncertainty score in combination with the power and dependency structure are expected to provide companies with an excellent indicator of where major performance improvement gains are hidden. High uncertainty indicates waste and poor performing operations. However, a positive power and dependency structure signals that the preconditions for achieving integration are in place; change is likely to occur fast(er) and is expected to have a higher impact on supply chain performance.

The model and the methodology presented inevitably have limitations. Although it is a fact that the model focuses primarily on process and manufacturing industry purchasing of a variety of different products and services, it is judged that it could be readily adapted for use with service, government, and not-for-profit organisations. The five step data collection process (as described here) focuses on

improving the current situation; however, some companies would also benefit from using the process for scenario analysis during strategic planning. It is recognised that the research setting, being New Zealand, plus the small sample size could limit the generalisability of the findings.

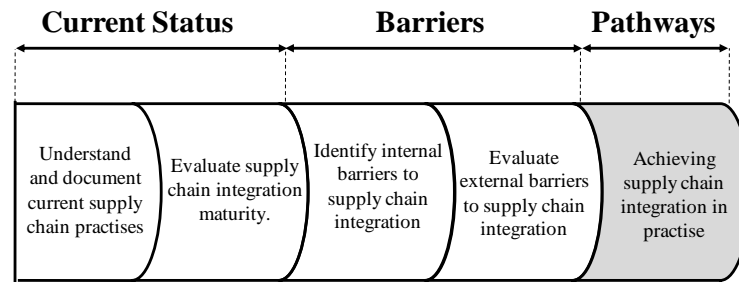
7.7 Conclusion

New Zealand value streams are poorly integrated. Internally, managerial and socio-cultural factors are the main barriers to internal supply chain integration. This chapter has sought to gain a better understanding of how power and dependency affects external integration. Further, the research has revealed how strategic supply chain decision-making can be conceptually supported and has specifically focused on power and dependency in external relationships. It has demonstrated that there is considerable scope for improved management practises to be applied within New Zealand organisations. The research also highlighted that organisations tend to be only weakly integrated with their suppliers and that power and dependency frequently limit the level of integration achieved. Some focal organisations that are highly dependent on their key suppliers are mismanaging the relationship. The research further revealed three ways to actively influence the power and dependency with suppliers and thereby strengthen the company's own position. In cases where the power and dependency structure cannot easily be influenced, companies often apply socialisation tactics to make a weak situation bearable.

This study contributes to theory by uniquely measuring power and dependency in buyer supplier relationships. The five step power and dependency evaluation process developed was very valuable when measuring dependencies in buyer/supplier relationships. Further, insights into the power and dependency structure of New Zealand business have been provided. Finally, the role that power and dependency play in external integration has been identified. A positive power and dependency structure has been identified as a precondition to achieve external integration.

Notwithstanding its contribution, this study has focused on the New Zealand situation. The question remains; How well are others externally integrated? Are they too being highly dominated by their suppliers? Based on the power and dependency considerations discussed here, is supply chain integration a feasible option for every company? Further research in New Zealand and elsewhere is needed, both to generalise the developed purchasing portfolio model, and to comment more generally on power and dependency between organisations and the influence on external integration.

In the next chapter, the pathways that New Zealand companies have taken to further integrate their supply chain is presented.



8. Achieving Supply Chain Integration in Practise

Research Question: How do companies achieve supply chain integrate in practise?

8.1 Introduction

The first findings chapter, Chapter 5, identified that New Zealand value streams are weakly integrated. Because the removal of barriers between and within organisations is critical for integrating the supply chain (e.g. Gimenez, 2004; Romano, 2003), Chapter 6 investigated internal barriers to supply chain integration and Chapter 7 investigated external barriers to supply chain integration. In order to address the overarching research question “how do companies achieve supply chain integration in practise”, this chapter aims to identify the pathways to supply chain integration. It also outlines the change processes undertaken by New Zealand companies and the consequent impact on the identified barriers to supply chain integration.

To answer the overarching research question, preconditions to supply chain integration are identified with the aid of a literature review plus findings from four longitudinal case studies. The impact of the change process on supply chain integration is assessed using: (a) the supply chain uncertainty circle (see Figure 5.1); (b) the developed supply chain integration evaluation tool (see Chapter 2.11.3); and, (c) the identified barriers to supply chain integration (see Chapter 6). Hence, Chapter 8 synthesises all the previous research findings, bringing together all the assessment tools and insights to show how supply chain integration is actually achieved in practise. The supply chain uncertainty scores are used to

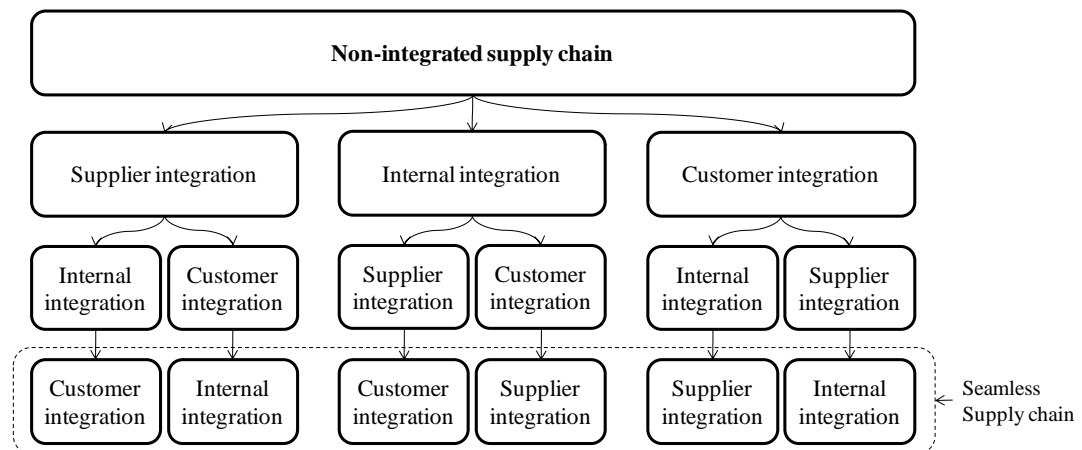
assess whether a focal company has managed to reduce supply chain uncertainty and hence has further integrated its supply chain. The developed integration evaluation tool highlights the focus area of supply chain integration efforts and measures supply chain performance improvements. The supply chain integration model developed in Chapter 5 is also further validated. First, a literature review is presented, followed by a detailed description of each case study. A cross-case analysis is then undertaken to highlight differences and similarities between the supply chain integration attempts.

8.2 Pathways to supply chain integration

Narasimhan and Kim (2001) note that much of the research on integration has been predicated on the assumption that integration occurs in distinct stages. Possibly the most influential work regarding a stage process towards supply chain integration is by Stevens (1989) (see also Figure 2.3). He suggests that companies follow an integration process that goes through different stages by first integrating internally and then extending the integration process externally to other supply chain members. Empirical evidence (Towill et al., 2000; Koufteros et al., 2005) and case study research (Gimenez, 2004) support the conceptual model developed by Stevens.

Bowersox & Daugherty (1995), Hewitt (1994) and Gimenez (2004) also emphasize that the improvement of each internal function should precede the external connection with suppliers and customers in the external integration stage. However, Gimenez's (2004) qualitative study identified one exemplar that did not follow Stevens (1989) integration model. Also, Halldorsson et al. (2008) report that managers seem to achieve more successful integration with external business partners than they do with managers and departments within their own company. Finally, Chapter 5 identified further cases that did not follow Stevens' conceptual integration model. Hence, Chapter 5 proposed a four stage integration model with six distinct pathways to the seamless supply chain. Figure 8.1 presents the proposed supply chain integration model from Chapter 5.

Figure 8.1: Proposed supply chain integration model (see also Figure 5.11)



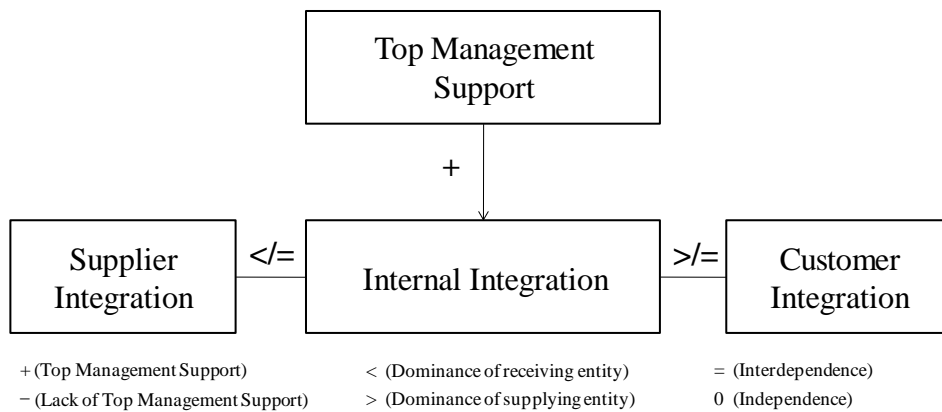
Source: Author

At the top of Figure 8.1 is the non-integrated supply chain stage. Companies that are at this non-integrated stage may choose to integrate internally or externally (with customers or suppliers) first. Once the first integration stage is achieved, the remaining integration areas are tackled until the seamless supply chain is achieved. The question remains, why does a company take a certain path to integrate its supply chain? Next, the key enablers for supply chain integration are identified.

8.2.1 Key enablers for supply chain integration

Halldorsson et al. (2008) provide an extensive list of identified supply chain integration enablers. However, the latest research shows that not all enablers are equally important. Halldorsson et al. (2008), Hammer (1990), Pagell (2004) and Story et al. (2005) identified top management support as the key enabler for internal supply chain integration and other types of major change efforts. These authors also agree that technology solutions to supply chain integration are of lesser importance and value. Chapter 7, Cox (2001) and van der Vaart & van Donk (2004) identified that a positive power and dependency structure (interdependence and/ or supplier dependency) is a key enabler for external integration. Resulting from the latest research on enablers for supply chain integration, the following conceptual model has been developed; Figure 8.2 highlights the preconditions to achieving a fully integrated, seamless supply chain.

Figure 8.2: Preconditions to achieving a fully integrated, seamless supply chain



Source: Based on Böhme et al., 2008c; Cox, 2001; Pagell, 2004; Storey et al., 2005; van der Vaart & van Donk, 2004

Top management support is expected to have a major impact on internal integration. However, the power and dependency structure is key to enabling external integration, especially if both parties equally depend on each other or the power is held by the focal organisation. Romano (2003) also concluded that the focal company's power position in the supply chain influences supply chain integration. The status of these three preconditions to supply chain integration is expected to have a major influence on the path a focal company takes to further integrate its supply chain. Consider for example, if a company lacks top management support for internal integration but dominates or is independent of its external entities; this company is expected to integrate externally first, before then integrating internally.

8.3 Method for investigating the pathways to integration

Four longitudinal studies were undertaken using Manufacturer 2, Forestry, Dairy 1 and Food 1. The longitudinal studies followed a structured approach; first, the supply chain status was re-evaluated using the same quantitative questionnaires, and for the same value streams previously investigated by the earlier Quick Scan, including the supply chain uncertainty analysis (see also Appendix C). Second, by predominantly interviewing staff members, the researcher gained an overview of

the change process before evaluating the change process. In a final step, the findings were presented to management and staff to gain consent. A detailed methodological description is highlighted in Chapter 4.8.1.9 and Table 8.1 presents the dates of the Quick Scan and the follow up study for each of the four cases.

Table 8.1: Time overview of case studies for longitudinal data

Company	Quick Scan	Follow up	Timeframe (months)
Manufacturer 2	December, 2006	March, 2008	16
Forestry	March, 2006	April, 2008	25
Dairy 1	January, 2004	December, 2006	35
Food 1	May, 2006	May, 2008	24

Source: Author

The longest timeframe between Quick Scan and follow up study was almost three years, with Dairy 1. Forestry and Food 1 cover a timeframe of approximately two years, whereas Manufacturer 2 covers only 16 months. The average time between the initial Quick Scan and the follow up case study is some 25 months. As many longitudinal case studies within the supply chain management discipline are conducted using timeframes of between one and four years (e.g. Harland et al., 2007; Holland, 1995; Leonard-Barton, 1989), the timeframe chosen to answer the research question is in line with other longitudinal case studies. Quantitative studies tend to encompass longer timeframes (e.g. Johnson & Leenders, 2008; Lorenzoni & Lipparini, 1999).

The uncertainty data was used to evaluate the conceptual model in Figure 8.1., which highlights three distinct areas for uncertainty reduction, and hence for supply chain integration, exist. In essence, a focal company can concentrate its efforts internally, thereby focusing on control and process uncertainty, or externally by focusing on supply or demand uncertainty reduction. Each of the three uncertainty areas were evaluated during the initial Quick Scan and a second time during the follow up case study. Table 8.2 presents these three distinct areas of uncertainty.

Table 8.2: Assessing the path to supply chain integration

Internal uncertainty	Demand uncertainty	Supply uncertainty	Outcome
High	High	High	No integration
	Low	Low	Supplier integration
		High	Customer integration
		Low	External integration only
Low	High	High	Internal integration only
	Low	Low	Internal + supply integration
		High	Internal + customer integration
		Low	Seamless supply chain

Source: Author

The research applied a 4-point Likert scale, which anchors 1=lowest uncertainty and 4=highest uncertainty. For simplicity, values of 1 and 2 were taken to represent low uncertainty; and 3 and 4 were taken to represent high uncertainty. Hence, Table 8.2 highlights that a focal company can be placed into one of eight possible outcomes. If a company faces high uncertainty in all of internal, demand and supply uncertainty no integration is present. Conversely, if a company faces low uncertainty in all these areas, the supply chain is seamless. The intervening six stages present uncertainty reduction for one or two uncertainty areas, and are named accordingly.

The supply chain integration evaluation tool (see Chapter 2.11.3), which was verified in Chapter 5, was applied during the initial Quick Scan and follow up case studies. Key personnel were interviewed to identify the current state of each of the 22 characteristics and the average score for each category was calculated for both data collection points. The individual company scores for each identified characteristic for each data collection point can be found in Appendix H.

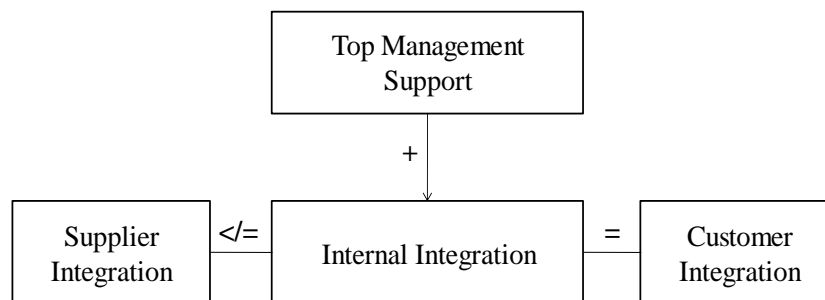
Finally, the impact of the change process on the barriers to supply chain integration is highlighted using the research findings from Chapter 6. The detailed description of each case helped to identify which barriers were reduced or overcome by the focal company. Next, each change process is presented in detail.

8.4 Individual longitudinal case study findings

8.4.1 Manufacturer 2: Change process

A Quick Scan was conducted in December 2006. The research identified an absence of the necessary preconditions for achieving a seamless supply chain. Figure 8.3 presents these preconditions, and shows that Manufacturer 2 has strong top management support, which supports a drive to change internally.

Figure 8.3: Preconditions for achieving a seamless supply chain: Manufacturer 2



Source: Author

Further, the external power and dependency structure is positive. Many suppliers are interdependent to or dominated by Manufacturer 2 and most of the customers belong to the wider corporate, hence interdependency is present. Therefore, the initial QSAM in 2006 identified Manufacturer 2 as possessing all the preconditions necessary to achieve a seamless supply chain.

The first change initiative occurred within days of the Quick Scan. Manufacturer 2 introduced a daily production meeting to better control and coordinate its operations. Manufacturer 2 also decided to hire a business process re-engineer to improve productivity on site. The re-engineering of the different shop floors followed closely the UDSO (Understand, Document, Simplify, Optimise) method (Watson, 1994) explained in Chapter 4.8.1.2. Table 8.3 presents an overview of the change process and how it is related to the UDSO method.

Table 8.3: Overview of the change activity for Manufacturer 2

Step	Activity
1. Stabilise	<ul style="list-style-type: none"> • Stabilisation of production
2. Understand	<ul style="list-style-type: none"> • Analysis of production • Implementation of additional operational measures
3. Document	<ul style="list-style-type: none"> • Documentation of current practises • Increase in production reporting
4. Simplify	<ul style="list-style-type: none"> • Up-skilling and empowerment of staff members • Increase in visibility of production • Implementation of two-bin system
5. Optimise	<ul style="list-style-type: none"> • Kanban on shop floor (infancy stage) • E-Kanban with key supplier • Upgrade of technology

Source: Author

Before analysing current operational practise, the business process reengineer needed to stabilise the production. The analysis stage required additional operational measures focusing on effectiveness as well as efficiency. Once the operational measures were in place, visibility of production was increased. The simplification of production followed. Key to the simplification step was the up-skilling and empowerment of current staff members. The staff members were trained to identify improvement opportunities. On the shop floor, a two bin system was introduced, to lead to a Kanban system for the entire plant in the optimisation stage. Also, each shop floor must deliver a progress report on a daily basis. The planning office functions as a central information hub where information is collected and processed. In fall 2007, major changes in the shop floor layout were introduced with the aim of reducing double handling and avoiding unnecessary movement between different workshops. Also, an E-Kanban system was implemented with the main steel supplier aimed at optimising raw material stock levels. Finally, the outdated ERP system, which captures only financial and accounting information is planned to have a MRPII function as well as an enhanced planning tool and reporting features.

Within the first ten months, a cultural shift was achieved using a communication platform. This was developed to improve the information flow and to move the organisation away from a blaming culture (Pagell, 2004). This platform was

further extended to the management level. In the first half of 2008, major changes to the reward system on the shop floor occurred. Staff are now rewarded for DIFOTIS (delivery in full on time in required specification), attendance, and health and safety. Especially, DIFOTIS is expected to cross-link each shop floor and bridge the functional silo mentality. In total, three supply chain management professionals have been hired.

Figure 8.4 summarises the impact of the change process on the internal/environmental barriers.

Figure 8.4: Longitudinal internal barrier assessment: Manufacturer 2

		2006	2008
Environment		Medium	Medium
Company	Culture	High	Medium
	Technology	Medium	Medium
	Finance	Medium	Medium
	Organisation	High	Medium
Value Stream		Low	Low

Source: Author

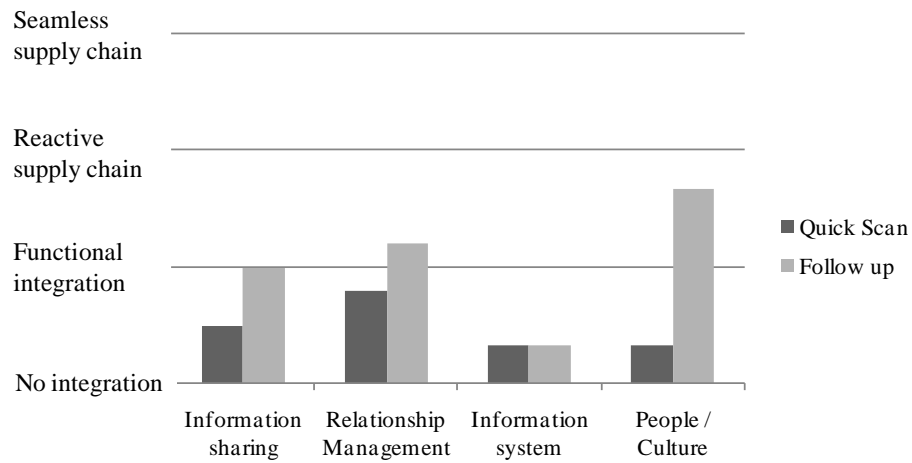
Figure 8.4 clearly shows that Manufacturer 2 has managed to reduce internal/environmental barriers to supply chain integration on a culture and organisation level. In short, Manufacturer 2's change programme is strongly anchored in the culture and attitude of the people working at the plant.

Externally, the remaining barrier for Manufacturer 2 is on the customer side. Manufacturer 2 requires top management (headquarter) support to be able to overcome this barrier because most customers are internal and belong to the wider corporate.

The integration evaluation tool was applied during the QSAM and the follow up study, so that major improvement areas in the area of supply chain integration

might be identified. Figure 8.5 presents the outcome of the application of the integration evaluation tool.

Figure 8.5: Integration assessment: Manufacturer 2

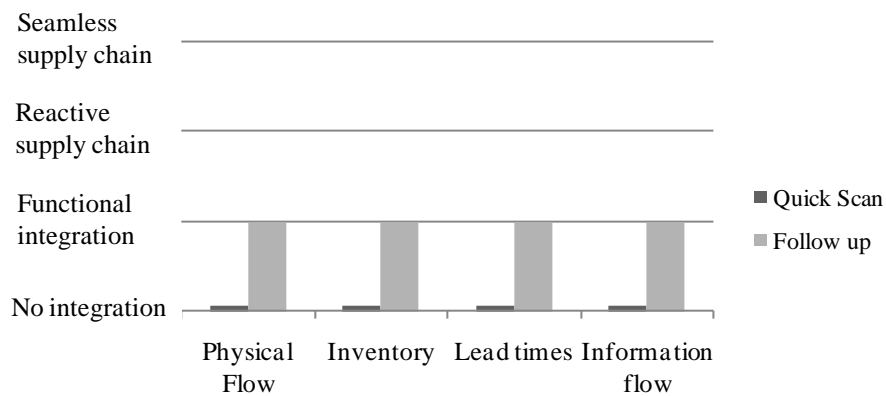


Source: Author

Figure 8.5 clearly shows that the changes have greatly impacted on integrating people working at the plant. The development of cross-functional KPIs and a strong team focus to reinforce the culture and attitude are responsible for the strong improvement in the people/culture category. The implementation of visual management and better relationships between individuals has helped to improve information-sharing. However, the initiated upgrade of the information system was not in place at the second point of data collection, hence has not apparently improved the information system category yet.

Figure 8.6 presents the supply chain performance improvements for Manufacturer 2.

Figure 8.6: Supply chain performance improvement: Manufacturer 2

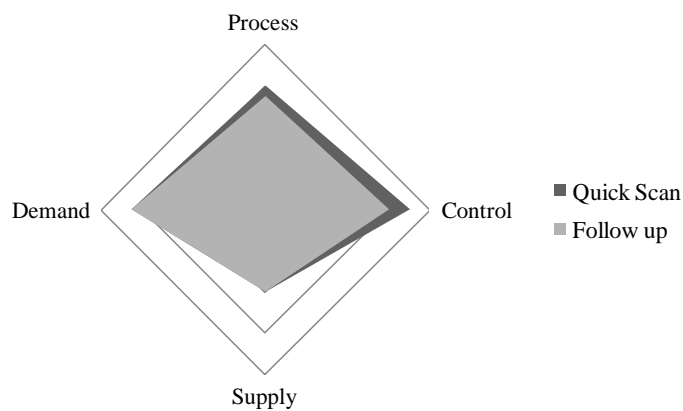


Source: Author

The changes implemented by Manufacturer 2 have resulted in positive effects on all four performance measures. Over the last 16 months changes have resulted in a decrease of steel scrap (from 45% scrap down to 18%) and an increase of machine utilisation. Further, the production lead-time has been reduced from five weeks to two weeks, which has resulted in a 100% increase of plant output. Also, the work in progress has been reduced by 240%. The visual management style and the implementation of a new working culture have improved the information flow in the plant. Finally, the change has positively influenced supply chain uncertainty.

Figure 8.7 presents the improved supply chain uncertainty situation.

Figure 8.7: Supply chain uncertainty improvement: Manufacturer 2



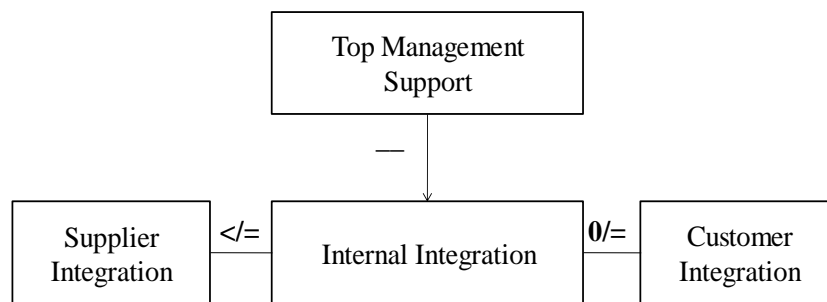
Source: Author

Figure 8.7 highlights that Manufacturer 2 has managed to reduce internal uncertainty in the form of process and control uncertainty only with greater gains for control uncertainty because the process side initiatives were only recently implemented.

8.4.2 Forestry: Change process

A Quick Scan was conducted in March 2006. The research identified an absence of the necessary preconditions in many areas for achieving a seamless supply chain. Figure 8.8 presents those preconditions and highlights that Forestry lacks top management support to further enhance internal integration.

Figure 8.8: Preconditions for achieving a seamless supply chain: Forestry



Source: Author

Also the power and dependency structure on the customer side is rather negative. Many commodities are sold to unknown customers to a market price. Interdependency exists only with the New Zealand-based customers and customers that are part of the wider corporate. However, focusing on the supplier side, Forestry has a positive power and dependency structure.

Soon after the Quick Scan was conducted, Forestry suffered major staff turnover within the supply chain management department; hence, the first three months were occupied with integrating new staff members. In the second half of 2006 a crucial decision was made to combine the management of four closely located pulp, paper and packing plants, rather than operate them as individual business units. The supply chain manager now became responsible for four separate plants consisting of three different value streams, and increasing complexity from a

management perspective. However, it also created opportunities in terms of potential purchasing power and synergy effects between the plants. A highly experienced national procurement manager was hired towards the end of 2006 and it was decided to implement a track and trace system for the make-to-order value stream (Bagchi & Skjoett-Larsen, 2002). This new information system allows customers to track their orders online.

In the first half of 2007, the supply chain manager introduced staff training in the areas of supply chain management and procurement. Also, the outbound logistics side was process mapped and the material and information flow further improved. Finally, an intranet web page was intended to centralise all supply chain relevant information. This increases cross-functional visibility and makes sure that only one version of the required information is used for decision-making (Fawcett & Magnan, 2002).

In June 2007, the national procurement manager started to consolidate the supplier base by establishing a preferred vendor list. The latest project started in February 2008, aimed at standardising the sales and operational planning process for all four plants, including aggregate planning and weekly allocation meetings for the sales and marketing team (Bagchi & Skjoett-Larsen, 2002). Table 8.9 presents Forestry's barriers to supply chain integration and highlights the impact of the change process on those barriers.

Figure 8.9: Longitudinal internal barrier assessment: Forestry

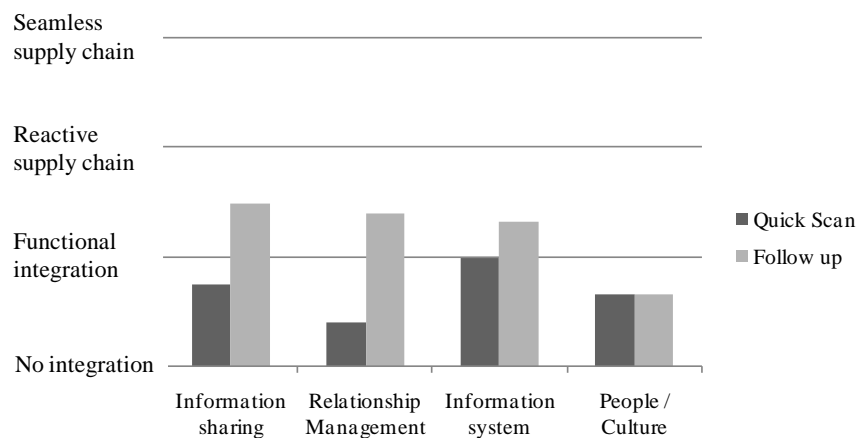
		2006	2008
Environment		High	High
Company	Culture	High	High
	Technology	High	Medium
	Finance	High	High
	Organisation	High	High
Value Stream		Low	Low

Source: Author

Forestry has not fully addressed even one internal barrier to supply chain integration. Instead, the supply chain team implemented solutions affecting just their own departments. For example although, a cultural shift has occurred within the supply chain management team, functional silos on the shop floor and other parts of the management team remain. The only barrier that has been lowered is on the technology side; the intranet website strongly supports cross functional visibility. Because a wider implementation across different functions is not supported by the top management, the key remaining barrier for Forestry is the lack of top management support.

Figure 8.10 presents the supply chain performance improved for Forestry.

Figure 8.10: Integration assessment: Forestry

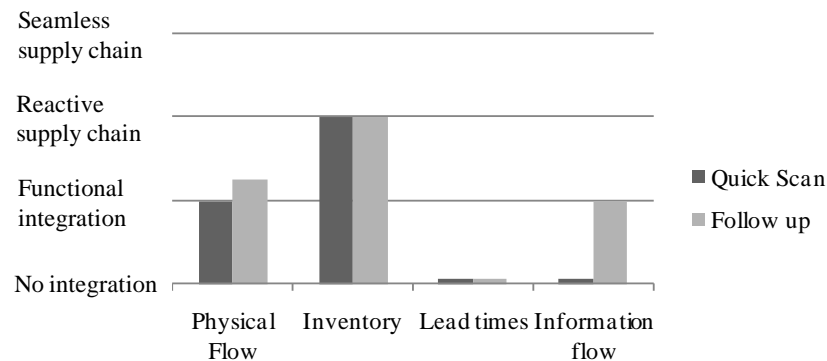


Source: Author

Figure 8.10 shows that the changes here mainly impacted information sharing and relationship management. Minor integrational changes have occurred within category information system. The implementation of the extranet has resulted in an increase of operational data sharing as well as data visibility. Further, the employment of a new national procurement manager supports the integration of key suppliers. This manager has also impacted the relationship management category by enhancing VMI practises with key suppliers. Further, a track and trace system for outbound logistics has been implemented.

The implementation of the changes has resulted in the supply chain performance improvements highlighted in Figure 8.11, which shows that major improvements have occurred within the information flow category and minor improvements on the physical flow (focusing on outbound logistics only).

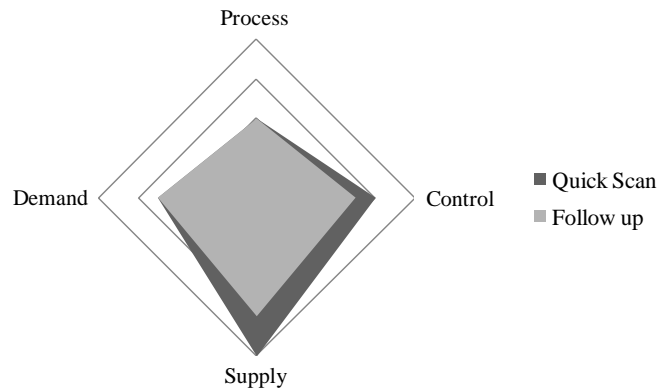
Figure 8.11: Supply chain performance improvement: Forestry



Source: Author

Forestry focused predominantly on low cost improvement opportunities, thereby limiting necessary long term strategic changes. All the changes implemented so far have had only a very minor impact on overall stock levels (raw material and finished goods) and no impact on production and/or customer lead time. Hence, the implemented change has had only minor influences on supply chain uncertainty. Figure 8.12 presents the positive outcome regarding supply chain uncertainty, and highlights that Forestry has managed to reduce uncertainty on the supply side and the control side.

Figure 8.12: Supply chain uncertainty improvement: Forestry



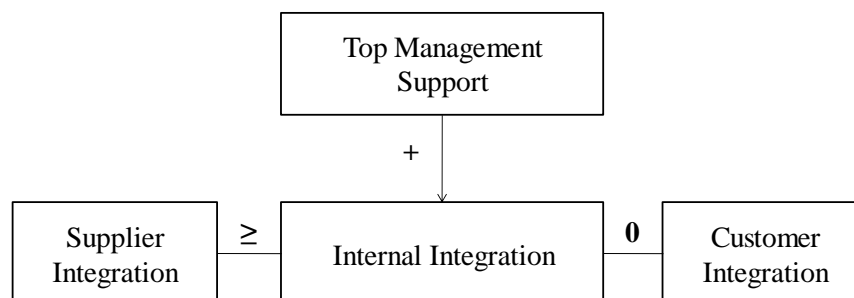
Source: Author

The implemented intranet webpage impacts positively on control uncertainty and the newly hired national procurement manager has already taken uncertainty out of the supply side by reducing the supplier base and identifying key suppliers.

8.4.3 Dairy 1: Change process

A Quick Scan was conducted in January 2004. The research identified an absence of the necessary preconditions in most areas for achieving a seamless supply chain. Figure 8.8 presents those preconditions, and indicates that Dairy 1 has top management support to further enhance internal integration.

Figure 8.13: Preconditions for achieving a seamless supply chain: Dairy 1



Source: Author

Dairy 1 operates with a weak external power and dependency structure. Most commodity products are sold to market price, hence many independencies are

present. Also, the company suffers from under supplier dominated relationships. Only a few interdependencies have been identified.

Six months after the Quick Scan, a new CEO was appointed. The new CEO has a strong Marketing background and gained experience on the board of directors for one of New Zealand's leading dairy companies. One of his first actions was to restructuring the business and flatten its structure (Harrington, 1995). Further, to overcome the geographical dispersion of sales/marketing and production, fortnightly sales and operational planning meetings were introduced and the information flow improved.

In the second half of 2004, the new CEO established a customer focused vision statement and aligned the company strategy accordingly (Peck & Juttner, 2000). Dairy 1 also appointed a procurement manager. To gain better control of procurement spending, all process managers and most management staff were deprived of procurement accreditation. Stronger links to key suppliers were developed, including three vendor managed inventory agreements.

In early 2005, cross-functional staff training through staff rotation was introduced. The staff rotation increased awareness and understanding for others' tasks, and staff flexibility (Pagell, 2004). In mid-2005, Dairy 1 introduced new operational measures focused on efficiency as well as effectiveness. Also the visibility of the supply chain related data was increased via more formal and informal cross-functional meetings (Bagchi & Skjoett-Larsen, 2002). Key supply chain data is displayed and made accessible. Dairy 1 also implemented a new outbound information system that is capable of measuring desired stock levels.

In late 2005, Dairy 1 introduced a new value stream to the business, when a new onsite production facility was set up to produce a variety of protein products. The maintenance department was centralised. Aside from synergy effects, a reduction in maintenance stocks and increase in maintenance stock turn has been achieved.

One of the final improvements focused on the strategic element of supply chain management. The old operational strategy was one of ‘make to stock’ for the entire product range. Now, high volume low margin products continue to be made to stock; however, low volume high profit margin products are made to order (Aitken et al., 2005).

Figure 8.14 presents summarises the impact of the change process on the internal barriers to supply chain integration.

Figure 8.14: Longitudinal internal barrier assessment: Dairy 1

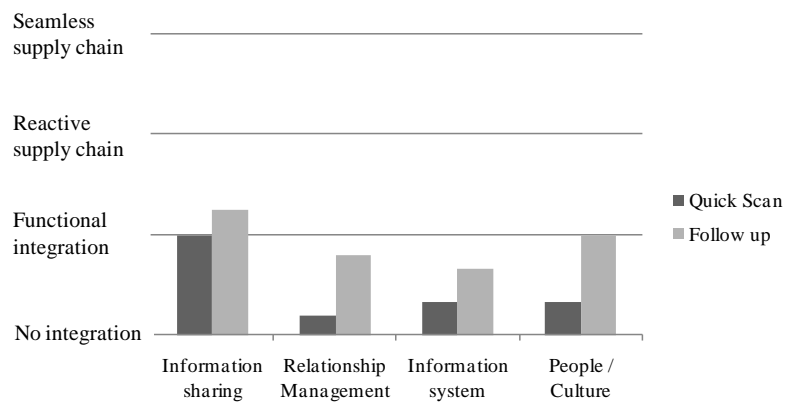
		2006	2008
Environment		High	High
Company	Culture	High	Medium
	Technology	High	High
	Finance	Low	Low
	Organisation	High	Medium
Value Stream		High	High

Source: Author

Although the environment barrier and value stream barrier remain high the coordination of the different value streams has improved due to the increased complexity of a new value stream as well as an increased product mix. The change at the company level is closely linked with the newly appointed CEO, who restructured the business and developed a company strategy to give employees a shared direction. Hence, the organization category barrier reduced from a high to a medium barrier. The restructuring of the business positively affected the company culture.

Figure 8.15 presents the effects of the changes on supply chain integration.

Figure 8.15: Integration assessment: Dairy 1

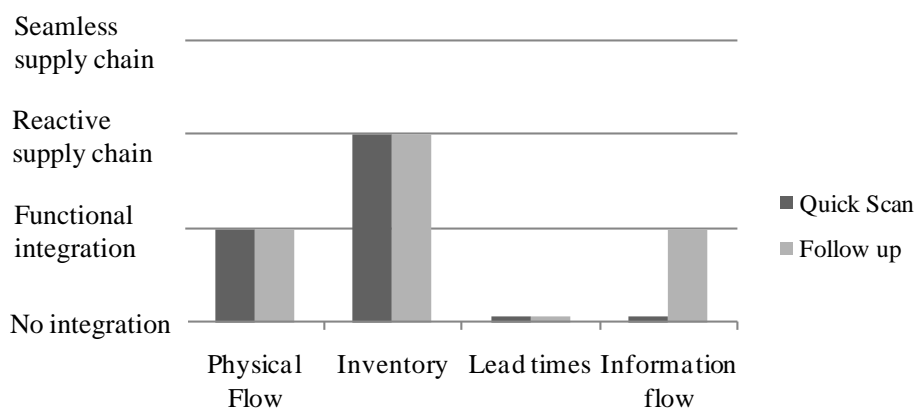


Source: Author

The appointment of the new CEO, and his restructuring of the business, had a major impact on the people/culture category. The procurement manager implemented vendor managed inventory agreements, which positively impacted the relationship management category. Further, job rotation and visual display of key operational data increased integration in the information sharing category. Finally, the new outbound logistics software positively impacted the information system category.

Figure 8.16 presents the supply chain performance improvement of Dairy 1 over the three year period.

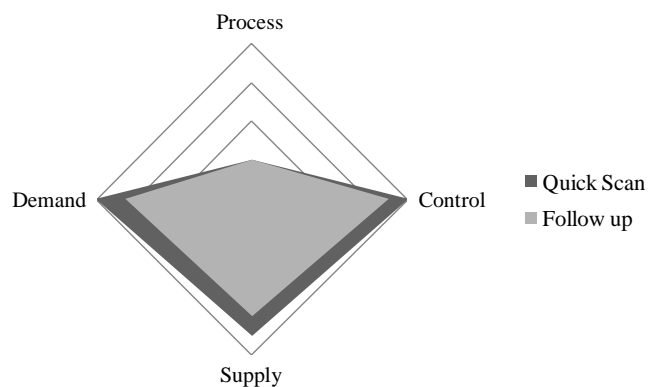
Figure 8.16: Supply chain performance improvement: Dairy 1



Source: Author

Information flow is the only performance improvement area; due to the fortnightly sales and operational planning process that, improved data sharing. The appointment of the procurement manager resulted in only a marginal reduction of supplier lead-time. Also, the reduction of the maintenance warehouse did not impact the inventory category; because the inventory level was previously judged to be below except at company boundaries for both of their value streams. Hence, the inventory category has not improved. Figure 8.17 shows the impact of the changes on supply chain uncertainty.

Figure 8.17: Supply chain uncertainty improvement: Dairy 1



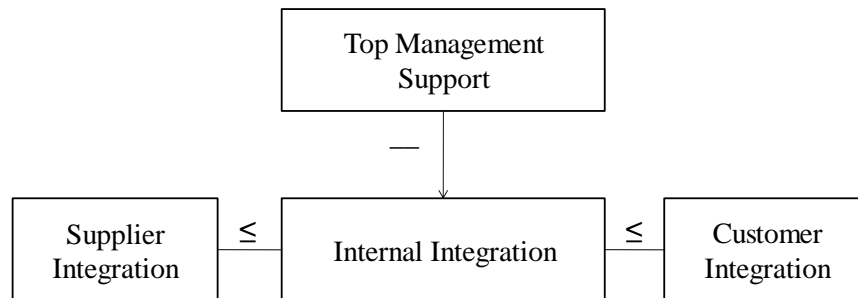
Source: Author

Dairy 1's processes are highly automated, hence process uncertainty is minimised. Most improvement appeared on the demand side; the newly introduced supply chain strategies for the different value streams allow the business to take uncertainty out of the demand side. Further, the additional value stream allows for better customer integration because low volume products are now sold to key customers. Also, the new procurement manager improved some major supplier integrations. Finally, uncertainty on the control side was reduced by restructuring the business, thereby leading to increased visibility.

8.4.4 Food 1: Change process

A Quick Scan was conducted in May 2006. The research identified mostly an absence of the necessary preconditions for achieving a seamless supply chain. Figure 8.18 presents those preconditions.

Figure 8.18: Preconditions for achieving a seamless supply chain: Food 1



Source: Author

Food 1 has a weak power and dependency structure on the customer side. Many large retailers dominate the relationship. Interdependency is present only with customers belonging to the wider corporate. Further, the research identified a lack of top management support to optimise processes internally. However, a strong power and dependency structure is present on the supplier side.

The research revealed two major change areas. Early in 2007, Food 1 implemented a new S&OP software solution that is integrated with the current ERP system (Bagchi & Skjoett-Larsen, 2002). Food 1 implemented three major modules of the S&OP software; the first is an outbound logistics scheduling tool, which enables the company to schedule production towards the shipping schedule, hence reducing customer lead time. The second module is an aggregate planning tool, which allows production planning for 12 months in advance and breaks down the aggregate plan into monthly and weekly production plans. The software also takes changeover and inventory cost into account, hence striving for operational cost optimisation. The final module is a sequencing module that supports the daily production scheduling.

In June 2006, a new logistics manager was appointed. The newly appointed manager further enhanced the relationship with the third party logistics provider, updated the warehouse management systems, upskilled and empowered warehouse management staff, and restructured the information flows.

Figure 8.19 presents the impact of these changes on the internal and environmental barriers to supply chain integration.

Figure 8.19: Longitudinal internal barrier assessment: Food 1

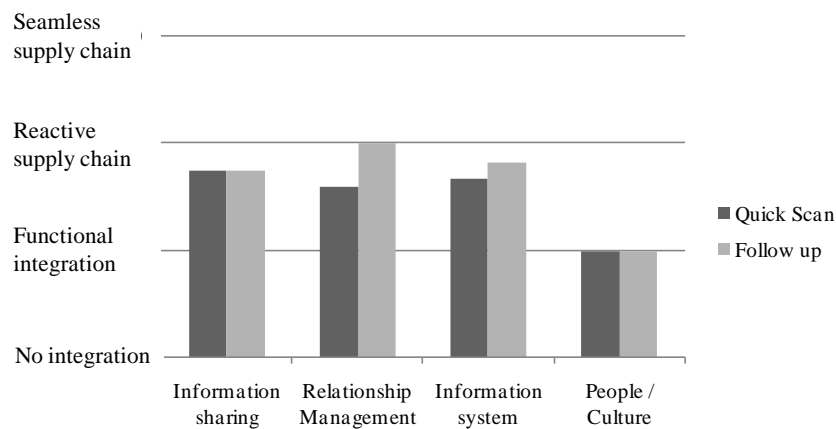
		2006	2008
Environment		Low	Low
Company	Culture	Medium	Medium
	Technology	High	Medium
	Finance	Low	Low
	Organisation	High	High
Value Stream		Medium	Medium

Source: Author

Due to the high production complexity, Food 1 concentrated on improving the sales and operational planning by implementing new software and thereby weakened the technology barrier. However, many of the issues that cause functional silos such as organisational structure and reward system, have not been addressed. Hence, the key remaining barrier for Food 1 is on the organisation level.

Next, the outcome of the application of the supply chain integration assessment tool is presented and Figure 8.20 visualises the outcome for the four identified categories.

Figure 8.20: Integration assessment: Food 1

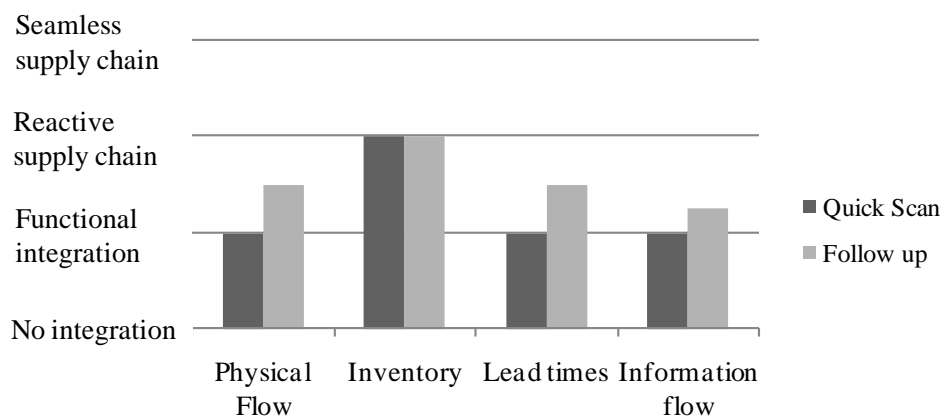


Source: Author

Figure 8.7 highlights that most of the changes implemented by Food 1 have had only marginal impact on supply chain integration. The newly appointed logistics manager developed stronger relationships with key customers, including using vendor managed inventory agreements; which positively affected the relationship management category. However, the people category remains at the level of functional integration.

Figure 8.21 presents the supply chain performance outcome of the change process.

Figure 8.21: Supply chain performance improvement: Food 1

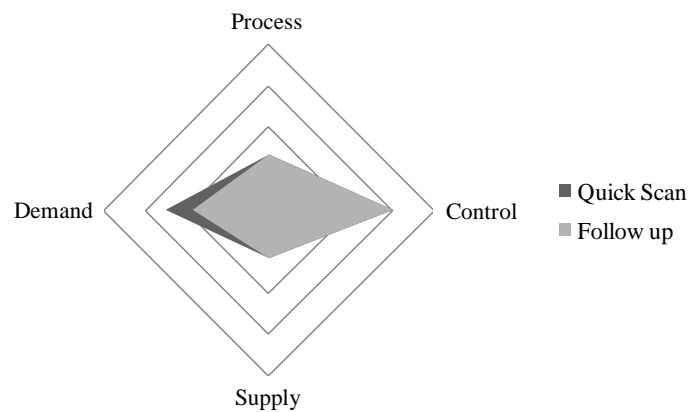


Source: Author

Figure 8.21 shows that the change process has positively impacted on three performance attributes. The upgrade of the warehouse management system and the sales and operational planning software improved the information flow. Also, better co-ordination with key customers resulted in an improved physical flow and a reduction in order lead time.

Figure 8.22 presents the impact of the change programme on supply chain uncertainty.

Figure 8.22: Supply chain uncertainty improvement: Food 1



Source: Author

Uncertainty reduction only occurred on the demand side. The main reasons are the vendor managed inventory agreements and improved customer relationships. The new S&OP software is expected to reduce control uncertainty; however, at the time of data collection the software was not fully implemented.

The next section discusses the cross-case analysis.

8.5 Cross-Case Analysis

The cross-case analysis focuses on three distinct areas. First, the change process of the four case companies is compared to identify common patterns among the cases. Second, the developed supply chain integration evaluation tool examines which category received the highest attention and the outcome of those changes

for supply chain performance. Finally, the impact of the change process on the uncertainty score is presented.

8.5.1 Cross-case analysis of supply chain change processes

The first section places emphasis on the common patterns among the four case companies when addressing certain supply chain integration issues. Here, Evans et al.'s (1995) parallel assessment between business process reengineering and supply chain management is used to highlight a focal company's sequencing of the area of change (see also Table 2.10).

Table 8.4 presents the outcome of the cross-case analysis. The first column presents the area of change, the second column a description of the terminology. The remaining columns highlight each case company and the order in which each supply chain change areas were addressed.

Table 8.4: Similarities within the four change processes

Area for change	Terminology	Sequence of Events			
		Manuf 2	Forestry	Dairy 1	Food 1
People	<ul style="list-style-type: none"> • Board level commitment • A management that questions • A work force that questions • Multi-skilled work force • Attitudinal changes 	1 st	1 st	1 st	1 st
Relationship Management / Innovation	<ul style="list-style-type: none"> • Supplier relationship management • Customer focus • Constant innovation at the interfaces of the company • Constant product / process innovation 	3 rd	2 nd	2 nd	2 nd
Process	<ul style="list-style-type: none"> • Elimination of waste around the cores processes • Speed up core processes • Concentration on core processes 	2 nd	-	3 rd	-
Technology	<ul style="list-style-type: none"> • Technology change • IT-a key to SCM 	4 th	3 rd	-	3 rd

Source: Based on Evans et al., 1995

Table 8.4 highlights that all four companies invested effort into people first. Often the upskilled and/or newly hired staff had a positive effect on the working culture

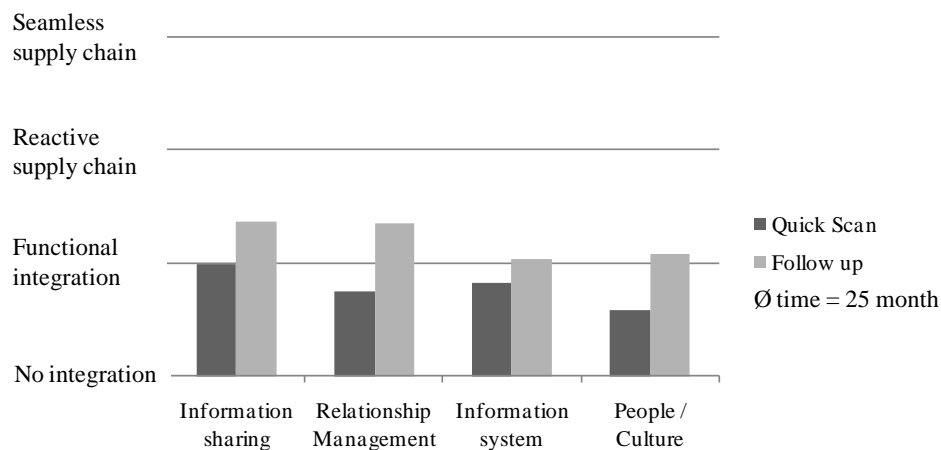
and attitude within the function and/or entire company. In a second step, companies tend to improve supplier/customer relationship management or internal process. Many newly hired people were supply chain specialists. Once the new staff has been inducted, they addressed relationship related issues or improved internal core processes. However, only as the final step did all companies focus on improving or upgrading their current technology.

The impact of the changes on supply chain integration is presented in section 8.5.2.

8.5.2 Assessing the affects of change via the integration evaluation tool

All four companies implemented new supply chain management practises. However, each company also had different emphases regarding supply chain integration. Figure 8.23 presents the overall supply chain integration improvements across the four cases using the developed integration evaluation tool.

Figure 8.23: Integration assessment across the four cases



Source: Author

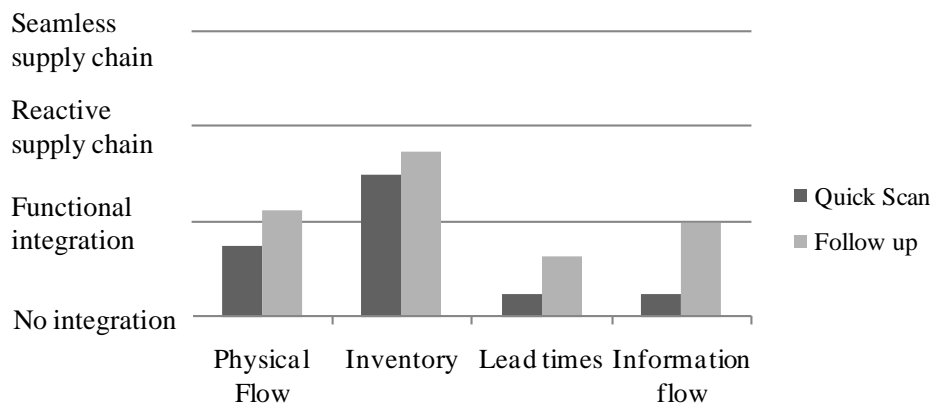
Figure 8.23 highlights that, previously, all categories were either at or approaching functional integration. Currently, all four categories have passed the functional integration stage and are progressing towards the reactive supply chain. The categories showing the biggest gains over the 25 month average period are

relationship management and people/culture. Improvements in the relationship management category are predominantly related to better relationship management styles and an increase in numbers of vendor managed inventory agreements. The people category gained from the upgrade and upskilling of staff with supply chain management knowledge, as well as an improvement in the culture and attitude in the work place.

The two categories showing least improvements are information sharing and information system. In many cases, although operational data was centralised and made available across functions and the visibility of data increased, the investments in an improved information system were minor.

Figure 8.24 highlights the overall supply chain performance improvement from the four cases.

Figure 8.24: Supply chain performance improvement across the four cases



Source: Author

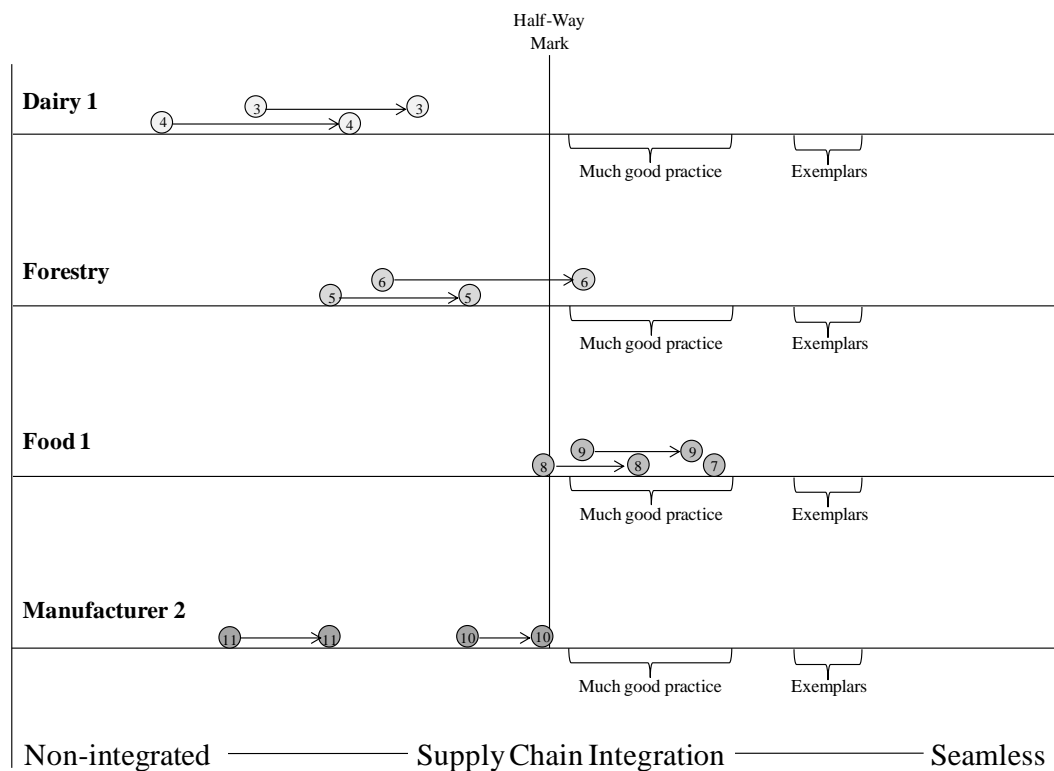
Process improvement over some 25 months improved all four performance categories. The two areas with the greatest performance gains are lead times and information flow, which were also the areas that performed most poorly during the initial Quick Scan. The superior performance of the inventory category is predominantly related to the process industry, where work in progress inventory is almost non-existent (due to high production automation).

It is evident that companies face different integration barriers and address those barriers differently, hence, the pathways to supply chain integration are next described on a more holistic level using uncertainty data. The impact of the changes on supply chain uncertainty for the four case study companies is presented next.

8.5.3 Assessing the affects of change using the uncertainty circle

The detailed case description revealed that uncertainty was reduced in all four case companies. Figure 8.25 presents this uncertainty reduction for the four case companies representing a total of nine value streams.

Figure 8.25: Uncertainty reduction



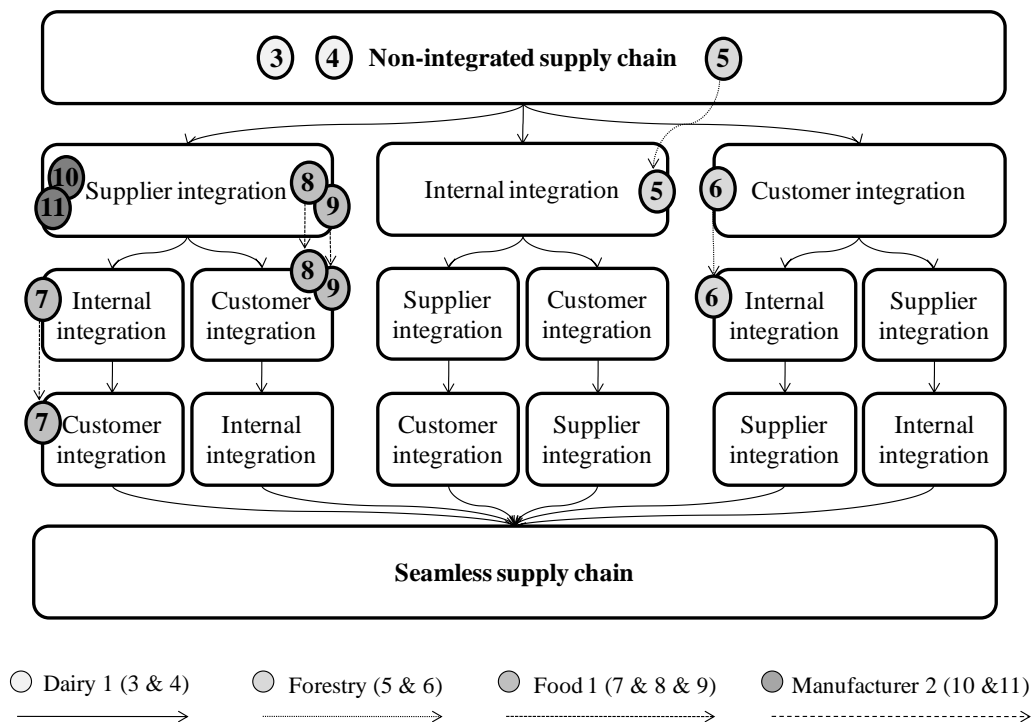
Source: Author

Figure 8.25 shows, with the exception of value stream seven, the uncertainty associated with all value streams has been reduced. Companies implemented many good practises resulting in internal and/or external value stream integration. Figure 8.25 shows that many value streams have progressed towards the half-way

mark. Two value streams actually crossed the half-way mark; one belongs to Forestry (6) and the other to Food 1 (8). Further, Forestry (6) and Dairy 1 (4) achieved the largest uncertainty reduction. The most advanced supply chain integration practises were adopted by Food 1, with all three value streams falling within the 'much good practise' category. They were also benchmarked the highest for supply chain integration. Additionally, only Forestry managed to improve one of its value streams (6) into the 'much good practise' category. Minor gains were achieved by value streams 8, 9, and 10. Further, the research revealed no exemplars and no seamless supply chains in the sample. A reasonable amount of uncertainty remains in all value streams.

Applying the uncertainty data to Table 8.2 allows the researcher to map the current stage of each value stream on the developed conceptual model in Figure 8.1. Figure 8.26 has been slightly amended from the original conceptual model shown in Figure 8.1. The reason lies with the measurement process. Consider value stream 7, for example, which experienced considerably reduced supplier and customer uncertainty. Also, while the process uncertainty was reduced to a minimum, medium to high control uncertainty remains. Calculation of the Euclidean norm results in a low-medium value of internal uncertainty. However, value stream 7 still needs to implement many improvements on the control side in order to become truly seamless. Thus for any value stream that only reduces uncertainty to low-medium levels uncertainty remains, and the value stream is not truly seamless. Thus a new, seamless supply chain stage has been added at the bottom of Figure 8.26.

Figure 8.26: Validation of proposed integration model



Source: Author

The value streams of the four case companies are at various stages on their individual pathway to supply chain integration and have chosen various routes to achieve the seamless supply chain. Dairy 1 has reduced uncertainty but still faces high uncertainty in all three areas. Hence, both value streams (3, 4) remain in the non-integrated supply chain stage. Manufacturer 2 has reduced supplier uncertainty in the past and therefore is placed in the supplier integration stage. Currently, Manufacturer 2 is reducing internal uncertainty; however, internal uncertainty remains high. Further, all of Food 1's value streams integrated with their suppliers in the past. However, from the supplier integration stage, value stream seven took a different route than the remaining two value streams eight and nine. Value stream seven is one of Food 1's high volume products and the company place high emphasis on reducing process uncertainty to a minimum. Hence, internal integration was achieved before recently reducing demand uncertainty. However, control uncertainty remains medium-high. Therefore, Food 1 still needs to put a lot of effort to achieve the seamless supply chain stage for value stream seven. Internal uncertainty (process and control) remains medium-high for value stream eight and nine. Hence, Food 1 managed to achieve external

integration with customers and suppliers before integrating internally. Finally, Forestry's value streams predominantly reduced internal uncertainty.

Value stream five moved from the non-integrated supply chain stage to the internal integration stage. Therefore, value stream five is currently the only value stream that follows Stevens' (1989) integration model. Value stream 6 instead managed to reduce uncertainty on the customer side in the past and likewise benefits from better supply chain control mechanisms. The key reason for Forestry and Food 1 to manage to move into the internal integration stage is a highly automated process, which impacts positively on internal uncertainty. However, control uncertainty for those two companies remains high. Part of the follow up study was a discussion about the future improvement opportunities. The outcomes of the discussions are presented next and provide further insights into the expected future path.

8.5.4 Future supply chain improvement outline

Manufacturer 2 will focus on re-engineering its internal processes as well as supplier/customer development in the near future. Internally, the aim is to increase automation. Further, bar-coding of finished goods will be introduced. Also, lean manufacturing will be further matured to sustain lean production. Externally, the global enterprise will introduce a software solution that allows for more customer visibility. Supplier development will also increase as Manufacturer 2 aims for more visibility in the supplier cost structure (open book costing).

Forestry plans to introduce current best practise used in the main plant to the three remaining plants as well as to the corporate customers in Australia. Further, supplier performance will be closely measured, and actions will be taken with poor performing suppliers. Finally, the third party logistics provider will implement a new software tool that enables more visibility of cost and volume for the outbound logistics side.

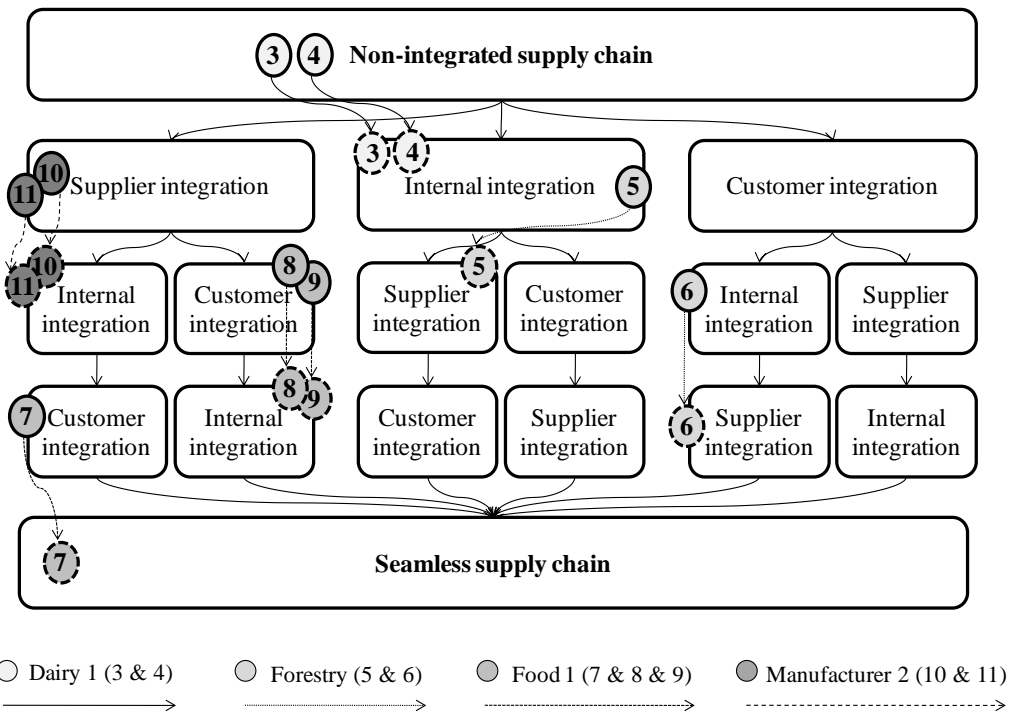
Dairy 1 will continue restructuring its business and further integrate internally. Externally, Dairy 1 will emphasize supplier relationship management, since most

cost savings for the company are predicted in this area. The supplier base will be evaluated and new international supply sources will be developed to reduce dependency on key New Zealand suppliers.

Food 1 plans to roll out the three sales and operational planning modules for the remaining production facilities. The company also plans to implement continuous improvement at the production process level. Further, Food 1's key customers have requested the implementation of EDI. In the long term, this is expected to be rolled out to key suppliers. Further, the development of an integrated track-and-trace system is planned. Also, some cross functional activities are planned by integrating R&D in the supplier selection process.

In light of these planned developments, Figure 8.27 presents the expected pathways to supply chain integration.

Figure 8.27: Expected future pathways to supply chain integration



Source: Author

Manufacturer 2 (value stream 10 and 11) will most likely continue to integrate internally before integrating with in-house customers because customer

integration is highly dependent on European headquarters input. Due to the positive power and dependency structure on the supplier side, Forestry (value stream 5 and 6) is expected to integrate with key suppliers next. Dairy 1 (value streams 3 and 4) instead will continue to restructure their business and will most likely move into internal integration. Finally, Food 1 has managed to integrate externally, hence only internal integration for value stream 8 and 9 remains. Value stream 7 will benefit from the internal integration efforts only if control uncertainty can be addressed.

8.6 Discussion

This research makes an early attempt at investigating how companies achieve supply chain integration in practice using longitudinal studies. Chapter 8 provides some evidence that the pathway to supply chain integration is not a single one as proposed by Stevens (1989). The four cases reveal that currently only one value stream followed the Stevens' integration model. Hence, the research contradicts Stevens conceptual supply chain integration model and Romano's (2003) findings that intra-company integration is a precondition for inter-company integration. In fact, the research reveals that the case companies have tended to take the 'path of least resistance' when integrating their supply chain. This path of least resistance is closely related to the preconditions to achieve a seamless supply chain, as identified in Figure 8.2. The external preconditions are in the form of the power and dependency structure (independence and/or buyer dominance) and, internally the presence of top management support. Food 1, for example, due to a positive power and dependency structure, integrated on the supplier side before focusing on the customer side. However, the internal functional silos remain due to a lack of top management support. Manufacturer 2 is a similar case; the company is predominantly working with smaller local suppliers and has managed to integrate with those suppliers first. Currently, the company is addressing internal integration with strong top management support. However, Manufacturer 2 depends on the European headquarters to better integrate with key customers because the majority of the customers are part of the wider corporate. Hence, the

research supports the conceptual model developed in Figure 8.2 and the following proposition can be stated.

Proposition 8.1:

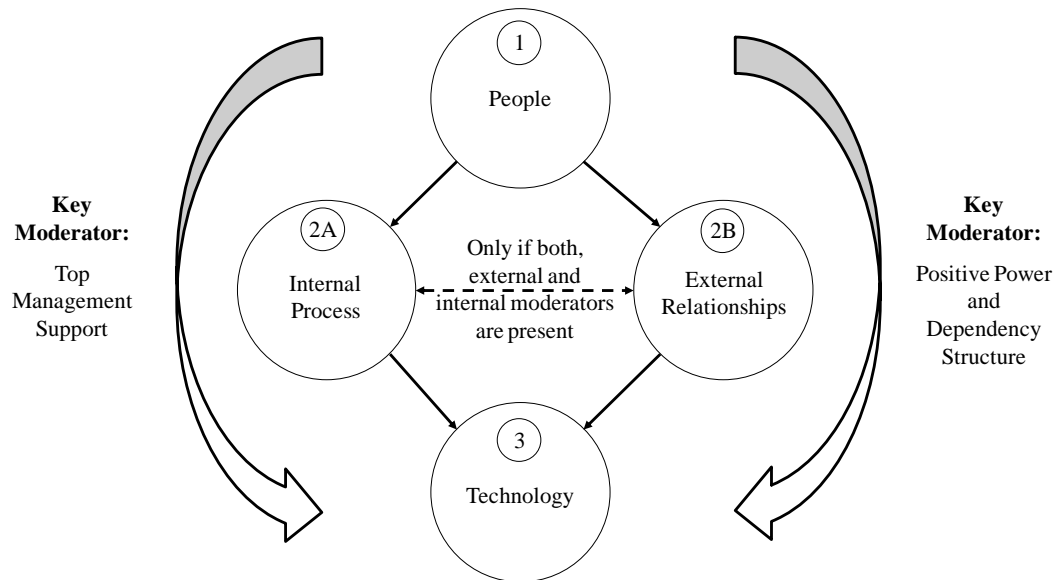
- Companies face internal and external barriers and choose ‘the path of least resistance’ when integrating their supply chain.

Six distinct pathways to supply chain integration have been identified. It should be noted that, in this early stage of the research, it is impossible to compare or rank the pathways to supply chain integration. Arguably, companies in the non-integrated stage face high uncertainties in all four areas of control, process, supply, and demand. Reducing process and control uncertainty first will take waste out of their own operations and will have a direct impact on a focal company’s bottom line. The drive to further enhance efficiency will result in targeting the purchasing price on the supply side next. Lastly, customer integration will be addressed to increase the effectiveness of the supply chain. Frohlich’s (2002) findings also suggest that an ‘inside-out’ strategy of first removing internal barriers and then bringing upstream suppliers and downstream customers onboard is the best way to change the supply chain. Hence, it might be argued that Stevens’ (1989) conceptual integration model represents the ideal theoretical path to supply chain integration; however, as shown by the findings of this chapter, in many cases this is not the most feasible pathway to supply chain integration in the real world. Notwithstanding the fact that Fine (1998) introduced clock speed as a concept to characterise different rates of evolution in various industries, the present research has clearly demonstrated that there is no single route to supply chain integration; that the pathway to supply chain integration is essentially organisation specific.

Further, the cross-case analysis revealed that companies follow similar behaviour patterns when further integrating their supply chain. They hired new supply chain management expertise and upskilled/empowered their existing staff. As a second step, processes and/or external relationships were addressed before investing in an

upgrade to integrated technology. Figure 8.28 presents the conceptual model developed based on these findings.

Figure 8.28: Sequencing of target areas to further integrate the supply chain



Source: Author

The research identified that all companies upgraded knowledge and skills in a particular area before addressing internal processes and/or external relationships. The second step in Figure 8.28 is highly dependent on the preconditions or key moderators for supply chain integration, identified earlier in Figure 8.2. If a focal company has a weak power and dependency structure externally and strong top management support internally, it would choose path 2a before moving to technology improvement. If a focal company has a strong power and dependency structure and lacks top management support, it would choose path 2b before moving to technology improvement. However, if a focal company has both strong power and dependency externally and top management support internally, it would choose either 2a or 2b, before addressing technology.

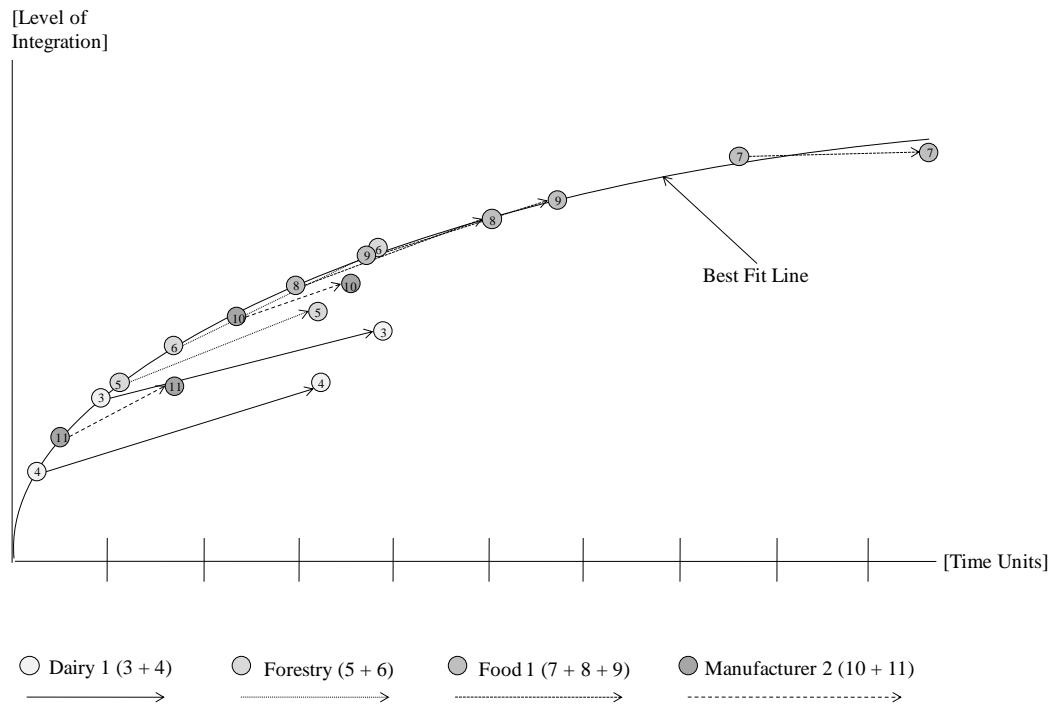
Food 1 followed pathway 2b by integrating externally before investing in technology. However, internal functional silos remain due to a lack of top management support. Dairy 1 is currently in step 2a focusing on internal process

integration after investing in people. However, external integration will be difficult to achieve due to a weak power and dependency structure. Manufacturer 2 heavily invested in people before improving internal processes due to top management support. Currently, the supplier base is further developed because of the positive power and dependency structure in place before upgrading the current information system.

Halldorsson et al.'s (2008) quantitative study stressed that people appear to be more important than computers in supply chain management implementation, in both Scandinavia and the USA. Also, Pagell (2004) identified that face-to-face communication and visual management aids seem to be more important than implementing a highly sophisticated information system. Zhao et al. (2008), in their recent quantitative study, identified that normative relationship commitment had a very strong positive impact on customer integration, whereas instrumental relationship commitment had no impact on customer integration.

Longitudinal studies give further opportunity to investigate the rate of change. Here, the achieved uncertainty reduction is compared to the time it took to reduce uncertainty to a certain level. Figure 8.29 presents this comparison.

Figure 8.29: Speed of supply chain integration



Source: Author

The x-axis in Figure 8.29 contains time units; the y-axis, the level of integration based on consideration of supply chain uncertainty. A best fit line has been added which is adapted from the learning curve. This is based on the proposition that companies can move from poor integration to a medium level of supply chain integration faster than from medium integration to a seamless supply chain (also called diminishing returns). The initial Quick Scan data is then placed on the best fit line. The second data point is then placed according to the time-lag and uncertainty reduction.

The proposition that it is faster to move from a low to a medium level of supply chain integration than from a medium level to high level of supply chain integration is only conditionally true. Food 1's value streams (7, 8, 9) are the most advanced value streams and all follow the best fit line. So are value streams 6 (Forestry) and 10 (Manufacturer 2). However, value streams 3 and 4 (Dairy 1), 5 (Forestry) and 11 (Manufacturer 2) all appear below the best fit line. Hence, to move from a low level of integration to a medium level of integration is not as fast

as predicted by the best fit line. The value stream with the steepest line is value stream 11 (Manufacturer 2). The company considerably improved their value stream in a short period of time. In conclusion, Figure 8.29 highlights that the speed of integrating the supply chain is slow. Fawcett and Magnan (2002) also identified that supply chain change is slow, especially in regard to people and culture.

It seems that the speed of change does not necessarily depend purely on the current level of supply chain integration; it is more complex than this. Preconditions to achieving the seamless supply chain (see Figure 8.2) need to be considered as well as the significance of environmental, internal and external barriers. It is also reasonable to expect that company size impacts the speed of change.

This exploratory investigation into the pathways to supply chain integration is not without limitations. The most obvious is that the small sample of four organisations does not allow for generalisation. The question remains if other companies follow different or similar pathways to supply chain integration shown in Figure 8.1. Also, part of the Quick Scan Audit Methodology is the development of improvement opportunities. Hence, the Quick Scan is already pointing companies in the direction of where to put most emphasis to further integrate the focal company's supply chain (Böhme et al., 2008b). Finally, all four case companies were studied during a time of continuous growth and (relative) global economic stability.

There are a multitude of further research avenues to extend this exploratory research. Firstly, the identified six pathways to supply chain integration need further validation. Also the question remains, which of the six pathways is the ideal path to achieve the seamless supply chain? And, unless being concerned with speed of change, what is considered ideal for one company is unlikely to be ideal for another. Is the achievement of the seamless supply chain always feasible or even desirable? Chapter 7 provided some insights that supply chain integration is difficult to achieve if the focal company depends highly on an external entity.

Similarly van Donk and van der Vaart (2004) identified that integration is not always feasible in the context of shared resources, i.e. the academia already points out that limitations to integration are present. The academia recently also started debating the desirability of supply chain integration. Here, it is important to emphasise that the debate is not about full integration versus zero integration. Rather, it is about how much integration is justified and under what circumstances. The answer to these questions depends very much on the nature and purpose of the individual value stream. For example, it is difficult to envisage any circumstance in which internal integration will not prove essential to competitiveness (Stevens, 1989). Indeed as described by Busalacchi (1999), for those companies responding to electronic auctions this may be the single most important action that they can take. Other authors argue that supply chain integration should follow investment logic (e.g. van Donk & van der Vaart, 2005b).

Further, the supply chain integration evaluation assessment tool needs further validation from larger empirical data sources. One successful application of the integration of the evaluation assessment tool within the UK steel industry can be found in Böhme et al. (2007c). However, further applications in other countries are necessary. Also, further characteristics or even categories need to be identified to capture the totality of supply chain integration in different industry sectors and countries. This chapter made an attempt to investigate the speed of change towards the seamless supply chain and further research is required on this aspect. Also of interest, is the question of which changes have the greatest impact on supply chain integration and supply chain performance.

8.7 Conclusion

This chapter aimed to answer the overarching research question How do companies achieve supply chain integration in practise? Here, the initial Quick Scan Audit Methodology has been extended to enable longitudinal case study data collection. Four longitudinal case studies into achieving supply chain integration in practice were conducted. The average timeframe between Quick Scan and

follow up study was 25 months. The effects of the change process have been measured in three distinct ways. First, the effect of a focal company's change process on internal supply chain barriers was assessed. Secondly, the impact of the change on supply chain uncertainty was measured. Finally, the effect of the change on supply chain integration was assessed using the supply chain integration evaluation assessment tool developed in Chapter 2.11.3.

The conceptual model developed in Chapter 5 containing six pathways to supply chain integration has been validated. The conceptual model contains three different areas to supply chain integration: internal integration, supplier integration and customer integration. Which path a focal company chooses is highly dependant on the external power and dependency structure and the internal top management support, because the research identified that companies tend to take the 'path of least resistance' when further integrating their supply chain. Hence, there is no single path to supply chain integration. Some common patterns regarding supply chain change have been identified among the four cases studied. All four cases invested in people before addressing supply chain related issues. Only in the final step did companies invest in technology improvements.

The major contribution to theory lies in the close examination of pathways to supply chain integration. First, the conceptual integration model developed in Chapter 5 (see also Figure 8.1) has been validated. Here also, the preconditions that influence the choice of one of the six paths to supply chain integration have been identified. Second, the effect of change on barriers to supply chain integration has been examined. Finally, the research revealed key supply chain integration categories and their impact on supply chain performance via the application of the developed supply chain integration assessment tool.

9. Discussion

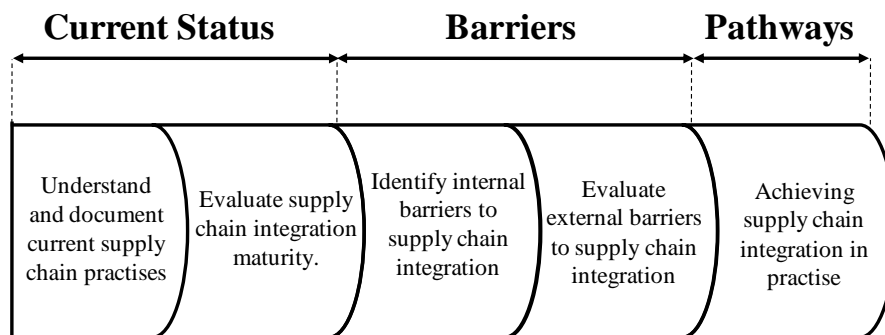
9.1 Supply chain integration in practise: An exploration

One of the most significant shifts in the paradigm of modern business management is that individual companies no longer compete as autonomous entities, but rather as supply chains (Christopher, 1998). Success of business management in an era of inter-network competition will depend on management's ability to integrate the company internally, as well as, externally with customers and suppliers (Lambert et al., 1998). Supply chain management offers the opportunity to capture the synergies afforded by intra- and inter-company integration. Thus, for almost two decades, researchers have sought to identify a common pathway to supply chain integration with possibly the most influential work being by Stevens (1989), who suggested that companies follow an integration process that proceeds through different stages; first by integrating internally, then extending the integration process to other supply chain members externally (Stevens, 1989). However, Stevens conceptual model has many proponents (e.g. Towill et al., 2000; Frohlich, 2002; Koufteros et al., 2005; Romano, 2003) as well as opponents (e.g. Gimenez, 2004; Halldorsson et al., 2008; Potter et al., 2004). In conclusion, many researchers have identified a lack of understanding/knowledge of the pathways to supply chain integration (Cigolini et al., 2004; Frohlich & Westbrook, 2001; van Donk & van der Vaart, 2005b). This thesis has made an early attempt at closing the gap in understanding of the routes companies actually follow when integrating their value streams. A summary table of all original contribution of this thesis can be found in Table 10.1.

A particular challenge, when investigating pathways to supply chain integration, is that academia has not agreed on a common framework, or even a definition, of supply chain integration. In this thesis, supply chain integration is viewed as three dimensional; having internal supply chain integration, and external (customer and supplier) integration (Bowersox et al., 2007; Frohlich, 2000). Here, external integration is viewed as advancing supply chain management practises that support the optimisation of end-to-end material and information flow. Following

clarification and definition of the term supply chain integration the overarching research question regarding the pathways to supply chain integration was addressed, and a stepwise procedure was introduced to enable researchers to investigate the actual pathways to supply chain integration. The five step procedure also gives practitioners clear guidance when aiming to integrate their supply chain because each step includes unique supply chain integration assessment techniques. Figure 9.1 presents the five step procedure, which mirrors the overall structure of this PhD Thesis.

Figure 9.1: Five step procedure to investigate supply chain integration in practise



Source: Author

The overall objective of the first two steps is to evaluate the current status of the company focal supply chain. This involves a thorough understanding and documenting of current practises and the resultant evaluation of supply chain integration maturity. Once the current status is assessed barriers to internal and external integration are investigated. This step is necessary to fully understand why the focal company chose a certain route, and to understand which barriers to supply chain integration need to be addressed. Once the current status and the key barriers are established, a longitudinal study allows the researcher to investigate the pathway to supply chain integration that was taken.

9.1.1 Current supply chain status

The current understanding of supply chain management established the basis for the investigation into barriers and pathways to supply chain integration. Here, the Quick Scan Audit Methodology (QSAM) was identified as a very valuable

methodology for investigating the current status of real life supply chains and to gain in-depth insight into a focal company's supply chain practises.

Many scholars report that few companies are actually engaged in extensive supply chain integration practises (Akkermans et al. 1999; Harps & Hansen, 2000; Kilpatrick & Factor, 2000; McAdam & McCormack, 2001; Towill et al., 2002; Poirier & Quinn, 2003; Zailini & Rafagopal, 2005). This research into supply chain integration in New Zealand revealed that overall a significant gap remains between integration theory and practise. The research identified weak practitioner uptake of the supply chain integration concept. If this is in any way representative of New Zealand organisations, it is evident there exists a considerable gap between best practise supply chain management theory and its adoption and application by New Zealand practitioners. Thus, considerable scope for improvement exists.

9.1.2 Barriers to supply chain integration

The question of why supply chains are so weakly integrated internally was also investigated. The internal supply chain barriers were identified and assessed using systems thinking, a method that offers a way of understanding complex problems and communicating this understanding to others (Holmberg, 2000). The research revealed that most internal integration barriers are people related. Some are directly related, like supply chain skills of individuals or company culture, and some are indirectly related to people in the form of the organisational structure and reward systems; because people are embedded in the real-world structures provided by the focal company (Childerhouse et al., 2003). Many other authors agree (Andraski, 1994; Lambert & Cooper, 2000; Mentzer et al., 2000; Pagell 2004; Storey et al., 2005; Whipple & Frankel 2000).

The research also revealed that the case companies are only weakly integrated with their suppliers. Every company in the sample was simultaneously dominated by at least three of their key suppliers, which considerably reduces the chances of supplier integration. Power and dependency appear to play a mediator role (also

termed a precondition) for external integration, as no direct link between power and dependency and external integration has been identified.

9.1.3 Achieving supply chain integration in practise

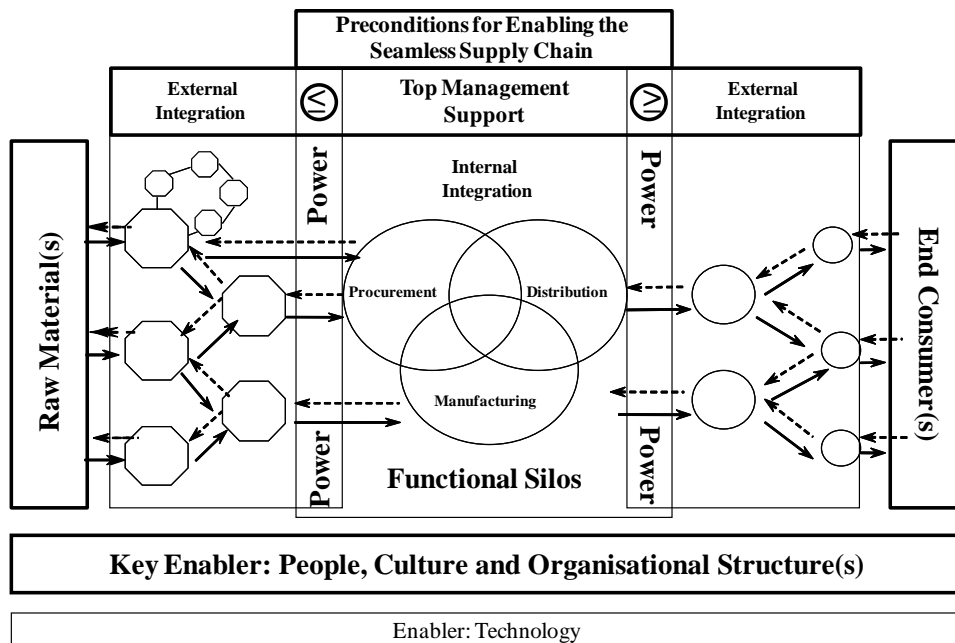
After establishing current supply chain status and the barriers to supply chain integration, longitudinal studies enabled investigation of how supply chain integration is actually achieved. QSAM was extended to allow for longitudinal data collection. The impact of the integration change process were assessed using three distinct measures; (a) the effect on barriers to supply chain integration; (b) the effect on supply chain uncertainty; and (c) the effect on integration using the developed supply chain integration assessment tool.

The thesis provides some evidence that there are many pathways to supply chain integration, which contradicts Stevens (1989). The four cases studied revealed that only one value stream followed the Stevens' integration model; Stevens' supply chain integration model does not always reflect reality (Potter et al., 2004; Gimenez & Ventura, 2005). In fact, the research revealed that the case companies tended to take the 'path of least resistance' when integrating their supply chain. This path of least resistance is closely related to the preconditions to achieve a seamless supply chain; namely, external power and dependency structure (independence and/or buyer dominance) and internal, top management support. Further, the investigation revealed that companies follow similar pathways when further integrating their supply chain: the four case companies all invested in people before addressing internal processes and/or relationship issues. Only as the final step was the current information technology improved.

This thesis has increased the understanding of supply chain integration for academics and for practitioners. It appears that organisational and behavioural complexity are often underestimated, (Storey et al., 2005) and, conversely, strategic alliances (Drago, 1997) and partnerships (Spekman et al., 1998) are overrated within the supply chain integration literature.

Figure 9.2 adapts the Handfield and Nichols (2002) supply chain integration model. It illustrates the key findings of this PhD thesis in a single diagram and proposes several key focus areas regarding supply chain integration.

Figure 9.2: Implications of the research for the wider integration landscape



Source: Adapted from Handfield and Nichols, 2002

The adapted version integrates the research findings and places them into perspective. Firstly, the study acknowledges the existence of barriers, both internally and externally. Internally, people in the guise of a company culture and a company structure can encourage functional silos, which seem to be the most critical barrier to supply chain integration. Whipple and Frankel (2000) similarly highlighted that the largest barrier to integration is organisational (e.g. culture) rather than being technical or financial. Externally, a predominantly high dependency on external entities can limit the integration efforts (Cox, 2001; van der Vaart & van Donk, 2004).

Figure 9.2 also highlights the pathways to supply chain integration. The pathways are visualised by including the preconditions to supply chain integration shown at the top of Figure 9.2. The research revealed that top management support plays a critical role when aiming to integrate internally. Externally, a positive power and

dependency structure involving both, buyer dependency and interdependency, play a critical role. All of these preconditions appear to dictate the route a focal company will take, as the research showed that companies tend to take the supply chain integration path of least resistance.

The preconditions to supply chain integration also contribute to research on the feasibility of supply chain integration. In circumstances when the balance of power is held by the external entity, an integrated supply chain can likely only be achieved if the company that holds the power desires integration. Even then, Chapter 7 identified some strategies to overcome such supplier or customer dominance. Also, if there is a lack of top management support, a company will most likely struggle to integrate internally.

Enablers to supply chain integration have been added to the lower part of Figure 9.2. Successful supply chain integration is a function of how well people work internally and with key external entities. Although technology is a powerful enabler, it is not the key to supply chain integration; people are (Mentzer et al., 2000). The culture and the organisational structure have been found by this research to be very critical for achieving internal integration. Managerially, this implies encouraging cooperation, information sharing, co-ordination, and joint planning across organisational boundaries. Specific tools and mechanisms to achieve these goals can be generally found in the organisational behaviour management literature (e.g. Murphy and Poist, 1992). The present research findings support Halldorsson et al.'s (2008) quantitative study that reported that people appear to be more important than technology in supply chain management implementation in both Scandinavia and the USA. Pagell (2004) also identified that face-to-face communication and visual management aids seem to be more important than implementing a highly sophisticated information system. Similarly, Zhao et al. (2008) recently identified in their quantitative study that normative relationship commitment had a very strong positive impact on customer integration, whereas instrumental relationship had no impact on customer integration. In summary, the adapted version of the Handfield & Nichols (2002) model in Figure 9.2 visualises a holistic, systems perspective regarding supply

chain integration, which requires systems thinking for properly managing and researching supply chain integration.

This research also revealed that integrating a supply chain is a slow and incremental process, especially with regard to people and culture (Gattorna & Walters, 1996; Fawcett & Magnan, 2002); the effort and resources required to implement supply chain integration should not be underestimated. It is a marathon, not a sprint (Halldorsson et al., 2008). Hence, the road to supply chain integration is not an easy one; however, it is a road well worth travelling (Mentzer et al., 2000).

9.2 Areas of investigation where further evidence is required

Although this thesis makes significant contributions to both academia and practise, there are several limitations that open up avenues for further research. Research constraints include time, finances and access to data. As a consequence, it is not possible to conduct comprehensive, robust research that takes into account every factor that affects the subject area (see also Figure 3.3). Further, the author acknowledges the limitation of conducting this research as a one-sided approach, in which the information is acquired only from the focal company. No information is acquired from the suppliers and customers. This section reflects on these shortfalls through a review of the areas that require further evidence.

9.2.1 Current supply chain status

The current status relates to the QSAM and its application within New Zealand. Firstly, limitations arise around the methodology itself due to the limited amount of time spent on a Quick Scan. It is simply not possible to understand and document the entire supply chain, so focus is instead placed on gaining in-depth knowledge of specific value streams. There is also a clear need for buy-in from those organisations under analysis. Since, if this is not forthcoming, the quality of the information and resultant understanding of the supply chain can be significantly reduced.

Limitations also result from the application of the Quick Scan to identify the level of value stream integration in New Zealand. The New Zealand sample was fairly small and biased to companies with low levels of internal and external integration, and high levels of uncertainty. The sample is not a comprehensive representation of New Zealand value streams but does allow for insights to be gained on the general health of New Zealand value streams. Also, some industry sectors, like the retail sector, are not included in the sample and others like the service sector, are underrepresented.

9.2.2 Barriers to supply chain integration

Although there is no evidence, it is possible that the supply chain systems in New Zealand may exhibit different characteristics to those in other countries. Hence, the barriers identified need further validation from larger empirical data sources. Also, the power and dependency dyadic relationship model, (see Figure 7.1) and the three layers of internal supply chain integration barriers models (see Figure 6.1) lack robustness due to the limited number of cases and single New Zealand research setting. Hence, both conceptual model require wide verification.

9.2.3 Achieving supply chain integration in practise

The investigation into how companies actually achieve supply chain integration is limited by a small sample size (four companies, nine value streams in New Zealand) and the results cannot be used to generalise about pathways to supply chain integration; the research setting of companies in New Zealand, could limit the generalisability of the findings. Finally, the application of the QSAM may have biased the longitudinal research results because part of the QSAM involves the development of improvement opportunities. The Quick Scan advices companies to move in a particular direction to further integrate the company supply chain. However, the follow up studies revealed that practitioners only partially need the advice provided by the Quick Scan team (Böhme et al., 2008b). Finally, all four case companies were studied during a time of continuous growth and (relative) global economic stability. The question remains how different economic climates impact supply chain integration in practise.

9.3 Research strengths

The major strength of the thesis is the large quantity, and more importantly the high quality, of case data gathered via the Quick Scan Audit Methodology; which has impacted on all the findings chapters. The author was in a very fortunate position to be part of the Waikato Management Quick Scan Audit team. Here, the author was able to work alongside well known researchers like A Prof Paul Childerhouse and A Prof Eric Deakins from Waikato University, as well as Prof Stefan Seuring from the University of Kassel, during the process of data collection.

Many authors conclude (Frankel et al., 2005; Mentzer & Kahn, 1995; New & Payne, 1995; Seuring, 2005; Westbrook, 1994) that supply chain management problems are often unstructured, even messy, real-world problems. The authors suggest that, to gain relevance for supply chain researchers, a “one paradigm, one approach” perspective should not automatically be the obvious choice (Frankel et al., 2005; Mentzer & Kahn, 1995; New & Payne, 1995; Seuring, 2005; Westbrook, 1994).

The Quick Scan Audit Methodology has been developed in order to accurately describe, truly understand, and explain a complex and messy environment by applying multiple data collection methods (data triangulation). Further, a team of researchers ensures that the research does not reflect simply one person’s opinion (investigator triangulation). Also, the applicability of the Quick Scan and the different integration assessment tools and techniques to different industry sectors, using case study research, is a further strength (method triangulation). The Quick Scan is anchored within the systems thinking theory. Systems thinking is particularly fruitful for investigating supply chain integration issues because it takes a holistic view of the supply chain. Systems thinking is the holistic process of considering both the immediate outcomes and the longer-term systems wide ramifications of decisions (Fawcett et al., 2007).

Seven Quick Scans, four follow up studies, seven relationship evaluations, and three interviews were conducted to explore supply chain integration in practise. In

total, some 240 person days were spent on site observing, interviewing, auditing, and analysing archival data in eleven different case companies. The researcher gained an in-depth insight into the real world managerial context of supply chain integration and was able to extract a large amount of rich case study data. Since the case companies also belong to four distinct industries all of the findings chapters feature at least two different industry sectors; which increases the generalisability of the findings.

10. Conclusion

Successful supply chain management requires integrating business processes internally and with key members of the supply chain (Lambert et al., 1998). The literature is clear on the importance of integration, but lacking in terms of prescribing the manner in which companies create integration across operations internally and with suppliers and customers externally. This research has taken an early step in investigating how supply chain integration is actually achieved using qualitative research and longitudinal case studies. The backbone of this thesis is a five step methodology developed to investigate pathways to supply chain integration. This methodology proposes that, before investigating pathways of supply chain integration, the current status of a supply chain should be evaluated and internal and external barriers identified. This barrier assessment is critical because the removal of barriers between and within organisations seems to be the crucial issue in integrating any supply chain (Gimenez, 2004; Romano, 2003).

The major foci of this thesis are twofold. First, the thesis aimed at the development of a method to investigate how companies achieve supply chain integration in practise. Second, each findings chapter focused on the development of conceptual models that enabled the researcher to assess current supply chain status, as well as barriers and pathways to, supply chain integration. A systematic methodology for supply chain diagnostics was presented in Chapter 4, followed by two distinct assessment methods to investigate the current status of supply chain integration: the uncertainty circle; and the developed supply chain integration assessment tool. Chapter 6 provides a conceptual model that allows for

categorisation and assessment of internal and environmental barriers to supply chain integration. Chapter 7 proposes a five step method to assess external relationships on the basis of power and dependency. Finally, Chapter 8 enables the researcher to map out the change processes within a focal company and assess the impact of the change on (a) barriers to supply chain integration, (b) supply chain uncertainty, and, (c) the developed supply chain integration assessment tool; thereby highlighting the pathways to supply chain integration.

10.1 Original contribution

The original contribution to knowledge is best explained in relation to the stepwise method presented in Figure 9.1. Table 10.1 illustrates the research questions and resultant original contribution of each findings chapter. There now follows a detailed summary of the research conducted at each step and the resultant original contribution to knowledge.

10.1.1 Quick Scan Audit Methodology

The first major contributions to knowledge appeared in the methodology chapter. Here, a rigorous method was developed which adapted the Quick Scan method to suit longitudinal case studies. Applying the Quick Scan Audit Methodology (QSAM) to New Zealand increased its rigour and generalisability; Quick Scan was applied in new industry settings (the New Zealand process industry and the health sector), further demonstrating its validity and reliability.

10.1.2 Supply chain integration in New Zealand

The investigation into current supply chain integration practises in New Zealand supports the current literature of its assessment that a gap exists between supply chain integration theory and actual uptake in practise. Best-in-class performance remains an elusive goal for most companies in New Zealand, with best practises adoption being patchy. The investigation further revealed that New Zealand value

streams are significantly less integrated on the customer side than on the supplier side.

The data collected was also used to validate currently available supply chain integration models. Here, the research findings contradicted existing models and a new supply chain integration model has been proposed, which was subsequently validated in Chapter 8.

10.1.3 Internal and environmental barriers to supply chain integration

The major contribution regarding internal and environmental barriers to supply chain integration lies in the clear categorisation and close examination of the topic. Barriers to supply chain integration were identified and categorised using a three layer conceptual model. The categories are termed: (a) environmental barriers; (b) company specific barriers; and, (c) value stream barriers. The research further provided support for the literature that the identified barriers are also common to New Zealand, and that a multitude of barriers obstruct supply chain integration in practise. Finally, the research revealed that many barriers to internal integration relate to people and the structures and working arrangements imposed on those people by the focal organisation.

10.1.4 Power and dependency barriers to external integration

The assessment of external barriers to supply chain integration in terms of power and dependency made three contributions to theory; first, by uniquely measuring power and dependency in external relationships. Here, commonplace variables have been identified influencing the power and dependency structure. The developed five step power and dependency evaluation process was very valuable when measuring dependencies in buyer/supplier relationships. Second, insights into current relationship management practises and the power and dependency structure of New Zealand business were presented. Here, poor relationship management practises and a high number of supplier and customer dominance relationships were highlighted. Indifferent customer relationship management and supplier relationship management practises are common; therefore often external

integration is immature. Finally, the role that power and dependency play for external integration was identified. A positive power and dependency structure has been identified as an important precondition for achieving of external integration. Likewise, unfavourable external dependencies often obstruct supply chain integration uptake.

10.1.5 Achieving supply chain integration

Regarding the pathways to enhancing supply chain integration, the major contribution to theory lies in the close examination of supply chain integration practises using longitudinal case studies. First, the conceptual integration model developed in Chapter 5 (see also Figure 8.1) was validated.

Second, the preconditions or moderators that influence the selection of one of the identified six paths to supply chain integration were highlighted. These preconditions are: a positive power and dependency structure externally (buyer dominance and interdependency); and good top management support internally. The research revealed that managerial buy-in significantly enhances internal supply chain integration. Also, favourable external dependencies coupled with senior management conviction offers the best setting for supply chain integration in practise. However, if a focal company lacks top management support and/or has an unfavourable power and dependency structure; managers follow the path of least resistance when enhancing integration in practise.

Third, the effect of change on: (a) barriers to supply chain integration; (b) supply chain uncertainty, and; (c) supply chain integration were examined. The research revealed commonalities among the four case companies regarding targeted improvement areas during the change process. The 'people' factor and the cultural change to supply chain management philosophy is often the first step in integration. Either internal functional boundaries or external dyadic relationships are tackled afterwards, depending on the practical setting. Technological inhibitors to supply chain integration are often left to last when enhancing integration. Finally, the research presented early exploratory insights that the

speed of supply chain integration development in practise follows a learning curve trajectory.

Table 10.1 provides an overview of the major theoretical contributions provided by this thesis; including research questions, the methodological approach used to answer the research questions, and the key theoretical basis for each of the findings chapters.

Table 10.1: Research question and original contribution

5 Step Method	Theory	Research Question	Methodology	Major contribution	Chapter
Understand & document current supply chain practises	Watson (1994)	What is an effective methodology to investigate supply chain integration maturity, barriers, and enhancement in practise?	Verification by multiple applications	1.1 Generalisability of the QSAM 1.2 Development of the QSAM to collect longitudinal case study data 1.3 Rigorous method to measure power and dependency in external relationships 1.4 Development of an integration assessment toolkit	4
Evaluate supply chain integration maturity	Frohlich & Westbrook (2001); Mason-Jones & Towill (1998); Stevens (1989); Towill et al. (2002)	How integrated are New Zealand supply chains? In what ways do companies pursue supply chain integration in practise?	Seven QSAMs Two interviews	2.1 The application of supply chain theory is poorly represented in practise. Most New Zealand supply chains are poorly integrated 2.2 Currently available supply chain integration models do not reflect reality 2.3 Upstream integration is more common than downstream integration 2.4 New Zealand companies have significantly lower control mechanisms in place than their UK counterparts 2.5 Supply chain managers do not always integrate internally first	5
Identify internal barriers to supply chain integration	Gimenz (2004); Halldorsson et al. (2008); Pagell (2004)	What barriers obstruct internal supply chain integration in practise?	Six QSAMs	3.1 Close assessment and categorisation of internal and environmental barriers 3.2 A multitude of barriers obstruct supply chain integration in practise 3.3 Managerial, socio-cultural factors are the major obstacles to supply chain integration in practise	6
Evaluate external barriers to supply chain integration	Cox (2001); van der Vaart & van Donk (2004)	What is an appropriate technique to measure power and dependency across inter-organisational boundaries?	Seven case studies	4.1 Identification of commonplace variables influencing the power and dependency 4.2 Indifferent customer relationship management and supplier relationship management practises are common, therefore often external integration is immature	7

		How do power and dependency affect external supply chain integration?		4.3 Unfavourable external dependencies often obstruct supply chain integration uptake	
				4.4 Dependent suppliers are easier to implement integrative practises with	
Achieving supply chain integration in practise	Stevens (1989)	How do companies achieve supply chain integration in practise?	Four longitudinal case studies	5.1 Conceptualisation of feasible integration pathways	8
				5.2 Managerial buy-in significantly enhances internal supply chain integration	
				5.3 Favourable external dependencies coupled with senior management conviction offers the best setting for supply chain integration in practise	
				5.4 Managers and change agents follow the path of least resistance when enhancing integration in practise	
				5.5 The speed of supply chain integration development in practise follows a learning curve trajectory	
				5.6 The 'people' factor and the cultural change to supply chain management philosophy is often the first step in integration in practise	
				5.7 After 'people', either internal functional boundaries or external dyadic relationships are tackled depending on the practical setting	
				5.8 Technological inhibitors to supply chain integration are often left to last when enhancing practise.	

Source: Author

10.2 Relevance of thesis to industry and practitioners

This thesis also makes strong contributions to practitioners. First of all, the five step methodology to investigate pathways to supply chain integration provide practitioners with a roadmap to improve supply chain integration. Further, each of the findings chapters supports the practitioner with supply chain integration assessment tools and techniques. The developed supply chain integration assessment tool enables practitioners to undergo a self-assessment of their current supply chain integration level, and identifies major shortcomings.

The Quick Scan Audit Methodology cause and effect analysis enables practitioners to gain a holistic view of the various internal supply chain integration barriers; hereby focusing on environmental, company and value stream aspects. This categorisation is very useful as it provides supply chain managers with a barrier assessment so they might align resources accordingly. However, barriers should not be viewed in isolation; they are often uniquely interlinked and managers also need to understand the resulting effects of their actions internally as well as externally, as visualised via the cause and effect diagram (see, for example, Appendix F). This, however, requires staff with systems thinking capabilities.

The application of the Quick Scan Audit Methodology identified that supply chain theory is poorly represented in practise. Most New Zealand supply chains are poorly integrated. These findings should comfort supply chain practitioners because practical integration seems to be very difficult to achieve. Both data sets, from the UK and New Zealand, further show that not one single value stream has achieved a seamless status. However, much good practise is present in some value streams and practitioners need to understand that advanced practises are attainable.

This thesis offers opportunities and guidelines for practitioners to enhance their performance through understanding the role of power in supply chain integration and better management of external relationships. Here, key variables and their

overall importance for power and dependency in external relationships have been identified. The power and dependency model provides better understanding of how strategic decision-making can be conceptually supported via a focus on power and dependency in external relationships. The five step methodology for measuring power and dependency provides managers with a self-assessment technique to investigate their own particular external power and dependency structure. Suggestions have also been made to mitigate situations where a focal company is highly dependent on a key external entity.

The thesis also highlights the importance of people, culture and relationships regarding supply chain integration. Companies that initiate an integration process have to overcome some internal barriers, such as resistance to change, the existing company culture, and functional silos. Managerial, socio-cultural factors are the major obstacles to supply chain integration in practise. Companies also need to overcome external barriers in the form of unfavourable power and dependency. Appropriate upskilling of staff and management of the changes needed can substantially reduce these internal and external barriers.

If managers intend to further enhance supply chain integration practises, this study reveals that currently available supply chain integration models do not reflect reality well. Companies tend to take the path of least resistance when integrating their supply chain. 'Areas' with a positive power and dependency structure and/or top management support are easier to address than those with unfavourable power and dependency structures or a lack of top management support. The developed supply chain integration assessment tool (see Chapter 2.11.3) combined with the preconditions to supply chain integration offer a road map for practitioners as they channel future efforts into further integrating their supply chain to reduce uncertainty.

However, the speed of supply chain integration development in practise is slow. In all cases managers invested in people and the necessary cultural change to supply chain management philosophy first. Staff members need to understand the wider trade-offs of their actions, before effective process and relationship changes

can take place. Technological inhibitors to supply chain integration are best left until the end when seeking to enhance practise.

10.3 Further Research

There are a number of opportunities for further research which arise from this thesis. Research is a continuous process. The starting point for this thesis was presented in the literature review and the contributions to the body of knowledge were summarised in this chapter. This final section identifies further research that can build upon this new knowledge to further investigate the validity of the findings. Three key areas for further research are highlighted.

10.3.1 Investigation into supply chain integration

The central focus of this thesis is the pursuit of supply chain integration. The literature review highlighted the confusion that exists around the concept. Currently, supply chain management as well as supply chain integration is ill-defined and not well understood; and the academia lacks a common, universal view of supply chain integration. This thesis identified three 'layers of confusion'. The first layer is the range of the integration concept; for example, some authors include internal integration, while others solely focus on external integration. The second layer is introduced by the industry focusing on different supply chain integration practises. Finally, academia adds to the confusion around the concept of supply chain integration by focusing on selected aspects of supply chain integration. These three layers of confusion highlight the fact that supply chain integration lacks well-developed measures and standards that would make inter-organisational comparisons easier. This thesis has addressed this by highlighting the importance of viewing integration internally and externally. Also, a first set of supply chain integration measures has been developed (see Chapter 2.11.3). However, much more research is required to identify and standardise supply chain integration research.

10.3.2 Investigation into supply chains practise

The Quick Scan Audit Methodology (QSAM) is still capable of improvement. As such, a great deal of further validating research is required. The method itself is constantly being updated, strengthened, and streamlined, and may therefore be regarded as evolving. Currently, only four research groups are applying the QSAM; based in the UK (2), New Zealand and Thailand. Obviously further applications in other countries would be beneficial. To further establish the transferability of the method, other researchers need to utilise the QSAM. Also, the process and the results of QSAM imply the necessity of further development of the QSAM interviews and questionnaires. Regarding the current status of supply chain integration in New Zealand, the question remains whether other companies in New Zealand are similarly weakly integrated; hence more research is needed to explore the level of supply chain integration in New Zealand.

10.3.3 Barriers to supply chain integration

Barriers to supply chain integration have been identified internally (within a focal company) and externally (with suppliers and customers). Regarding the internal barriers, further research is required to validate the conceptual model presented in Figure 6.1. Also, the list of internal barriers presented in Table 6.2 is not expected to be exclusive. Further research is required to identify additional barriers, or even barrier categories to supply chain integration.

Externally, much more work is needed to further clarify the role of power asymmetry in the supply chain. First, methodologies similar to the one used in this thesis (see Table 4.12) could be applied in other industries and countries where power plays a prominent role. Longitudinal analyses could study the effects of power over time. Furthermore, power was only measured from the viewpoint of the supplier base as the power target, so the dyadic perspective of power in the supply chain remains to be fully explored. Analysis could also be extended to the multiple echelons of the supply chain in order to understand power effects on a network of relationships. Finally, the effects of power-based relationships upon

performance could be greatly expanded through the use of objective performance measures.

More significantly, now that internal and external barriers to supply chain integration have been identified, research needs to identify ways to remove or at least mitigate their effects, thereby improving the uptake of supply chain integration.

10.3.4 Achieving supply chain integration

There are a multitude of further research avenues to expand this exploratory research. The six pathways to supply chain integration identified need further validation. Also, the question remains: which of the six pathways is the ideal path to achieve the seamless supply chain and; Does this 'ideal' vary according to circumstances? Is achievement of a seamless supply chain always feasible or even desirable? Further research is required to investigate the speed of change in achieving a seamless supply chain. Also of interest, is the question of the changes with the greatest impact on supply chain integration and supply chain performance. Perhaps there is no single path to supply chain integration which is always ideal. However, even if this is the case, the key principles supported by this research might provide a beginning and an impetus for the search for the ideal guiding principle for a company achieving supply chain integration.

This study draws on data from the process, manufacturing, and service industries. There may be particular characteristics of such supply chains that do not apply to other sectors. Sector specific studies of pathways to supply chain integration and their relation to performance improvement will potentially yield different insights. Finally, the adaptation of the QSAM to suit longitudinal studies can be further refined; for example, the follow up data collection process could be improved by introducing a second researcher to increase validity and extend the triangulation practise from that of data triangulation to researcher triangulation.

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Appendices

Appendix A: Gimenz (2004) investigation into supply chain integration

Appendix A.1: Barriers to supply chain integration

Table A. 1: Barriers to implementing SCM programmes

Barriers	Ratio
History, habits (traditional commercial relationship)	2/14
Knowledge (the need of a know how)	1/14
Size	1/14
Information systems and information technologies	4/14
Culture and attitudes of people working in the company	8/14
Departmental barriers	4/14
Lack of trust	4/14
Lack of culture of sharing information	1/14
Being afraid of the benefits going only to the retailer	3/14
Conditions established by retailers (such as small batches)	1/14

Source: Gimenez, 2004

Appendix A.2: Validation of the supply chain integration assessment tool using Gimenez (2004) case description

Table A.2: Application of Gimenez (2004) case description to the developed supply chain integration assessment tool

Manufacturer from Gimenez (2004)	Degree of integration according to Gimenez (2004)	People	Relationship Management	Information Systems	Information sharing	Final Comment
Manufacturer A	Developing external	✓	✓	—	✓	Consistent
Manufacturer B	Internal	—	—	—	—	Insufficient evidence to assess internal integration
Manufacturer C	Internal, starting external	✓	✓	—	✓	Consistent
Manufacturer D	Internal and external	✓	✓	✓	✓	Consistent
Manufacturer E	Internal, starting external	✓	✓	✓	✓	Consistent
Manufacturer F	Internal and external integrated	✓	✓	✓	✓	Consistent
Manufacturer G	Not internal integrated yet but signs of externally integrated	✓	✓	—	↓	Slightly lower assessment
Manufacturer H	Neither internal nor externally integrated	✓	✓	✓	✓	Consistent
Manufacturer I	Internally and externally integrated	✓	✓	✓	✓	Consistent
Retailer 1	Internal and external	✓	↓	↓	↓	Slightly lower external assessment
Retailer 2	Neither internal nor externally integrated	↑	↑	—	↑	Slightly higher assessment
Retailer 3	Neither internal nor externally integrated	✓	✓	—	—	Consistent, however only 2 data points
Retailer 4	Internal and external	✓	✓	✓	✓	Consistent
Retailer 5	Internal and external	✓	✓	↓	↓	Slightly lower assessment
Retailer 6	Neither internal nor externally integrated	✓	✓	—	✓	Consistent

Source: Author

Appendix B: Further supply chain assessment techniques

B.1 Other commercially available supply chain assessment techniques

- 1) Andersen Consulting developed a web-based supply chain diagnostic tool called the Supply Chain Value Assessment Model. It was promoted as enabling users to cut the time spent on a supply chain evaluation process to less than four weeks (Foggin et al., 2004).

- 2) The Ernst and Young Navigator is developed from an IT approach to suit business process reengineering programs. The Navigator contains a tool box with a best practise database, example work sheets and an implementation methodology. However, it is only available via consultant and under licence (Towill 1999a).

- 3) The IBM on demand supply chain maturity model is a tool that IBM designed for evaluation of how customer-driven and responsive a supply chain is. The model groups supply chains into the following five categories of increasing integration, customer-orientation and responsiveness: (1) static supply chain; (2) functional excellence; (3) horizontal integration; (4) external collaboration and (5) on demand supply chain (Huettner & Song, 2007)

B.2 Other academically available supply chain assessment techniques

1. Allen & Helferich (1990) suggested the use of expert systems for supply chain and logistics diagnoses. However, these examples were, in large part, narrowly focused on limited functions within purchasing and logistics. Like most such expert systems, Allen & Helferich (1990) used heuristics to work through decision trees or networks to reach decisions.
2. Mentzer & Konrad (1991) describe a process to develop a tailored, company-specific, performance measurement system built upon an earlier diagnostic 12-step process by Novak (1984) to budget transportation costs.
3. Sinha & Babu's (1998) diagnostic study termed 'Depot Service Index' was intended to provide insight into the dynamics of a supply chain. The Index applies statistical techniques, including analysis of variance (ANOVA) and multiple regression. Four clusters of facilities were identified and the properties of each cluster were analysed, which enabled the authors to develop a supply chain simulation model.

Appendix C: Supply chain integration maturity questionnaire

Select a single value stream to analysis. The value stream should be a major product family that is reasonably representative of the supply chain operations. If necessary repeat the questionnaire for other value streams if major differences are present.

Organisation Name	
Interviewee Name	
Product Name	
Brief description of the product and its associated value stream	
Major value adding processes (e.g. assembly or machining)	
Location of Plant/ organisation	

Outbound Logistics	Definition	Response	Units
Customer Delivery Lead Time	Please state the time between when a firm order is placed and when the product is delivered. (Call-off)		
Customer Delivery Frequency	State the frequency of deliveries to your customers for the specified product.		
Number of Customers	Please state the number of alternative customer companies.		
Customer Locations	State the number of customer locations the specified product is deliver to.		
Customer Delivery Distance	State the average customer delivery distance.		

Internal Logistics	Definition	Response	Units
B.O.M. Levels	Please state the number of levels in the Bill of Materials for the specified product.		
Manufacturing Lead Time	State the average time between when the raw materials are taken out of stock to when the final product is completed ready for delivery.		
Position of De-Coupling Point	Products are manufactured and distributed to stocking points close to the customer. End products are held in stock at the end of the production then sent to customers on demand. Sub-assemblies held in stock, no FG stock, final assembly triggered by specific customer order. Only raw materials are kept in stock; each order for a customer is a specific project. No stocks are kept at all; purchasing takes place on the basis of the specific customer order.	Make and ship to stock Make to stock Assemble to order Make to order Purchase and make to order	

Product Characteristics	Definition	Response	Units
Product Variety	State the number of variants of finished goods for the specified product. (i.e. FG live part numbers)		
Product Margins	What is the products profit margin?		
Annual Volume	What was last years total sales volume? Please also specify the units (e.g. tones, pallets).		
Echelons from end consumer	Number of organisations carrying out activities on the product before end consumption, excluding transport.		
Length of product life-cycle	Please state your best estimate of the products total life-cycle length.		
Customer Schedule Stability	Please give your best estimate of the percentage variation between what was scheduled one month ahead and what was actually required on the day.		
Stage of product life-cycle	Which of the three alternatives best describes the current stage of the products life-cycle?	Infancy	Maturity Decline

Inbound Logistics	Definition	Response	Units
Number of Suppliers	How many different suppliers do you require for the specified product?		
Customer Specified Suppliers	How many suppliers are specified by the customer?		
Suppliers Delivery Lead Time	Please state the average time between when you place a firm order with your suppliers and when they deliver the product (Call-off).		
Suppliers Delivery Frequency	How frequently do your suppliers deliver components for the two specified products?		
Suppliers Delivery Distance	State the average delivery distance for the suppliers of the specified product.		
Bought Out Components	How many different bought out components are required to produce one product?		
Supplier relationships	On the whole how close a relationship do you have with your suppliers?	Partnership 1 2	Adversarial 3 4

Source: Childerhouse, 2002

Complex Material Flow

Class of symptoms	Symptoms of complex material flow	Observed Symptom 1= present, 2= not present or ?= not looked for or investigated
Dynamic behaviour	Systems-induced behaviour observed in demand patterns.	
	System behaviour often unexpected and counter-intuitive.	
	Causal relationships often geographically separated.	
	Excessive demand amplification as orders are passed upstream.	
	Rogue orders induced by system "Players".	
	Poor and variable customer service levels.	
Physical situation	Large and increasing number of products per pound of turnover.	
	High labour content.	
	Multiple production and distribution points.	
	Large pools of inventory throughout the system.	
	Complicated material flow patterns.	
	Poor stores control.	
Operational characteristics	Shop floor decisions based on batch-and-queue.	
	"Interference" between competing value streams.	
	Causal relationships often well separated in time.	
	Failure to synchronise all orders and acquisitions.	
	Failure to compress lead times.	
	Variable performance in response to similar order patterns.	
Organisational characteristics	Decision-making by functional groups.	
	Excessive quality inspection.	
	Multiple independent information systems.	
	Overheads and indirect costs allocated across product groups, and not by activity.	
	Excessive layers of management between CEO and shop floor.	
	Bureaucratic and lengthy decision-making process.	

Source: Childerhouse & Towill, 2003

Simplified Material Flow Questionnaire

For each of the following 12 simplicity rules rank how closely they are adhered to.

Rule	Description and definition	Adherence (1=never, 2=sometimes, 3=most of the time or 4=always)
1	Only make products which can be quickly despatched and invoiced to customers	
2	In any one 'time bucket' only make components needed for assembly in the next period	
3	Streamline material flow and minimise throughput time, i.e. compress all lead times.	
4	Use the shortest planning period, i.e. the smallest run quantity that can be managed efficiently	
5	Only take deliveries from suppliers in small batches as and when needed for processing or assembly	
6	Synchronise 'time buckets' throughout the supply chain	
7	Form natural clusters of products and design processes appropriate to each value stream	
8	Eliminate all uncertainties from all processes	
9	Understand, document, simplify and only then optimise (UDSO) the supply chain	
10	Streamline and make highly visible all information flows throughout the chain	
11	Use only proven, simple yet but robust Decision Support Systems	
12	The operational target is to facilitate a Seamless supply chain i.e. all players to "think and act as one"	

Source: Childerhouse & Towill, 2003

Uncertainty Questionnaire

Questions asked of each value stream	Rating by QS Team			
	Strongly agree	Weakly agree	Weakly disagree	Strongly disagree
The value added process(es) generates low system uncertainty	1	2	3	4
The supplier side generates low system uncertainty	1	2	3	4
The demand side generates low system uncertainty	1	2	3	4
The system controls do not generate uncertainty	1	2	3	4

Source: Towill et al., 2002

Appendix D: Quick Scan reports

D.1: Forestry – Quick Scan report

Executive Summary

Forestry supply chain achieved functional integration and is moving towards internal integration. Seven improvement areas were identified: cross-functional integration, implementation of one overall ERP/information systems, conversion from tacit to explicit knowledge, reduction of stock levels at every point of the supply chain, implementation of strategic procurement to overcome supplier dominance, customer relationship management and trimming cost improvement. Islands of good practise have been identified; those good practises need to be better integrated so as to optimise the whole. The current loosely coupled information system is inadequate and has been adapted several times, but is currently holding back the organisation in terms of full systems visibility and supply chain integration. Finally, regarding staff development, a silo mentality needs to be addressed by adopting cross-functional performance measures. Forestry needs to invest in staff, plus a range of actions to reinforce a cross-functional, team-based Forestry culture.

Quick Scan Audit Methodology

The Quick Scan is a tried and tested method for auditing the health of supply chains. Five researchers from the University of Waikato conducted the audit in February 2006. In total, 26 person days were invested in evaluating the status of supply chain operations at Forestry. The Quick Scan team examined the integration of the internal supply chain and its fit with the wider supply chain.

Findings

The overall level of supply chain integration was judged somewhat on a medium level, mostly due to internal procedures that result in control uncertainty. Of the two value streams, Pulp was better integrated and was placed above the mid-point (46th percentile) - when compared to the value streams of 70 other companies. In

contrast the Paper process suffered slightly from higher demand uncertainty and was ranked at the 57th percentile.

Although the Quick Scan was primarily focused on identifying weaknesses and developing a route map for advancement at Forestry, four important positive aspects were noted during the investigation:

1. Forestry operates in a very efficient manner with an increased plant reliability despite age.
2. There is a strong desire for improvement at all levels within the organisation.
3. Employees have strong ability to work around problems including knowledgeable operations managers.
4. A good and strong working relationship with five of their key suppliers.

Seven major areas of shortcoming were observed namely functional silos, multiple loosely coupled information system, lack of integration inbound and outbound, high tacit knowledge in all areas of supply chain activities, high stock levels (including low stock turns especially with maintenance) and high paper trimming cost.

Information systems / Stock levels

It was noted that Forestry currently operates with multiple independent and loosely coupled information systems which leads towards incomplete and inadequate end-to-end information flows.

Considering the size of the organisation, the ideal long-term and costly solution for Forestry would be a fully integrated information system (ERP). However, even in the medium term an IS solution for inbound logistics and In-Transit finished good stocks would gain high benefits by reducing excessive stock levels.

Strategic Procurement / High Stock levels

Forestry's supplier base numbers 1206 suppliers. Twenty out of 1206 are currently main suppliers and of strategic importance for the organisation however, the investigation identified that Forestry is highly dependent on some of their key strategic suppliers.

Solutions to such problems are suggested for the medium and long term. Forestry needs to address procurement from a strategic point of view to reduce its supplier base and manage relationships with key strategic suppliers. Further, ways need to be identified to overcome the strong supplier dependency. A more strategic approach to procurement will automatically also lead to a reduction of stock levels on the inbound side, due to better information flows, consignment stock and/or VMI (vendor managed inventory) agreements.

Customer Integration / High stock levels

Forestry currently operates in a plant efficiency mode instead of focusing on effectiveness. Therefore, Forestry has NZD 1.9 million finished good holding costs. Solutions to such problems are again rather medium to long term. Firstly Forestry needs to segment their customers and analyse them. In a second step a customer/market profitability analysis needs to be undertaken. From those analysis long-term customer alliance can be build up which will support forecast accuracy and therefore reduce stock levels on the outbound side.

High paper trimming cost

Currently paper is produced “make to order” and trimmed to the customer needs. The “make to order” strategy causes the current yield produces too much waste. Forestry is on average 5 days behind schedule. A statistical correlation has been identified between trimming costs and days late what leads towards excessive trimming costs.

A significant percentage of the paper has been identified as a functional type product. Therefore, Forestry should make paper to stock and to order to reduce waste to a minimum. To be able to do that Forestry needs to catch up with current production and reduce the production delays down to 0. This will also have a great impact on the reduction of the trimming cost.

Tacit Knowledge

Forestry has knowledgeable staff especially on the shop floor. Most of the staff members are with the organisation for decades and therefore gained especially tacit plant knowledge. Forestry currently has no procedure in place to capture the

knowledge that is tight up in individuals. Forestry needs to address this problem to all staff members and convert the tacit knowledge into explicit knowledge by mapping out processes, update manuals for modified machinery and by writing down procedures.

Staff Development / Functional silos

Reasons for Forestry's functional silos are many (and common to most organisations); for example, the geographical dispersion of production and management fosters a 'them and us' mentality supported by a strong union culture and the organisational structure obstructs the horizontal flow of information and teamwork across functional boundaries. Further, existing performance measures and reward systems are primarily functionally focused and show inconsistency 'down' the organisation. To overcome this functionalism in the short term Forestry needs to emphasize the importance of cross-training at all organisation levels. In a second step a training matrix should be developed.

Forestry's functional areas are also not interlinked. A systems perspective of a supply chain clearly identifies the need for optimisation of the whole of the system; not just each of the sub-systems. To help overcome this, cross-functional performance measures need to be developed, and staff on either side of the functional boundaries made aware of each others needs and problems; the potential for working together jointly is to vastly improve performance. Second, shared total process performance indicators are needed, and staff should be empowered to make production improvements without the need to refer to higher authority; simple measures of customer service and cost-to-serve would be appropriate here. Third, a most important change is the introduction of total process owners having authority to operate across multiple functions and empowered to challenge the functional heads. This would result in a more matrix-type organisational structure, with total process champions for product groups. Further, hiring excellent staff and investing in their training, and having clearly linked shared goals and reward systems tied to the strategic plan, will help cement in place and continually refresh a new company culture of Forestry being a great place to work.

D.2: Food 1 Quick Scan Report

Executive Summary

Overall, the supply chain was judged to be in very good health and with many examples of best practise. Three areas requiring improvement were identified: cross-functional integration, information systems development/use and market orientation. There are islands of excellence that need to be better integrated so as to optimise the whole, rather than each functional area; this can be achieved through shared performance indicators and total process champions. The current ERP system is inadequate and has been adapted as best possible, but is currently holding back the organisation in terms of full systems visibility and supply chain integration. Finally, the single focus on efficiency is not appropriate for all product types; specific value streams need to be partitioned and a more responsive supply chain developed for the innovative/fashionable products.

Quick Scan Audit Methodology

The Quick Scan is a tried and tested method for auditing the health of supply chains. Four researchers from the University of Waikato conducted the audit in June 2006. In total, 22 person days were invested in evaluating the status of the Food 1's (NZ) supply chain operations. In particular, the Quick Scan team examined the integration of the internal supply chain and its fit with the wider supply chain.

Findings

The overall level of supply chain integration was very good; in fact the three products studied in depth are the best of fourteen examined in New Zealand to-date. From a more global perspective, Food 1's supply chain maturity is in the top ten percentile. In particular, the team noted operational excellence in procurement, manufacturing and logistics. Further, the audit team was especially impressed with the 'can-do' attitude of middle and senior management and their positive mindset towards change.

The Quick Scan is primarily focused on identifying weaknesses and developing a route map for advancement. To this end three major shortcomings were observed; functional silos, information systems development/use and market orientation. It was noted that a strategic imperative for Food 1 is "... to deliver lowest cost, flexible, responsive, high valued-added manufacturing" (FOOD 1 Strategic Plan FY07-FY09 dated Nov. 2005); consequently, the following conclusions and improvement opportunities are being made within that strategic context:-

Food 1 Functional Silos

The excellent functional areas are not fully interlinked, with limited cross-functional trade-off analysis. A systems perspective of a supply chain clearly identifies the need for optimisation of the whole, not each, of the sub-systems. Hence, as indicated above, to advance the effectiveness of the Food 1 supply chain a more holistic perspective is required with a total process-based focus.

The reasons for the functional silos are many and common to most organisations. The geographical dispersion of marketing and manufacturing fosters a 'them and us' mentality. The historical and somewhat traditional hierarchical organisational structure obstructs the horizontal flow of information and team work across functional boundaries. Further, performance measures and reward systems are primarily functionally focused and (for example) limit acceptance of extra costs in one area for a large decrease in costs in another.

To overcome this functionalism, four key improvement opportunities are suggested based on theoretical and practical best practise. First, more performance indicators must be cross-functional and those on either side of the functional boundaries made aware of each other and the potential of working together to jointly improve performance. Second, a number of total process performance indicators are required that all members share and are empowered to improve. Simple measures like customer service and cost-to-serve would be appropriate. Third, the most important and key change is the introduction of total process owners that cut across multiple functions and are empowered to challenge functional heads. This would result in a more matrix type organisational structure,

with total process champions for product groups. Finally, an effective enterprise information system (discussed below) would provide visibility to all functions, the effects of any changes they are considering, and notification of changes by others that affect them.

Food 1 Information Systems

Improvement opportunities for information systems development/usage relate to three key areas:-

(1) Information Technology is not currently perceived as being of strategic importance:

It was reported that the company spends approximately 1 percent of its sales value on IT, whereas a Gartner Group survey notes an average of around 2.5 percent (for a follower/adopter organisation) and 5 percent (for a leader/cutting edge IT organisation).

It was also noted that, during the last 12 months, approximately eighty percent of systems development was devoted to non cross-functional systems. Such 'private' information systems and databases inevitably lead to 'multiple-truths' and a functionally optimised style of decision making.

Perhaps of most concern is that the Information Systems Manager reports to the Executive via an accounting (CFO) function, which is in contrast to many other organisations. To put this into perspective, CIO Magazine's well respected latest annual survey indicated that just 24% of companies have this reporting arrangement, and provided evidence of a rising trend of CIOs at Executive level reporting directly to the CEO (reversing an earlier trend). The CIO's role should be to provide a sound business case for any proposed IT intended to support business strategy, AND to directly contribute to business strategic direction by proactively envisioning innovative IT-enabled business possibilities.

(2) The Food 1's information system is limited in its ability to serve the business in its new operating environment:

It was noted that Food 1 has done a remarkable job of extending its (predominantly functionally-focused) systems. However, the current information

systems are very dated and hence lack the fundamental integration abilities required in a contemporary agile manufacturing organisation.

(3) Future IS requirements and considerations:

It was noted that a new enterprise information system (possibly SAP) could be in the wings for Food 1. Any such ERP system, if utilised appropriately, has the ability to provide real-time visibility across the entire supply chain (including with external suppliers and customers). Such a system enables a cross-functional (process view) to be obtained, improving company decision making, reducing handoffs, and breaking down functional silos (ERP systems *enable* cross-functional KPIs and reward systems to be set).

In choosing an appropriate ERP architecture, the key decision for FOOD 1 is whether to use SAP as the ERP backbone, and hang 'best of breed' applications from it; or to adopt SAP and the relevant SAP planning modules (which would virtually eliminate the integration problems inherent with the first option). Although FOOD 1 may be constrained in this choice it needs to begin planning and to initiate process realignment/redesign ahead of the ERP implementation.

Food 1's Market Orientation

The internal supply chain is very cost focused and attempts to remove waste of any form. This efficiency mindset is common to all functional areas and results in a 'one size fits all' approach to matching supply with demand. This is all well and good when the market characteristics dictate an efficient supply chain strategy.

The batch and queue mentality and capacity utilisation of manufacturing is particularly an issue for low volume or seasonal products. For example some products are produced in six month batches and hence incur a large inventory carrying cost for that individual product. As a result the internal supply chain treats all products equally. This problem is known as 'averaging' and results in those customers of low volume or unusual products being underserved, whilst the high volume customers are over charged. This issue has not been of great consequence in the past due to the high proportion of predictable, high volume products. However, desired future markets are more innovative and hard to

forecast and often have short life cycles; if the current 'one size fits all' approach is not corrected niche competitors will be able to compete, based on their responsiveness regardless of Food 1's efficiency.

The solution to this problem is to become more market orientated through alternative supply chain strategies. As a first step, two separate value streams need to be set-up; one using the current efficiency focus aimed at traditional high volume products and the other needs to be responsive and agile to best serve the more innovative/fashionable type products. The agile value stream could possibly utilise the concepts of postponement or base and surge to achieve the best of both worlds, with some elements of efficiency and some responsive elements, where appropriate.

D.3: Service – Quick Scan report

Executive Summary

Service's supply chain was benchmarked in the lower percentile (overall) for supply chain integration. Major reasons for this are the convoluted and disjointed internal supply processes, and the un-rationalised, outdated information systems. Root causes centre on a significant lack of strategic investment and a lack of strategic vision and leadership. Consequences are very severe, including: increased risks of critical patient incidents, inventory management and human resource inefficiencies, reduced staff morale and a lack of control/security of pharmaceuticals. Three main areas for improvement were identified: an overarching and shared focus on service quality, a consolidated logistical service, and an integrated information system. Overall, a step change is required to radically improve the supply chain, and this should be possible with excellent staff in place that has the desire and willingness for change.

It is recommended that the un-rationalised and multiple supply routes need to be consolidated to remove the excessive complexity and resultant uncertainty of the current processes. It is also recommended that the sound IMS replenishment process be enhanced and used as a template for the supply of consumables. Due to its increased risk of slippage and the higher value of products, a dedicated channel for pharmaceuticals appears appropriate. To rectify the disjointed and incomplete information flows, significant investment in an integrated information system is needed to provide needed information for decision makers; one that removes the current guess work and lack of data integrity. However, before either of these two improvements is implemented a fundamental change in mindset is required, away from a blame culture and functional viewpoint, to a more team-based collaborative approach. This change will need to be signalled from the top via a continually reinforced shared vision of service quality; a vision that also acknowledges that the supply chain is an integral part of providing excellent patient care delivery. Furthermore, a cross-functional, process view is needed driven by shared performance indicators and an over-riding cost-to-serve perspective.

Quick Scan Audit Methodology

The Quick Scan is a tried and tested method for objectively auditing the health of supply chains. Four researchers from the University of Waikato conducted the audit in January 2007. In total, 20 person days were invested in evaluating the status of supply chain operations at Service. By examining selected wards and operating theatres, the Quick Scan team was able to examine the integration of the internal supply chain and its fit with the wider external supply chain.

Findings

The overall level of supply chain sophistication at Service was judged as 'functional integration'. This is a minimal level of integration and highlights the very limited inter-functional and external integrations. Each functional area appears solely concerned with its own objectives and has no time to invest in managing the shared processes manifest in all supply chains.

Although the Quick Scan was primarily focused on identifying weaknesses and developing a route map for advancement at Service, five important positive aspects were noted during the investigation:

- The resilience of the staff, coupled with a focus on patient care and a clear recognition that the current poor situation needs to be addressed
- Some good inventory management practises are present, but only in isolation. For example, the IMS replenishment process is sound and worthy of further refinement and replication; also the suture's Vendor Managed Inventory (VMI) process is similar to best practises found in USA, for example
- The openness to trial new information system solutions and the willingness of clinical staff to use new technology; for example, the (repetitive) functions of Oracle...
- Suppliers (mostly) achieve the specified service levels.
- The internal auditing process is commendable and points towards continuous improvement.

Three major areas of shortcoming were observed: internal supply processes, associated information flows, and the lack of top level prioritisation of strategic supply chain management. While some of the lack in vision and strategy is

acknowledged, nevertheless considerable shortcomings are evident. As one example the information systems strategic plan (ISSP) discusses the apportioning of tasks, but does not outline an integrated information system to span the whole organisation and support its overall goals.

Improvement Opportunities

The following conclusions and improvement opportunities were identified:-

Supply Processes

Service operates with multiple, often convoluted, supply channels; multiple replenishment options have been identified for identical products. The key resultant effect is inefficiencies in time and money spent; staff members are confused about non-defined responsibilities for the replenishment process. Further, theatres are carrying expired products.

Currently, IMS is responsible for the wards, Pharmacy for most of the pharmaceuticals and the theatres operate with warehouse management staff. A key concern is that pharmaceuticals are being pushed into the facilities without specific documentation of the final usage.

Two separate supply chain channels are suggested. To overcome the issue of nurses chasing materials around the facilities, the first is to be a lean channel where all replenishment activities are done by IMS staff members (with 24/7 availability). The second supply channel is to be a pharmaceutical channel and the responsibility of the Pharmacy; ideally supported by machines in all wards and theatres, to enable document drugs usage.

Information Flows

It was noted that Service currently operates with multiple, convoluted, independent and loosely-coupled information systems. These cause incomplete and error-prone end-to-end information flows so that staff do not trust the limited information they are receiving. These also create fire-fighting activities among clinical staff members because information is not available where and when it is

needed. While some investment in information technology would be required, this is not perceived to be the major challenge; rather, without a vision of an integrated information system, there is the danger of fragmented investments continuing with little beneficial impact to the overall situation. The suggestion is to move beyond the proliferation of ‘islands of technology’ that is proposed in the Information Systems Strategic Plan. Other health providers in New Zealand and overseas, both public and private, can provide benchmarks for the needed enterprise-wide information system.

Supply Chain Management Prioritisation

It appears that the strategic value of supply chain management has not been recognised by Service for some considerable time, leading to longstanding underinvestment in personnel and training, and in the management systems that such staff need to do their jobs effectively. It is suggested that a suitably qualified supply chain manager be given the mandate, and the resources, to integrate supply chain processes. Such an appointment must have demonstrable support from the Executive.

Functional Silos

Functional silos are a particularly acute issue at Service, fostering a ‘them and us’ blame mentality; further obstructing the horizontal flow of information and teamwork across functional boundaries. Furthermore, the performance measures and reward systems that would help break down such attitudes are absent. To overcome this functionalism in the short term, Service must emphasise the importance of cross-training at all organisation levels. To help optimise the whole supply chain and not just each of the sub-systems, cross-functional performance measures need to be developed; staff on either side of a functional boundary must be made aware of each others’ needs and problems. Shared total process performance indicators are needed such as simple measures of customer service and cost-to-serve.

Manage suppliers to service level targets

Management of the ISDS agreement needs improvement as the current service levels and management fees (for example) appear to be both unsophisticated and strongly favour of the supplier. Rather than applying pressure, it is suggested that a close supplier partnership be developed, with a view to requiring the supplier to achieve higher service levels while remaining profitable.

Vision for change

Getting a first wave of improvements underway will help in two major aspects. Firstly, staff will see that Management is serious about making improvements and this will help improve staff morale and overcome the inevitable resistance to change. Secondly, the first successful projects can be expected to have rather short payoff-periods that would free up resources to help drive further investment.

D.4: Manufacturer 2's Quick Scan report

Executive Summary

Manufacturer 2's overall supply chain was benchmarked in the lower percentile segment for supply chain integration. The main reason for this is the company's planned significant increase in production volume requiring a critical step change in supply chain management and (particularly) operational planning. Three main areas for improvement were identified: production planning, physical flow, and staff development.

As production planning is predominantly based on experience and tacit knowledge, it was judged that the production volume increase will require that more formalised planning approaches become the norm at Manufacturer 2. These include a daily production meeting of all supervisors; creation of Manufacturing Resource Planning (MRP) procedures; and, in time, the adoption of Enterprise Resource Planning tools. Regarding physical flows, production processes need to be mapped in order to identify opportunities to remove wasteful production lead times and work in progress (WIP). Finally, regarding staff development, a silo mentality needs to be addressed by adopting cross-functional performance measures. The very high staff turnover (in the shop floors especially) requires investment in staff, plus a range of actions to reinforce a cross-functional, team-based Manufacturer 2 culture.

Quick Scan Audit Methodology

The Quick Scan is a tried and tested method for auditing the health of supply chains. Six researchers from the University of Waikato conducted the audit in December 2006. In total, 26 person days were invested in evaluating the status of supply chain operations at Manufacturer 2. The Quick Scan team examined the integration of the internal supply chain and its fit with the wider supply chain.

Findings

The overall level of supply chain integration was judged somewhat neutral, mostly due to internal procedures that result in control uncertainty. Of the two

products, Spare and ware parts was better integrated and was placed at the mid-point - when compared to the value streams of other companies. With further 'leaning' of the process Spare and ware parts would be a good example for the other Manufacturer 2 processes to emulate. In contrast the Machine process suffered from process uncertainty and, as the material flow is overly complex, was ranked at the 79th percentile.

Although the Quick Scan was primarily focused on identifying weaknesses and developing a route map for advancement at Manufacturer 2, 5 important positive aspects were noted during the investigation:

- The strong niche market position of the machine, enabled by an excellent R&D product development function
- Long-established relationships with key suppliers who support the R&D function to stay ahead of competitors
- ISO 9001 and ISO 14001 certification
- A financial reporting system that supports management with reports and performance measurement
- Shop floor staff with a strong 'can do' attitude produce high quality product geared toward individual customer needs.

Three major areas of shortcoming were observed: production planning and control, physical flow and staff development. It was noted from the strategic plan that , 'Manufacturer 2 wants to become the industry benchmark via customer satisfaction, solutions that best meet customer needs and customer-oriented approaches in all operations, operational excellence, continuous productivity and quality improvement, a great place to work (paraphrased).' The following conclusions and improvement opportunities were identified in light of this strategic intent:

Area	Short Term	Medium Term	Long Term
<u>Production Planning</u>	<ul style="list-style-type: none"> ■ Scheduling 	<ul style="list-style-type: none"> ■ Logic of MRP 	<ul style="list-style-type: none"> ■ ERP ■ S&OP (forecasts)
<u>Physical Flow</u>		<ul style="list-style-type: none"> ■ WIP locations ■ Lean Tips production 	<ul style="list-style-type: none"> ■ Factory layout
<u>Staff Development</u>	<ul style="list-style-type: none"> ■ Operator training 	<ul style="list-style-type: none"> ■ Formalised up-skilling ■ Reward system 	<ul style="list-style-type: none"> ■ Knowledge culture

(Please note that the improvement initiative order is indicated from left to right in the table; for example in the Production Planning area ‘Scheduling’ would logically be initiated before ‘Logic of MRP’ and so on. Similarly, ‘Short Term, Medium Term, and Long Term’ denote the time needed to achieve an improvement).

Production Planning

Observed production planning procedures showed weaknesses at the strategic, operational, and tactical levels of management. At the tactical-level Manufacturer 2 lacks a formal production plan, which is currently solely based on the shipping schedule for the finished product; this does not allow decomposition of activities and the related backward scheduling. Production decisions are based on historical, tacit production planning knowledge and lacks world-wide ‘best practise’ approaches. At the strategic level, ‘wears and spares’ have still to be recognised as a strong value stream in their own right.

Suggested short term improvement opportunities to overcome this situation are, first, that management needs to take process ownership and schedule production on a daily basis, -which leads to the need for a daily production meeting attended by all supervisors to align the production schedule of each shop. Further, there is a need for the service department to cut to plan, because four shops are dependant on timely supply from this particular department.

In the medium to long term, Manufacturer 2 needs to map its processes and adopt Manufacturing Resource Planning (MRP) procedures; perhaps with a view to eventually implementing Enterprise Resource Planning (ERP) tools, and a Sales and Operations Planning (S&OP) system – hence sales forecasting data should begin to be routinely collected from the overseas sales divisions.

Physical flow

The process map developed for the Machine and the Spare and ware parts highlighted some inefficient operating practises; including double handling and documentation of products, a ‘chaotic’ production process flow and multiple WIP storage areas.

Solutions to such problems are suggested for the medium and long term in order to align with the timing of production planning improvements. In the medium term a single dedicated area for WIP is recommended to reduce the search for parts. In the long term, it is suggested that Manufacturer 2 develop a factory layout plan from a mapping of material flows across the entire facility and estimation of capacity limitations. Further, the production process flows need to be re-engineered towards more of a streamlined, lean operation.

Staff Development

Reasons for Manufacturer 2’s functional silos are many (and common to most organisations); for example, the geographical dispersion of production and management fosters a ‘them and us’ mentality and the organisational structure obstructs the horizontal flow of information and teamwork across functional boundaries. Further, existing performance measures and reward systems are primarily functionally focused and show inconsistency ‘down’ the organisation. To overcome this functionalism in the short term, Manufacturer 2 needs to emphasize the importance of cross-training at all organisation levels. In a second step a training matrix should be developed.

Manufacturer 2’s functional areas are also not interlinked. A systems perspective of a supply chain clearly identifies the need for optimisation of the whole of the

system; not just each of the sub-systems. To help overcome this, cross-functional performance measures need to be developed, and staff on either side of the functional boundaries made aware of each others needs and problems; the potential for working together jointly is to vastly improve performance. Second, shared total process performance indicators are needed, and staff should be empowered to make production improvements without the need to refer to higher authority; simple measures of customer service and cost-to-serve would be appropriate here. Third, a most important change is the introduction of total process owners having authority to operate across multiple functions and empowered to challenge the functional heads. This would result in a more matrix-type organisational structure, with total process champions for product groups. Further, hiring excellent staff and investing in their training and having clearly linked shared goals and reward systems tied to the strategic plan, will help cement in place and continually refresh a new company culture of Manufacturer 2 being a great place to work.

Appendix E: Euclidean Norm

Appendix E.1: Overall supply chain benchmark

Figure E.1: Euclidean Norm fomula

$$\text{Euclidean Norm} = \left(\left(\begin{array}{c} \text{Process} - 1 \\ \text{Score} \end{array} \right)^2 + \left(\begin{array}{c} \text{Control} - 1 \\ \text{Score} \end{array} \right)^2 + \left(\begin{array}{c} \text{Supply} - 1 \\ \text{Score} \end{array} \right)^2 + \left(\begin{array}{c} \text{Demand} - 1 \\ \text{Score} \end{array} \right)^2 \right)^{1/2}$$

Source: Towill et al., 2002

Table E.1 presents the Euclidean Norm values for all twenty value streams.

Table E.1: New Zealand uncertainty data scores

Company	Value stream	Method	Euclidean Norm
Manufacturer 1	1	Quick Scan	5.10
Manufacturer 1	2	Quick Scan	4.58
Dairy 1	3	Quick Scan	4.69
Dairy 1	4	Quick Scan	5.20
Forestry	5	Quick Scan	4.24
Forestry	6	Quick Scan	3.87
Food 1	7	Quick Scan	2.06
Food 1	8	Quick Scan	3.04
Food 1	9	Quick Scan	2.83
Manufacturer 2	10	Quick Scan	3.43
Manufacturer 2	11	Quick Scan	4.74
Service	12	Quick Scan	2.83
Service	13	Quick Scan	3.61
Service	14	Quick Scan	4.80
Service	15	Quick Scan	5.10
Steel	16	Quick Scan	5.32
Steel	17	Quick Scan	5.10
Dairy 1	18	Interview	4.72
Retail	19	Interview	3.00
Storage	20	Interview	3.20
Mean			4.07

Source: Author

Appendix E.2: Internal and external uncertainty benchmarks

Figure E.2: External and internal uncertainty split Euclidean Norm formula

$$\begin{aligned} \text{Euclidean Norm (internal)} &= \left(\left(\text{Process - 1 Score} \right)^2 + \left(\text{Control - 1 Score} \right)^2 \right)^{1/2} \\ \text{Euclidean Norm (external)} &= \left(\left(\text{Supply - 1 Score} \right)^2 + \left(\text{Demand - 1 Score} \right)^2 \right)^{1/2} \end{aligned}$$

Source: Böhme et al., 2007a

Table E.2 presents the internal and external value stream uncertainty (Euclidean Norm values) for all twenty value streams.

Table E.2: New Zealand uncertainty data scores

Company (Value stream)	Data collection method	Internal Uncertainty	External Uncertainty
Manufacturer 1 (1)	Quick Scan	4.24	2.83
Manufacturer 1 (2)	Quick Scan	2.83	3.61
Dairy 1 (3)	Quick Scan	3.00	3.61
Dairy 1 (4)	Quick Scan	3.00	4.24
Forestry (5)	Quick Scan	2.24	3.61
Forestry (6)	Quick Scan	2.24	3.16
Food 1 (7)	Quick Scan	2.00	0.50
Food 1 (8)	Quick Scan	2.24	2.06
Food 1 (9)	Quick Scan	2.00	2.00
Manufacturer 2 (10)	Quick Scan	2.92	1.80
Manufacturer 2 (11)	Quick Scan	3.54	3.16
Service (12)	Quick Scan	2.00	2.00
Service (13)	Quick Scan	2.24	2.83
Service (14)	Quick Scan	4.24	2.24
Service (15)	Quick Scan	4.24	2.83
Steel (16)	Quick Scan	4.24	3.20
Steel (17)	Quick Scan	3.61	3.61
Dairy 1 (18)	Interview	3.04	3.61
Retail (19)	Interview	1.00	2.83
Storage (20)	Interview	1.00	3.04
Mean		2.79	2.84

Source: Author

The mean for the internal uncertainty is marginally lower than the mean for external uncertainty. The t-test results in a p-value of 0.8640, which is not significant.

Appendix E.3: Uncertainty data UK automotive

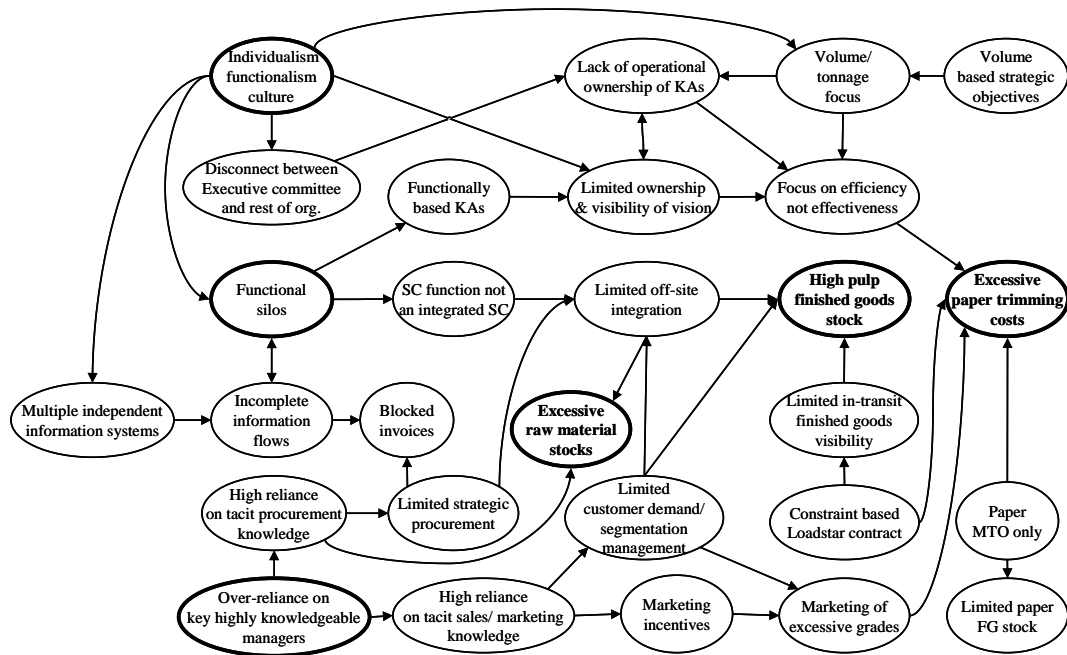
Table E.3: Detailed uncertainty data for the 20 UK automotive value streams

Value stream ID	Process	Control	Supply	Demand	Euclidean Norm
01	4	4	3	2	4.8
02	2	3	3	3	3.6
03	2	1	1	4	3.2
04	2	1	2	1	1.4
05	2	1	2	1	1.4
06	2	3	4	2	3.9
07	1	4	1	4	4.2
08	4	1	4	4	5.2
09	2	1	3	3	3.0
10	2	2	1	4	3.3
11	2	1	2	3	2.4
12	2	3	2	4	3.9
13	3	4	2	3	4.2
14	1	2	4	4	4.4
15	1	2	4	3	3.7
16	4	4	2	4	5.3
17	4	4	2	2	4.5
18	2	4	1	4	4.4
19	1	1	2	4	3.2
20	3	4	4	4	5.6

Source: Author

Appendix F: Cause and effect diagrams

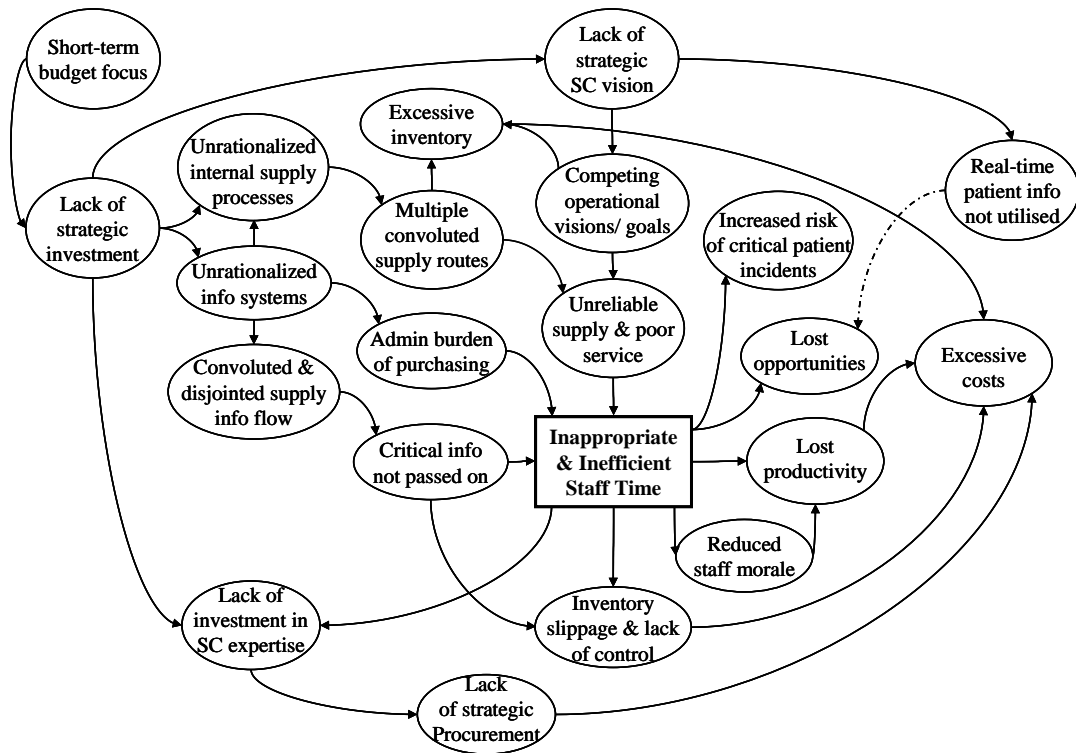
F.1: Forestry - Cause and effect analysis



Source: Author

For a detailed description see also Appendix D1.

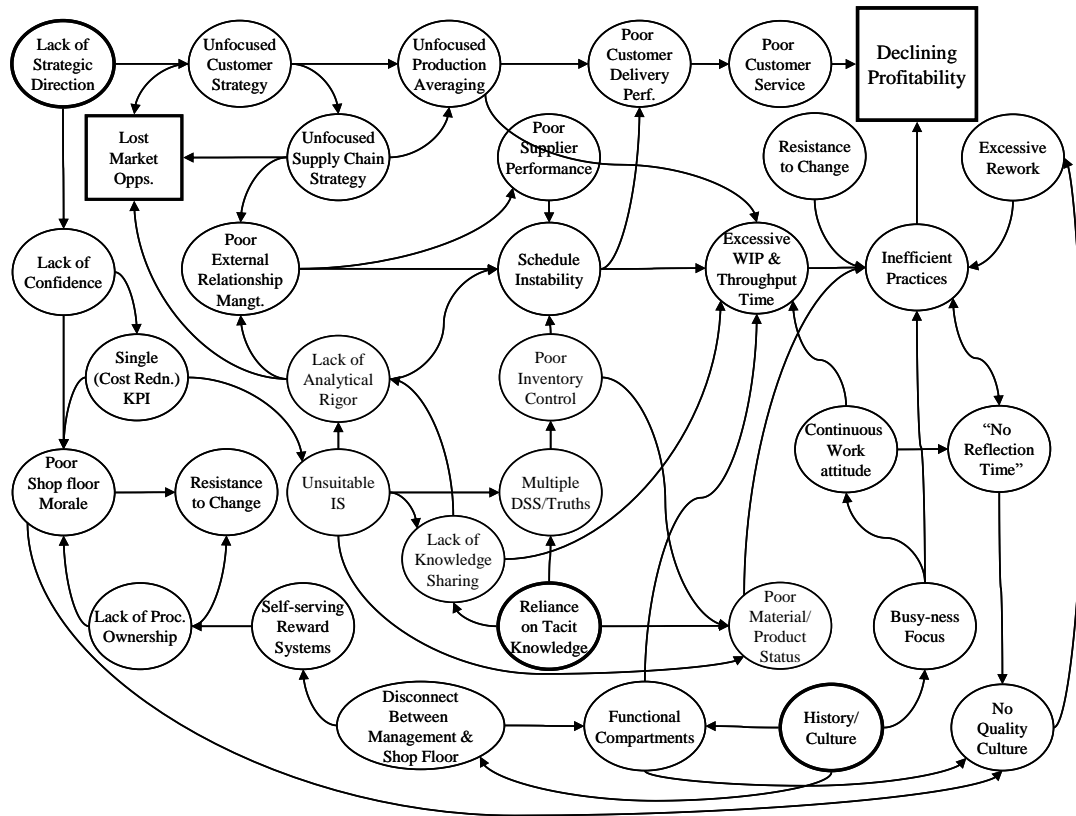
F.2: Service - Cause and effect analysis



Source: Author

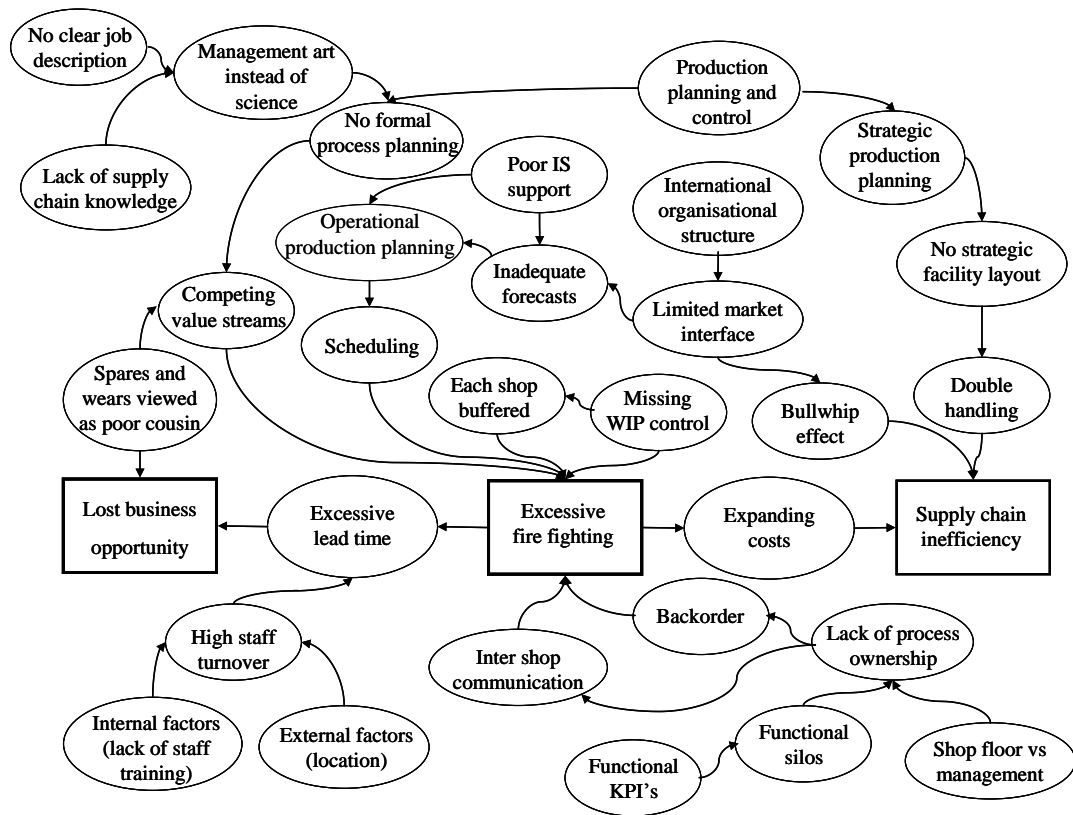
For a detailed description see also Appendix D3.

F.3: Steel – Cause and effect analysis



Source: Author

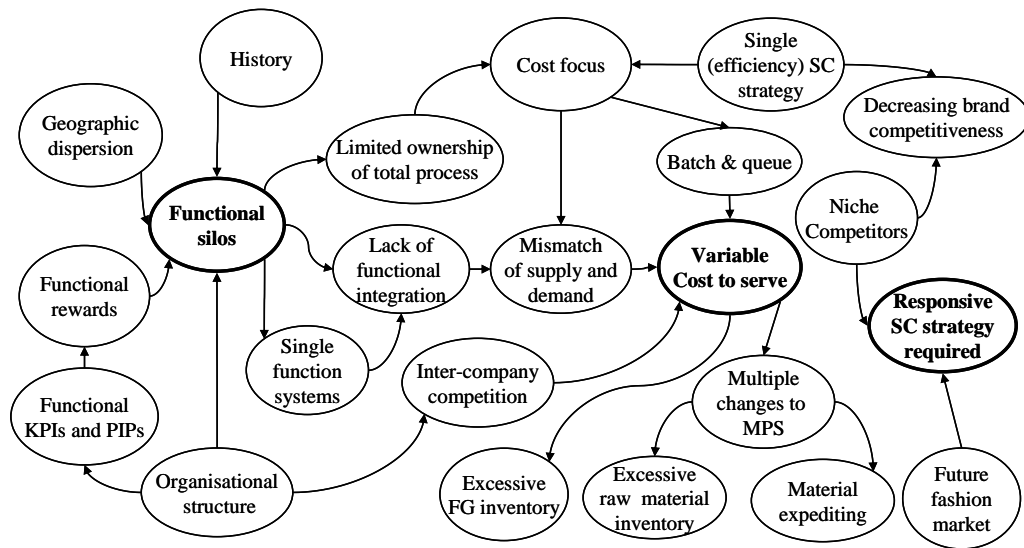
F.4: Manufacturer 2 – Cause and effect analysis



Source: Author

For a detailed description see also Appendix D4.

F.5: Food – Cause and effect analysis



Source: Author

For a detailed description see also Appendix D2.

Appendix G: Power and dependency in external relationships

G.1: Semi - structured interview guide (relationships)

Introduction

- What is your role, what are your day-to-day responsibilities?
- What are your personnel performance measures and how does this affect your behaviour?

Operations Questions

- How do you place orders on the suppliers?
- Do you have a choice of suppliers for identical products?
- How do you track the incoming material?
- Do you penalise your suppliers for late deliveries?
- What performance measures do you collect on the suppliers?
- How are the performance measures used to improve performance?
- How do you interface with the information system?
- What sorts of problems does the information system cause you?
- How are the parameters in the systems updated?
- What information are the suppliers supplied with?
- Are suppliers given forecasts?
- Are they given access to your information system?
- Who are your internal customers?
- Who has the power, do you bend over backwards for your internal customers or do they get what they are given?
- How do you attempt to best service your internal customers?
- Do your internal customers listen to your recommendations on such things as lead times, provision of forecasts and preferred suppliers?

Strategic Questions

- How do you select suppliers?
- How often do you review current suppliers and do you have a supplier database to capture tacit supplier knowledge?

- What kinds of contracts are used with suppliers?
- Are all suppliers equal?
- Are some suppliers treated as partners and others as single transactions?
- How are supplier relationships matched to product/ supplier type?
- Are you dependent on any of your suppliers (who has the power)?
- How do the companies overarching supply chain strategy impact your supplier selection and relationships?
- How has the supplier base changed over the past 5 years?
- Has the supply base been rationalised?
- How has the way you treat your suppliers changed during this time period?
- Where are you going with your supply base in the next 5 years?
- What are your long term objectives in regard to the suppliers?
- What are the next (1 year) goals for supply base improvement?
- How much joint work do you perform with your suppliers?
- Do you perform any form of supplier development or joint R&D?
- Do you perform joint marketing with any of your suppliers?
- Do you have any VMI or consignment agreements with suppliers?

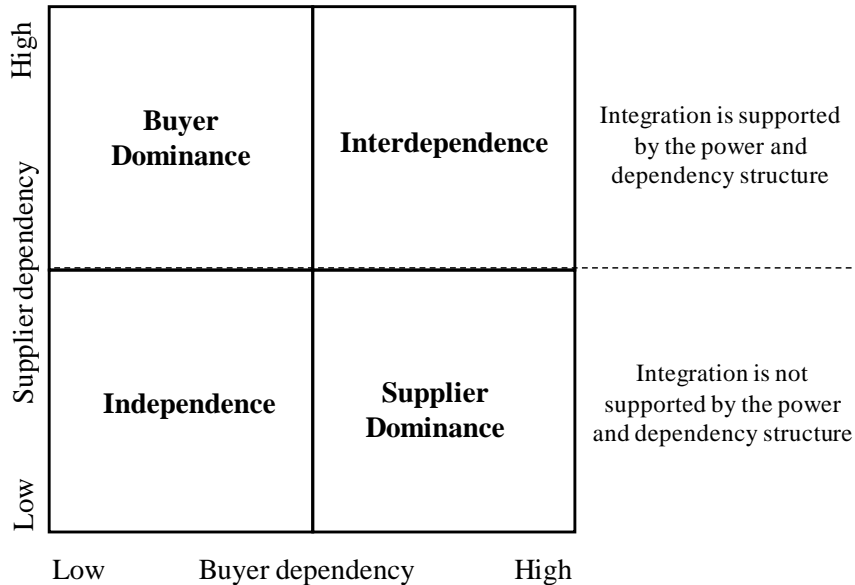
Generic Questions

- What is the most annoying thing about your day-to-day job?
- What problems keep re-accruing?
- What things do you have to do repeatedly that you feel are unnecessary?
- What information would make your job so much easier?
- What is your major pain?

G.2: Description of dyadic relationship model

The strategic supplier relationship research model used in the present research:

Figure G.1: Power and dependency dyadic relationship model



Source: Author

According to Figure 7.1, in a *Buyer Dominance* situation the buying organisation appropriates most of the commercial value and sets price and quality trade-offs. The *Independence* category contains relationships that are relatively straightforward to manage and indicate a low strategic importance. If the products have been identified as non-critical, the organisation should reduce the number of suppliers and the number of duplicate products; hence, key considerations are standardisation and consolidation of purchase (Bechtel & Jayaram, 1997; Olsen & Ellram, 1997). The focus of most *Interdependence* relationships is to achieve the simultaneous objectives of continuous improvement (Buzzell & Ortmeyer, 1995). However, such relationships are very resource intensive to maintain and are therefore not applicable to every relationship/organisation (Das, 2005). Finally, when an organisation is cornered in a *Supplier Dominance* situation, effort is needed to modify the relationship.

Regarding prospects for supply chain integration, the best possibility of the focal organisation achieving supplier integration occurs in the *Interdependence*

category due to the even balance of power and dependency between the organisations. In contrast, the focal organisation will likely find it hardest to achieve supplier integration with any supplier that falls into the Supplier Dominance category, since the power held by the supplier potentially creates a real barrier to integration. In a Buyer Dominance situation, when the power is held by the focal organisation, integration can be forced on the supplier to an extent (e.g., via insistence that the supplier acquires an inter-organisational information system). As organisations will not generally enter into arrangements in which the costs outweigh the benefits, implementing advanced integration practises in an Independence relationship may not even be desirable; particularly if it involves a one-off transaction.

G.3: Individual case finding – power and dependency structure

Food 1

Food 1 has the most advanced supplier relationship management practises in place (see Table 7.2). Regarding supplier uncertainty, Food 1 scored lowest with a score of 1.5. Food 1 has no misalignment of current and ideal relationship management. More than half of the relationships (52%) are within the interdependence and buyer dominance category, which should enable Food 1 to integrate even further. Food 1's key customers are major supermarket chains in Australasia. Those supermarket chains clearly dominate the relationships. The second key customer is the sister company in Australia. Here, power is balanced. Food 1 scored higher on demand uncertainty (2.5) than on supply uncertainty.

Food 2

Food 2's power structure is of concern. In total, 65% of all relationships are within the categories of independence and supplier dominance, which creates a real barrier to supply chain integration. The research identified some major misalignments in Food 2's current approach of supplier relationship management and idealised relationship management. Overall, Food 2 is among the most immature businesses regarding relationship management. External integration is not supported by the power and dependency structure because Food 2 is supplying major retail chains in Australasia (the uncertainty scores are not available).

Dairy 1

Dairy 1's power structure exhibits the strong market dominance of Dairy 2. Both companies operate with a similar supplier base; however, Dairy 2 dominates the New Zealand market. Currently, the opportunity to integrate with suppliers based on a power and dependency approach is rather limited because 86% of all relationships are within the supplier dominance and independency category. The immaturity of the procurement function also results in a high supply uncertainty score of 3.5; and this disregard of procurement and supplier relationship management results in misalignments of current and ideal relationship management. The customer side is predominantly independent because the

company supplies international customers with commodities to a market price. The demand uncertainty score was joint highest (4.0).

Dairy 2

The power and dependency structure of Dairy 2 has been evaluated as good when compared to other companies in this sample. In total, 65% of all the top 20 volume suppliers are within the interdependence and the buyer dominance categories. This outcome is not surprising since Dairy 2 is the largest dairy producer in New Zealand. Only minor misalignments have been identified so that Dairy 2 has minor problems integrating with the remaining suppliers. The customer side is predominantly independent because the company supplies international customers with commodities to a market price. The uncertainty scores are not available.

Forestry

Forestry has by far the healthiest power and dependency structure. In total, 85% of all the relationships evaluated are within the interdependence and buyer dominance categories, which support integration efforts. However, regarding the supply uncertainty score Forestry scored the highest (4.0). The research identified a strong misalignment of current relationship management and ideal relationship management. Purely focusing on power and dependency, Forestry has the highest potential to engage in truly integrative practises with key suppliers. The customer side is predominantly independent because the company supplies international customers with commodities to a market price. The second key customer is the sister company in Australia. Here, power is balanced. Also the strong local market results in many interdependent relationships. Forestry scored lower on demand uncertainty (2.5) than on supply uncertainty (4.0).

Manufacturer 2

Manufacturer 2 implemented many good relationship management practises. Further, the company has the largest proportion of buyer dominated relationships (32%). Overall, 43% of the evaluated relationships fall within buyer dominance and interdependence. Hence, the power and dependency structure supports

integration. The good practises applied by Manufacturer 2 result in a low uncertainty score of 2.0. Misalignments in current relationship management and ideal relationship occur predominantly within the buyer dominance category. On the customer side, most products are delivered to corporate-owned sales businesses, hence interdependency exist. Due to poor visibility on the demand side, demand uncertainty scored higher (3.0) than supply uncertainty (2.0).

Steel

Steel's overall power structure is evaluated as poor compared to the sample. In total, 71% of Steel's top 20 volume suppliers are in the independence and supplier dominated categories, hence supplier integration will be difficult to achieve. Poor supplier relationship management causes major misalignments between current supplier relationship management and idealised relationship management. This poor practise also results in a high supply uncertainty score of 3.0. Steel has weak links to key customers. The customer base is predominantly independent and poorly managed, which results in a customer uncertainty score of 4.0.

Appendix H: Supply chain integration evaluation scores

	Dairy 1		Forestry		Food 1		Manufacturer 1	
	<i>QS</i>	<i>Follow up</i>	<i>QS</i>	<i>Follow up</i>	<i>QS</i>	<i>Follow up</i>	<i>QS</i>	<i>Follow up</i>
Operational data	2	3	2	3	3	3	1	2
Visibility	2	2	1	3	2	2	1	2
Performance Measurement	2	2	2	2	3	3	2	2
Communication across SC	2	2	2	2	3	3	2	2
Supplier relationship	1	2	1	2	3	3	2	2
Customer relationship	2	2	1	2	2	3	1	1
SC strategy	1	1	2	3	2	2	1	3
VMI/ CPFR	1	2	2	3	3	4	3	3
Procurement	1	2	1	2	3	3	2	2
Track & trace system	1	2	2	3	3	3	1	1
Data & communication system	2	2	2	2	2	2	2	2
Transaction system	1	1	2	2	3	4	1	1
Decision points	1	2	1	1	2	2	1	2
Formal lateral org	2	2	2	2	2	2	2	3
Organisational structure	1	3	1	1	1	1	1	2
HR KPI	1	1	2	2	2	2	2	3
SC focus	1	2	2	2	3	3	1	3
Organisational culture	2	2	2	2	2	2	1	3
Physical flow	2	2	2	2	2	2.5	1	2
Inventory	3	3	3	3	3	3	1	2
Lead time	1	1	1	1	2	2.5	1	2
Information flow	1	2	1	2	2	2	1	2

1 = traditional supply chain (sc); 2 = functional sc; 3 = reactive sc; 4 = seamless sc

Source: Author

Reflection of the study of supply chain integration

Trying to find answers to the identified research questions highlighted the fact that supply chain management is embedded in a complex environment. Each layer and component subsystem adds complexity that makes generalisations more difficult to substantiate. This complexity creates barriers to developing well-substantiated theories (see also Stuart et al., 2002). Further, working hand in hand with practitioners the research highlighted that supply chain management problems are in many cases unstructured and messy.

The Quick Scan Audit Methodology, being a multiple paradigm approach, was applied in order to accurately describe, truly understand, and explain the complex and messy supply chain environment. Although the Quick Scan is a fairly new method developed in the early 1990s, its rigour is well established.

Since the late 1990s, the method has continued to be refined by the original members with assistance from other academics around the world. As expressed in both Chapter 6 and 7, the application of the method to the New Zealand environment has resulted in a heightened people and relationship focus when studying supply chain integration. The Quick Scan method is flexible in its approach, allowing both for personal researcher preferences, and also making it attractive to other researchers in other subject areas. Currently the Quick Scan is branching off in different directions including knowledge management audits, information systems audits, and innovation management audits.

Reflection of the PhD journey

This journey has been a fantastic opportunity to engage with practitioners and discuss the supply chain through an applied lens. Likewise, discussing the subject area with my supervisors, publishing journal articles, and visiting international conferences stimulated the academic lens. Particular highlights have included Quick Scan trips throughout New Zealand and visits at international conferences including Euroma in Glasgow, ISL in Budapest, and SCMIS in Melbourne.

Of course, the study was constrained by limitations of time and other resources. For example, the Quick Scan team had to be opportunistic regarding company willingness to engage in a supply chain audit. Time constraints meant that the Quick Scan team only managed to conduct two Quick Scans per year, which resulted in a long data collection process; a more compressed data collection period would have been desirable. Also, much time was spent at the beginning of the PhD in defining the initial scope of the research area. This process could have been streamlined by engaging early on with practitioners to discuss the feasibility and relevance of the research.

On the plus side, having the opportunity to carry out research as part of a team together with the supervisors was an ideal way of action learning. This process was stimulating and advanced my system thinking capabilities. Even though it was time consuming, attendance at several national and international conferences and publishing in journals added to the “apprenticeship” of becoming an academic. Finally, the close collaboration with other Universities, including Cardiff University in the UK was very valuable for narrowing down the scope of this PhD, and enabled me to present the results of collaborative research at international conferences, and jointly publish peer reviewed articles. Similarly, receiving supportive critical feedback and being able to discuss ideas with subject-related researchers and PhD students proved to be invaluable.

Vita

Tillmann Böhme holds a Master in Business Administration (with Distinction) degree from Waikato University, New Zealand and a Diploma in Business Studies from the University of Applied Sciences in Kiel, Germany. His current research has focused on supply chain integration, change management, supply chain assessment, and the development of methodologies to investigate real life supply chains. He has published a number of research papers in: *Operations Management Journal*, *The International Journal of Production Research*, and *The International Journal of Electronic Customer Relationship Management*. He has served as a referee for *Supply Chain Management: An International Journal*. Further, he presented his research at international conferences, including *The International Symposium for Logistics*, *The International European Operations Management Association* and *The International Conference for Supply Chain Management and Information Systems*. He is a student member of the Operational Research Society of New Zealand (ORSNZ).