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Supply chain integration in New Zealand: fact or fantasy?

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Researchers at the Logistics Systems Dynamics Group (LSDG), Cardiff Business School, Cardiff University in Wales and the Systems Department, Waikato Management School, Hamilton, New Zealand have explored the issue on uncertainty in supply chains and have established a relationship between best-in-class supply chain practices (highly integrated supply chains) and levels of supply chain uncertainty using the Quick Scan Audit Methodology developed by LSDG. This approach has been applied to six New Zealand companies. The studies show that New Zealand organisations face high uncertainties and therefore are weakly internally and externally integrated. Six common root causes for the low level of integration have been identified, namely poor knowledge management, functional silos, weak operation processes, multiple independent information systems, human resources and lack of strategic supplier relationship management.

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Supply, chain, integration, Zealand, Fact, fantasy

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Supply chain integration in New Zealand: Fact or Fantasy?

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Abstract

Researchers at the Logistics Systems Dynamics Group (LSDG), Cardiff Business School, Cardiff University in Wales and the Systems Department, Waikato Management School, Hamilton, New Zealand have explored the issue on uncertainty in supply chains and have established a relationship between best-in-class supply chain practices (highly integrated supply chains) and levels of supply chain uncertainty using the Quick Scan Audit Methodology developed by LSDG. This approach has been applied to six New Zealand companies. The studies show that New Zealand organisations face high uncertainties and therefore are weakly internally and externally integrated. Six common root causes for the low level of integration have been identified, namely poor knowledge management, functional silos, weak operation processes, multiple independent information systems, human resources and lack of strategic supplier relationship management.

1. Introduction

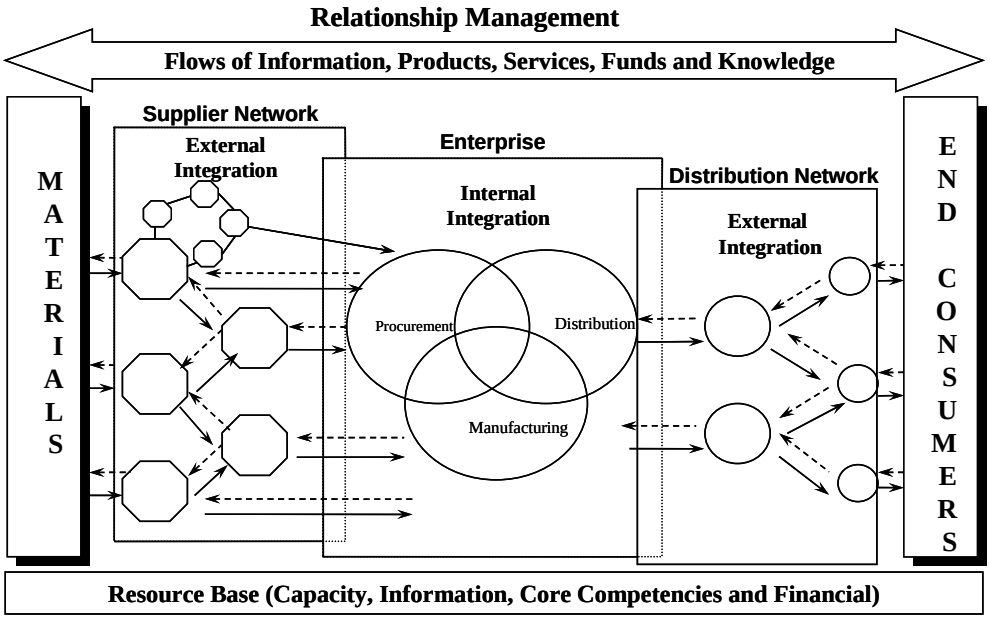
Supply chain management takes a holistic perspective regarding the various activities, functions, and systems required to bring a product or service to market. It requires the integration of activities, functions, and systems throughout the supply chain (Vickery, Jayaram, Droge, & Calantone, 2003). Therefore, one of the main themes in supply chain management is integration along the supply chain in order to improve performance and competitiveness by facing less uncertainty (Bagchi & Skjott-Larse, 2002; Childerhouse &

Towill, 2003). Uncertainties can occur in the form of sales deviate from forecast, components are damaged in transit, fabrication yields fail to meet plan, or shipments are held up in customs to name just a few. The structure of the paper is as follows: The paper begins with a review of the theoretical foundations of supply chain integration from a supply chain uncertainty perspective. A methodology section specifies the research design. Results are then presented illustrating the application of the methodology and findings from five cases. The paper concludes with a discussion of results, their implications for researchers/practitioners, and directions for future research.

2. Literature Review

The relevance of supply chain integration has been widely discussed and supported. Many studies confirm that the higher the level of integration the higher the operational and business performance of the firm (Frohlich & Westbrook, 2001; Gimenez & Ventura, 2005; Rosenzweig, Roth, & Dean Jr, 2003). The ultimate goal is the seamless supply chain wherein all players 'think and act as one' (Mason-Jones & Towill, 1998). This ideal version of a fully integrated supply chain has removed barriers so as to ease the flow of materials and information, thereby creating profits, increasing market share, strengthening competitive position, and enhancing the value of the company (Lee, 2000). Figure 1 represents the ideal version of a supply chain.

Figure 1: The integrated supply chain



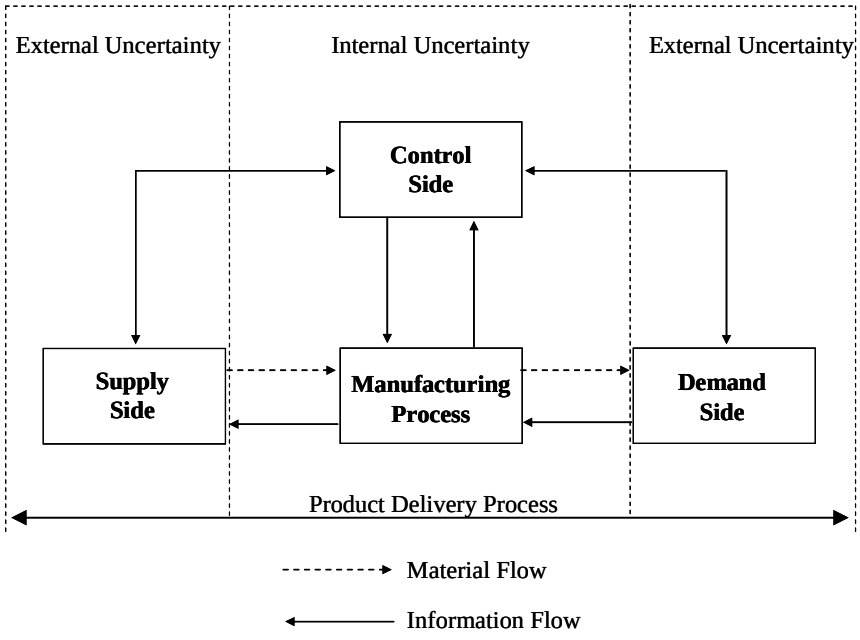
Adapted from: (Bowersox, Closs, & Cooper, 2007)

The literature defines two key supply chain integration areas namely internal integration and external integration. Internal integration focuses on divisions and boundaries within the organisation and seeks to eliminate the traditional functional 'silo approaches' (Gimenez & Ventura, 2005). External integration focuses on an organisation's interfaces with its customers and suppliers. It has been shown that even similar companies may progress through quite different stages to achieve a fully integrated, seamless supply chain (Childerhouse, Naim, Towill, & Disney, 2001; Lambert, Cooper, & Pagh, 1998; Lee, 2000; Stevens, 1989).

Researchers at the Logistics Systems Dynamics Group (LSDG), Cardiff Business School, Cardiff University in Wales and the Systems Department, Waikato Management School, Hamilton, New Zealand have explored the issue on uncertainty in supply chains and have established a relationship between best-in-class supply chain practices (high level of supply chain integration) and levels of supply chain uncertainty (Towill & Childerhouse, 2006). Exploration of both Universities results and of related research indicates a relationship among

uncertainty reduction, best-in-class operating practice, integration, extended visibility across the supply chain, and business success. Towill et al. (2001) carried out detailed case studies on 20 supply chains from the European automotive sector. They found that most companies still face high uncertainties and therefore are weakly integrated. To combat uncertainty and improve performance, companies need to work toward enabling the seamless supply chain. Supply chain uncertainty can be classified into four general types namely process-, supply-, demand-, and control uncertainty. Figure 2 represents the uncertainty circle highlighting the four supply chain uncertainty areas.

Figure 2: Four types of supply chain uncertainty



Source: Adapted from (Mason-Jones & Towill, 1998)

The control and the manufacturing process uncertainty problems can be solved predominantly internally where else the demand and supply uncertainty areas require the involvement of the external entities. Table 1 describes the four uncertainty areas in detail.

Table 1: Description of the four uncertainty areas

Area of Integration	Area of Uncertainty	Explanation
Internal Uncertainty	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, then 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.
External Uncertainty	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 or fill rates are often a result of demand uncertainty

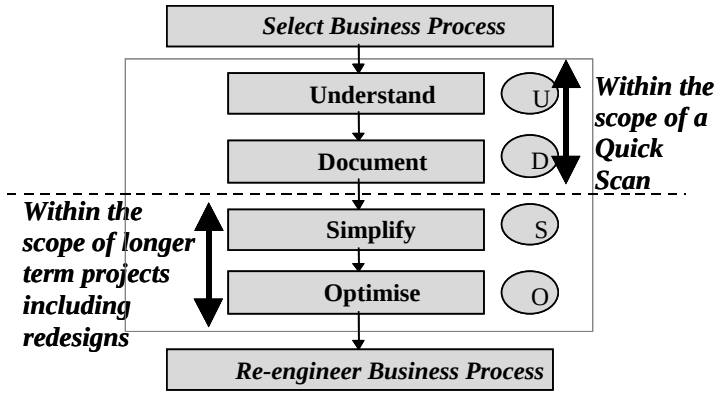
Source: (Naim, Childerhouse, Disney, & Towill, 2002)

Each of these uncertainties creates a drag on operational performance and therefore companies need to understand which of the four areas causes the greatest uncertainties first, before prioritising resources adequately when embarking on a change programme. What is needed is a systematic method of identifying and codifying the supply chain uncertainty (Towill, Childerhouse, & Disney, 2002).

3. Quick Scan Audit Methodology

The Logistics Systems Dynamic Group at Cardiff University (LSDG) developed the Quick Scan Audit Methodology (QSAM) in the early 90s and it has since been developed into a robust diagnostic tool through further work of the LSDG at Cardiff University and the work of the Systems Department at Waikato University. Figure 3 highlights the scope of the QSAM within the business process re-engineering procedure.

Figure 3: The UDSO business process re-engineering procedure

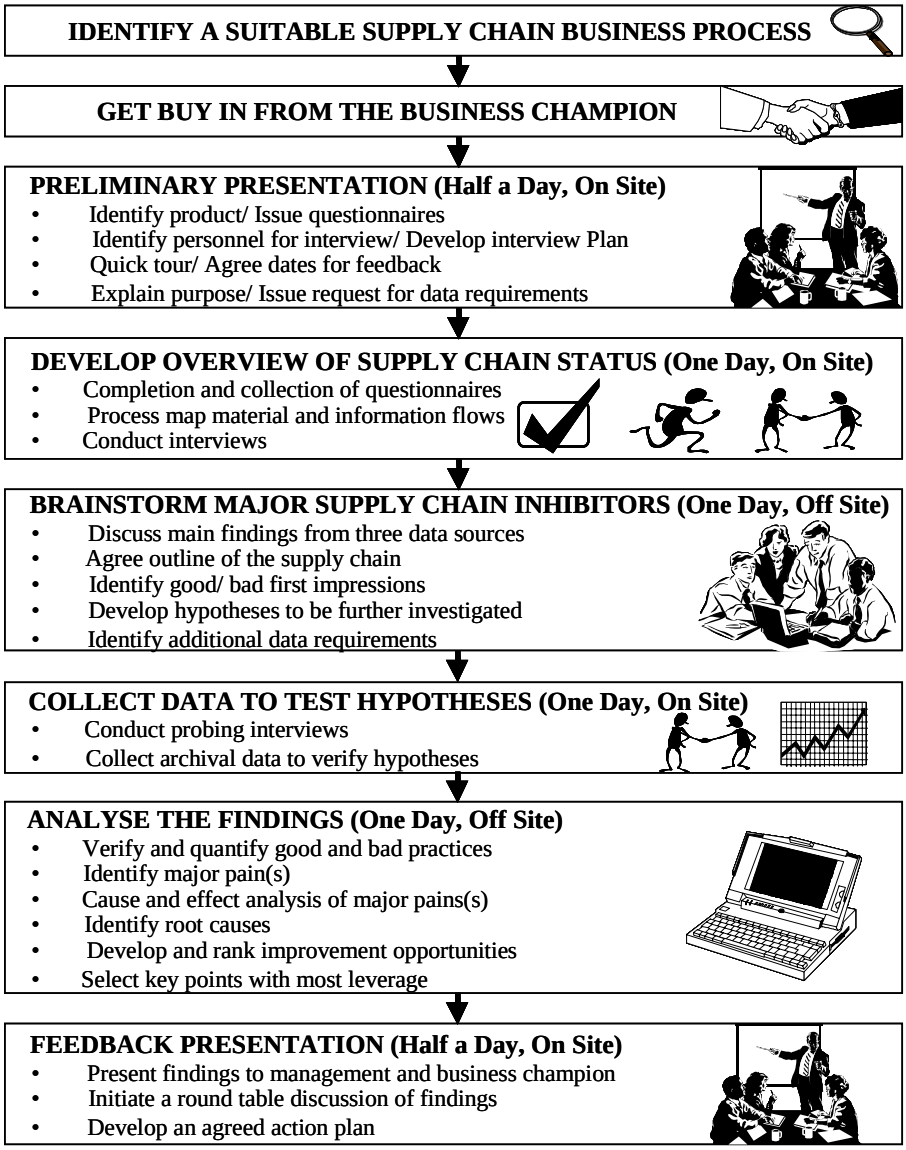


Author: (Watson, 1994)

The major focus of a Quick Scan is on the first two stages of a re-engineering program namely understand and document. However, the Quick Scan is valuable for organisations because the outcome provides recommendations on the simplification and optimisation of business processes that require long term change projects aimed at advancing the business process towards the seamless supply chain. Next to long term change projects the Quick Scan also leads to the identification of Quick Hit (not quick fix) improvement opportunities.

The Quick Scan Audit Methodology follows a structured approach. To satisfy the time requirement, the Quick Scan procedure have been designed to be completed within a one week period, of which only three days has to be spent on site to minimise resources and time allocation of the site's personnel who are busy with operational duties. In order to facilitate this short time scale the Quick Scan team normally consists of four diagnostic staff and a business champion. The structured approach of the Quick Scan is highlighted in detail in Figure 4.

Figure 4: The Quick Scan process



Source: (Authors)

Those organisations being quick scanned have received significant benefits in the short medium and long term (Boehme, Potter, Childerhouse, Corner, & Deakins, 2007; Potter, Mason, Naim, & Lalwani, 2004; Towill et al., 2002). The following section presents the outcome of the six Quick Scans conducted in New Zealand.

4. Findings

4.1 Background Information to the cases studied

Six supply chains existing in total of fifteen value streams have been investigated. The identities of the focal organisations have been changed for proprietary reasons. The case description has been induced principally from interviews with key informants at the focal organisations. Table 2 provides a brief overview of the six cases studied.

Table 2: Description of the five cases studied

Case #	Company Description
1	The company is a New Zealand based manufacturer producing items predominantly for the local farm supplying market. Two separate value streams have been investigated.
2	The company produces three different dairy products at one manufacturing site in New Zealand. The final products get mainly exported. Two separate value streams have been investigated.
3	The company produces a broad range of forestry products at several manufacturing sites in New Zealand and Australia. The final products get mainly exported. The research is based on one New Zealand site producing two different main products.
4	The company processes a broad range of imperishable food products for global customers at several manufacturing sites all over the world. The research is based on the NZ site. Three different products representing three different value streams have been investigated.
5	The mother company is a worldwide operating enterprise manufacturing machines for the process industry. The New Zealand site is producing items predominantly for international customers. Two separate value streams have been investigated.
6	The company is a New Zealand based service provider within the public health sector. Four distinguish value streams have been investigated

Source: (Authors)

The six companies being Quick Scanned are all medium to large New Zealand enterprises existing of multiple value streams. One company can exist of multiple value streams depending upon various clusters of either customer or product type (Fisher, 1997). Each cluster is managed differently and therefore is facing different uncertainties.

4.2 Supply chain integration findings

Data has been collected around the four types of uncertainty (see Figure 1). The primary data used for assessing uncertainty during Quick Scan investigations are listed in table 3.

Table 3: Primary archival data sources collected during a QS for the four sources uncertainty

Uncertainty Source	**Primary data collection during a QS**
Supply side	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	Delivery frequency, echelons to end consumer, marketplace variability, stage of product lifecycle, customer ordering procedures and forecast accuracy.
Process side	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	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.

Source: (Naim et al., 2002)

The codifying of the four uncertainty sources was undertaken by members of the quick scan team on the basis of the total information at their disposal. Table 4 shows the questionnaire then completed with respect to each value stream.

Table 4: Supply chain questionnaire to determine impact of the four uncertainty sources

		Rating by Quick Scan team			
	Question ask of each value stream	Strongly agree	Weakly agree	Weakly disagree	Strongly disagree
Internal Integration	The value added process(es) generates low system uncertainty	1	2	3	4
	The system controls do not generate uncertainty	1	2	3	4
External Integration	The demand side generates low system uncertainty	1	2	3	4
	The supplier side generates low system uncertainty	1	2	3	4

Source: Adapted from (Towill et al., 2002)

Where necessary the Likert scores were verified by cross-reference to detailed QS reports and re-visiting various data banks. The choice of a four point Likert scale was aimed at reducing any tendency to regress towards the mean, and instead focus on strengths and weaknesses of individual supply chains (Towill et al., 2002). The seamless supply chain will clearly have low uncertainty scores for process, control (internal) and supplier, demand (external). Using the supply chain scores (1:1) (1:1) as target values reflecting the seamless supply chain with no uncertainty and (4:4) (4:4) reflecting traditional supply chains, the researchers have calculated the Euclidean Norm for each supply chain process. The following equation shows the simple calculation performed to assess the overall level of supply chain uncertainty.

$$\text{Euclidean Norm (internal)} = \left(\left(\text{Process} - 1 \text{ Score} \right)^2 + \left(\text{Control} - 1 \text{ Score} \right)^2 \right)^{½}$$

$$\text{Euclidean Norm (external)} = \left(\left(\text{Supply} - 1 \text{ Score} \right)^2 + \left(\text{Demand} - 1 \text{ Score} \right)^2 \right)^{½}$$

This procedure provides two metrics which are presented in table 5.

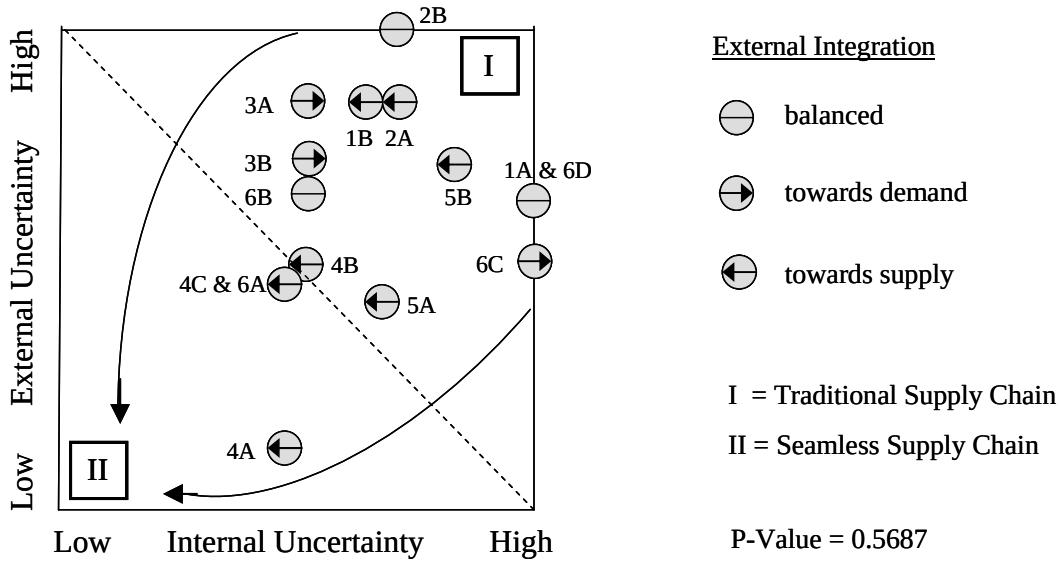
Table 5: Uncertainty Data Scores

Value Stream	Internal Uncertainty	External Uncertainty
1A	4.24	2.83
1B	2.83	3.61
2A	3.00	3.61
2B	3.00	4.24
3A	2.24	3.61
3B	2.24	3.16
4A	2.00	0.50
4B	2.24	2.06
4C	2.00	2.00
5A	2.92	1.80
5B	3.54	3.16
6A	2.00	2.00
6B	2.24	2.83
6C	4.24	2.24
6D	4.24	2.83
Mean	**2.86**	**2.70**
P-Value	**0.5687**	

Source: (Authors)

The data highlights that on average New Zealand organisations face higher uncertainty internally (mean = 2.86) then externally (2.70). Further, a t-test has been conducted with a p-value of 0.5687. Therefore, the difference between internal and external uncertainty is not significant. The data in Table 5 enables to map the six supply chains existing of fifteen value streams in a 2x2 matrix as shown in Figure 5.

Figure 5: Supply chain integration in New Zealand

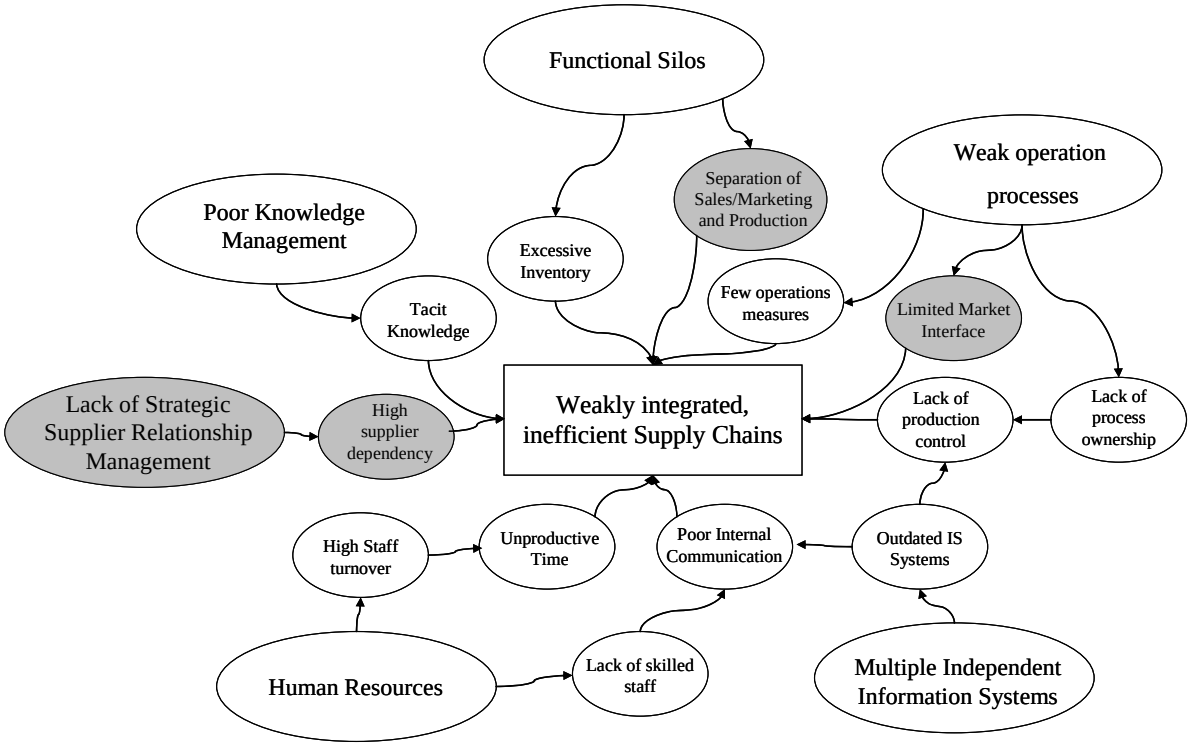


Source: (Authors)

The top right corner (I) reflects the traditional supply chain with high uncertainty on both axis, internally (x-axis) and externally (y-axis). Where else the bottom left corner (II) represents the seamless supply chain facing minimum uncertainty. The dotted line is the centre line where the overall uncertainty (internal and external) is halved. The area between the two curved errors represents possible positions and paths to further integrate the value stream. Figure 5 clearly identifies that the organisations studied struggle with the concept of supply chain integration and are facing high uncertainty both, internally as well as externally. Nine (~60%) of all value streams are clearly positioned right-top from the centre line and therefore closer to the traditional supply chain approach. Four value streams (~27%) are

around the centre line. Supply chain managers introduced some good practices and managed to halve the uncertainty of those value streams. Only one exception (company 4 value stream A) could be identified that is close to the ideal version of a supply chain. Even so a lot of internal uncertainty remains, this company established excellent working relationships with their external entities, especially with their customers. Surprisingly, most New Zealand companies face higher uncertainty from the demand side rather than the supply site, which contradicts with the findings of (Frohlich & Westbrook, 2001). However, the question remains why New Zealand organisations are so weakly integrated. To answer that question the Quick Scan team developed a cause and effect diagram that clearly identifies the root causes for the weakly integrated and inefficient supply chains. Figure 6 represents this cause and effect diagram.

Figure 6: Root causes for weakly integrated supply chains



Source: (Authors)

The six root causes are namely poor knowledge management (KM), internal functional silos, weak operation processes, multiple independent information systems, human resources and lack of strategic supplier relationship management. The grey shaded areas represent the courses for the high level of external uncertainty where else the with areas focus on internal uncertainty courses. Table 6 provides more depth for each identified root cause.

Table 6: Description of root causes

Root causes	**Frequency**	**Explanation**
Functional silos	100 %	The geographical dispersion of production and management fosters a 'them and us' mentality. The organisational structure obstructs the horizontal flow of information and teamwork across functional boundaries. Existing performance measures and reward systems are primarily functionally focused.
Multiple independent IS	100 %	It was noted that all investigated organisations currently operate with multiple independent and loosely coupled information systems which leads towards incomplete and inadequate end-to-end information flows.
Poor KM	50 %	The companies have knowledgeable staff. Most of the staff members are with the organisations long term and therefore gained tacit plant knowledge. The companies currently have no procedure in place to capture the knowledge that is tight up in individuals.
Weak operation processes	50 %	Observed production planning procedures showed weaknesses at the strategic, operational, and tactical levels. Inefficient operating practices have been identified (double handling, large inventory buffers etc.)
HR	50 %	Throughout the cases a lack of skilled staff on management as well as operational level has been identified. Further, due to high staff turnovers in some areas companies are faced with unproductive working times.
Lack of strategic SRM	50 %	Most supplier bases were too large and all organisations had lacked a more strategic approach towards supplier relationship management. The investigation identified that every company is highly dependent on some of their key strategic suppliers.

Source: (Authors)

All six Quick Scans had two root causes in common, namely functional silos and multiple independent information systems. Supply chain managers need to address these issues by exploiting opportunities to overcome those barriers. The existing functional silos can be broken down by establishing cross-functional teams and cross-functional human resources key performance indicators. Further, companies should aim for a flat and less hierarchical organisational structure. The information system systems in all organisations need re-

engineering. Ideally a companies' 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. Further, ways need to be identified to capture in-depth plant knowledge of staff members. Companies also need to identify ways to motivate staff because in three out of six cases a high staff turnover ratio especially on the shop floor level has been identified. Further in half of the cases major operation process re-engineering programs need to be established in order to improve production processes and finally companies need to address supplier relationship management on a strategic level to overcome the high dependency on critical suppliers (Boehme, Childerhouse, Corner, Garland, & Varey, 2006).

5. Conclusion

Best-in-class performance remains an elusive goal for most supply chains in New Zealand. Organisations face high levels of internal and external uncertainty. Best practices adoption is spotty. Six common root causes for the low level of supply chain integration have been highlighted in this paper namely poor knowledge management (KM), internal functional silos, weak supply chain processes, multiple independent information systems, human resources and lack of strategic supplier relationship management. The Quick Scan methodology detailed in this paper is designed to support organisations to achieve a best in class supply chain. The methodology can be defined as a robust diagnostic tool developed to assess the current performance of an organisation's supply chain and identify potential improvement opportunities by applying a systematic approach. The outcome of the Quick Scan is twofold. On the one hand Quick Scan is capable of identifying best in class practices and on the other hand provided focal organisations with specific guidance for improvement. Future Research will consist of follow up case studies to identify the path organisations took to further

integrate their supply chain and the barriers those companies faced. Especially the high dependency on key suppliers will further be investigated.

Acknowledgement

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