Supply chain integration in Australia: Benchmark comparisons with the UK automotive sector

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ABSTRACT
Supply chain integration has been strongly linked with performance excellence. This research investigates the level of sophistication (maturity) of supply chain integration in Australia from the systems uncertainty perspective. The uncertainty levels of value streams are evaluated using the 'uncertainty circle' concept and the well-established Quick Scan Audit Methodology (QSAM) based on a sample of six Australian value streams and compared with 21 value streams in the UK automotive sector. This benchmarking revealed that value streams in Australia are weakly integrated. Common barriers to supply chain integration amongst the Australian sample are also identified.

Keywords: Supply chain integration, supply chain maturity, supply chain audit

INTRODUCTION
A supply chain (SC) can be described as a set of interlinked companies that make products and services available to customers, with the ultimate goal to create value for end customers and for the organisations in the SC network (Christopher, 2011). To accomplish this, organisations in the SC must integrate process activities internally and with customers and suppliers externally (Stevens, 1989). Nonetheless, several studies established that many organisations struggle with the implementation of SC principles in practice (Towill et al., 2002; Böhme, 2012).

This research study presents the early findings of investigations into SC integration sophistication (maturity) in Australia. A relative assessment of SC integration was achieved by comparing a sample of six value streams from two Australian organisations within the process and distribution industry with a sample of 21 value streams from the well-honed UK automotive sector published in Towill et al. (2002). The term ‘value stream’ was popularised by Womack and Jones (1996) and in many respects ‘supply chain’ and ‘value stream’ are synonymous. A practical interpretation is that a SC consists of a
bundle of one or more value streams; hence a focal company can have multiple value streams. Next, features of the methodological approach used are highlighted and a brief review of the relevant literature including the Australian landscape is presented. Finally, the findings are discussed, limitations highlighted and future research avenues presented.

LITERATURE REVIEW

Supply Chain Management and Supply Chain Integration

SC management, and in particular the concept of SC integration, originate from a systems perspective (Christopher, 2011) in which optimisation of the whole is held to achieve better performance than a string of optimised sub-systems. The argument behind this theory is that integration enables trade-offs and wider ranging decisions to be made based on shared information and co-ordination (Frohlich and Westbrook, 2001).

Despite more than 20 years of academic effort, scholars continue to report that few companies are actually engaged in extensive SC integration practises and there still is a significant gap between SC theory and its practise (Akkermans et al., 1999; Towill et al., 2002). Sohal (2013) mentions that this gap is also present in Australia.

Supply Chain Management Initiatives in Australia

Several studies conducted in the U.S.A., Australia and New Zealand identified a possible set of competencies for firms to focus on in order to achieve SC integration (Mollenkopf and Dapiran, 2005 and Closs and Mollenkopf, 2004). In particular, Mollenkopf and Closs (2005) showed that Australian and New Zealand firms tend to be more focused on being internally integrated rather than externally (Mollenkopf and Dapiran, 2005). Childerhouse et al. (2011) conducted in international comparison study of supply chain maturity in practice including countries like New Zealand, UK, and Thailand. The authors demonstrated that the uptake in practice is poor as well as that there is no clear evidence that SC maturity differs between national and industrial sub-groups (Childerhouse et al. 2011).
During the last decade, scholars have investigated supply chain management issues in different Australian industries. Those include the Australian agribusiness of beef processing (Jie et al., 2013, Lu and Swatman, 2009), the construction industry (London and Singh, 2013), hospital (Bhakoo et al., 2012, Böhme et al., 2014), and the road freight industry (Ferrer et al., 2010) to name a few. Topics include technologies such as RFID (Wamba, 2012, and Angeles, 2009), m-commerce (Lu and Swatman, 2009), and models for e-business (London and Singh, 2013). Figure 1 summarises the major topics of Australian SC literature and the relationship amongst them. Areas such as technology, supply chain relationships, distribution/logistics and methodology have been focused on more so than other areas such as supply chain integration.

According to the existing literature in the field, supply chain management issues in Australia are similar to those encountered in other countries. Trust, communication, information sharing and collaboration (Jie et al., 2013; Alfalla-Luque et al., 2013, Bhakoo et al., 2012, Ferrer et al., 2010) are described by many ANZ researchers as being key factors in achieving integrated or seamless supply chains (Childerhouse and Towill, 2003). However, little is known about the level of SC integration maturity in Australia (Böhme et al., 2014). Hence, this research compares SC integration maturity in Australia with earlier results obtained from the UK automotive industry (Towill et al., 2002).

The development of comparative measures of SC integration maturity is complicated by the wide variety of supply chains encountered in practice; the operational contexts within which they operate; and the complex multi-function, multi-organisation measures required. However, researchers have begun to use uncertainty for framing SC concepts, and as a comparative assessment measure, because this enables supply chains to be meaningfully compared irrespective of the context within which they operate (Böhme, 2012; Towill et al., 2002).

Mason-Jones and Towill (1998) segmented SC uncertainties into four areas which they termed the ‘uncertainty circle’, in order that root causes of problems can be identified and methods developed for
minimisation (Böhme, 2012). The four areas of uncertainty are explained in considerable detail in Naim et al. (2002); similarly, the supply chain uncertainty circle (Figure 2) has been successfully applied and validated (Böhme, 2012; Childerhouse et al., 2007; Towill et al., 2002).

*Figure 2 about here*

Value stream uncertainty is derived from site-based observations of: Our processes, Our controls, Our supply side, and Our demand side (Childerhouse and Towill, 2004) in order that the root causes of uncertainty can be identified and mitigation strategies developed. The detected symptoms of value-stream uncertainty are grouped into: Dynamics of behaviour, Physical situation, Operational characteristics, and Organizational characteristics (Towill, 1999), and this classification forms an integral part of the site-based audit protocols (Childerhouse, 2002).

The degree of process uncertainty within a value stream affects the ability to meet internal targets and can be established from traditional metrics like lead-time, delivery performance, and process configuration variability. In addition, if a value stream is competing with others for resources, this interaction must also be studied and codified (Böhme et al., 2008). Control uncertainty impacts the organization’s ability to manage its material and information flows. Its metrics include assessments of how streamlined and transparent is the overall replenishment process. Supply side uncertainty is the result of suppliers failing to meet the organization’s requirements and thereby hindering the value-adding processes. Its metrics include time series of orders placed, stocks, call-offs, actual lead-times, and supplier quality. Demand side uncertainty can be thought of as the difference between reported demand and end-marketplace demand, and its metrics include assessment of how well the replenishment process is meeting the demands made by production staff. In short, any business improvement program should attempt to reduce system uncertainty, as this aim is fully consistent with the goal of smooth and seamless materials flow (Towill, 1997).

*Assessment of Uncertainty*
In this research, SC maturity is quantified using the uncertainty circle of Figure 2. Qualitative and quantitative data relating to the various areas of uncertainty are used to assign the overall integration value by ranking each of the four areas of uncertainty. Codifying the four uncertainty sources is undertaken by all members of the QSAM-team, to achieve researcher triangulation. Codifying these separate uncertainty sources involves every member of the team and draws on qualitative and quantitative data. Each source is assigned a rating via a 4-point Likert scale (where, lowest uncertainty = 1; highest uncertainty = 4). Then, because ‘a chain is only as strong as its weakest link’, these are combined into a codified value stream uncertainty score via the Euclidean Norm (EN):

$$EN = \sqrt{[(\text{Our processes-1})^2 + (\text{Our controls-1})^2 + (\text{Our supply side-1})^2 + (\text{Our demand side-1})^2]}$$

The Euclidean Norm “estimates the distance of all individual value streams from the target score set at the fully integrated (and hence minimum uncertainty) value stream” (Towill et al., 2000, p. 591).

In total, some 84 person-days were spent investigating six value streams in two Australian companies from two industry settings. Next, the detailed uncertainty analysis for all four areas of uncertainty is presented.

**METHODOLOGY**

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. However, Salama et al. (2009) posit that a supply chain and operations audit is a fundamental foundation to any large-scale change initiative. The audit methodology used in the present study is based on the uncertainty circle model of Mason-Jones and Towill (1998). The so-called Quick Scan Audit Methodology (QSAM) essentially examines the degree of control achieved by the organization over its value-adding processes as it places orders on its
suppliers and responds to customer demands. Value streams are identified during the audit and are used to analyse the supply chain within the participating organisations. Unlike other measures that ‘compare apples to apples’, QSAM is not restricted by industry or context. QSAM was originally developed to provide a repeatable mechanism for establishing supply chain integration effectiveness in the European Automotive Sector (Towill et al., 2002) and has since been deployed globally within a broad range of industrial sectors, where it is updated as appropriate (e.g., Böhme et al., 2008; 2014; Naim et al., 2002). QSAM was recently classified as a prime example of the ‘therapies path’ to BPR (Salama et al., 2009) as its goal is to achieve a thorough understanding of how the constituent elements of an organization; including people, processes and technology interact with one another at a given point in time to constrain performance and innovation (Towill, 1997).

The 7-step QSAM process shown in Figure 3 requires that researchers with a broad range of expertise work together to achieve consensus on the state of the targeted value stream.

Figure 3 about here

Initial preparations ahead of an audit include discussions with the host organization to identify both the target value stream and a ‘champion’ who will work alongside the academic researchers. A formal presentation to managers and staff then aims to secure site-wide cooperation and access to the data needing to be collected. The evidence-based investigation is expressly intended to obtain value stream uncertainty data associated with the four uncertainty circle components described earlier. Five basic data collection techniques are used: observation, (attitudinal) questionnaire, process map, structured interview, and review of archive information. Thus, value stream judgements are based on a combination of case study-type metrics and statistically significant data, as the researchers aim to exploit knowledge from as many data sources as possible. Around five full days are needed to audit the value streams of a medium-sized organization, which includes three days actually on site.
Strictly implemented audit protocols enable different researchers to reliably assess the same things (Naim et al., 2002) and the multi-method approach draws on several types of triangulation (Denzin, 1989). Data triangulation occurs when different information sources are combined and, because the company situation is scrutinized to determine the performance enablers and inhibitors in the form of a cause-effect diagram, the combination of quantitative and qualitative data provides for methodological triangulation. In addition, investigator triangulation occurs by having several researchers involved in the study. A complete description of how a QSAM audit is conducted, and the robustness of its associated research methods, can be found in Böhme et al. (2008) and in Naim et al. (2002).

Site-based case studies were undertaken with two Australian-based companies, Table 1. Both companies were selected on the basis that they maintain a complex supply chain, and represent a range of industry sectors.

Table 1 about here

FINDINGS

Due to the complexity of SC integration maturity measures many researchers use subjective Likert scale measures (e.g. Rosenzweig et al., 2003) to assess respondents’ perception of their supply chain. In contrast, this research applied a subjective 'uncertainty' measure to evaluate SC integration maturity in practise, which enables the researcher to benchmark SC performances irrespective of the operating context.

Uncertainty is a context-free metric that makes direct performance comparisons possible even when the benchmarked organizations are in different business and economic settings (Böhme et al., 2008; 2014). Thus, to assess the relative performance, a rigorous QSAM assessment of value stream practices was conducted that used the material flow uncertainty profile (Our processes, Our controls, Our supply side, Our demand side) (Childerhouse and Towill, 2004) as its core metric (see also Figure 2).
The basic QSAM premise is that entities with similar EN values will have similar effectiveness and efficiency, hence EN anchors that correspond to the Stevens (1989) classification model for supply chain integration are utilized (Seamless EN = 1; Baseline EN = 6). The resulting codified uncertainty score for the value streams is indicated in Figure 4, together with summary statistics for the European / UK automotive sample of first tier suppliers (Childerhouse and Towill, 2004; and Böhme et al., 2008).

Figure 4 includes the QSAM sample results for the two Australian companies. Company A, an electrical distributor, and company B, from the printing industry, sit mostly in the functional integration section. Whilst they display good practices, there is still room for improvement. Value stream B3 however is an exception in this case, displaying more evidence of good practice and internal integration than the others. Compared to the 21 value streams from the UK automotive sector, the Australian companies have very high uncertainties generated especially from the control and demand side.

Many company specific barriers to supply chain integration were identified. However, a cross-case comparison based on the assessed value streams in Australia also revealed some common inhibitors. Table 2 summarises some of the core inhibitors identified in both cases.

Table 2 about here

Both case companies lacked a sense of strategic direction; leading to misaligned functional targets. Processes lack standardisation and measurement resulting in management based on “gut feeling” and in both cases of high levels of fire-fighting throughout the organisation. More importantly, these
problems lead to high amount of inefficiencies/ineffectiveness like rework, double handling, scrap, lost sales, and missed sales opportunities in both cases.

**DISCUSSION AND CONCLUSION**

The contribution of the present paper is twofold; first QSAM has been deployed in a new country and cultural setting, which further strengthen the generalizability of the method. Second, this early research into supply chain integration maturity in Australia reveals that value streams are weakly integrated, and lack behind compared to the well-honed UK automotive industry. Likewise, Closs and Mollenkopf (2004) report that Australian companies place less emphasis on internal integration than do their US counterparts. This research partly contradicts Closs and Mollenkopf (2004) findings since good SC practice to support internal integration was rarely evident. Sohal (2013) also highlights this gap in Australia, where industry, universities and industry associations have been attempting to coordinate their efforts towards improving SC management through various initiatives (Sohal, 2013). Developing SC professionals through using a set of competencies is highlighted as being of particular significance (Sohal, 2013 and Prajogo and Sohal, 2013).

The poor uptake of SC integration concepts has been reported by others and is not unique to Australia (Akkermans et al., 1999; Böhme, 2012; Towill et al., 2002) and, although some islands of good practise were detected, it is evident that a significant gap remains between SC integration theory and its practise in Australia. This should sound a clear warning to Australian industry because not only was the UK automotive sector SC maturity found to be significantly higher, the base data was collected some 15 years earlier than the Australian study.

Additionally, Böhme et al (2014) identified a strong link between systems uncertainty and innovation capabilities; where high levels of systems uncertainty inhibit innovation. The high levels of systems uncertainty present in Australia is hence even more alarming. The BRICS economies (Brazil, Russia, India, China, and South Africa) are marshalling substantial resources in the wake of a recent global financial crisis that has further weakened the manufacturing sectors of many countries (Cassiolato and Lastres 2009). In response, governments and trading blocs around the world, while
urging their own industries to become more innovative, increasingly recognise that ongoing cutting edge research, continuous improvement, and innovation is needed at the cutting edge of productivity (e.g. Coons 2014). In Australia, the government’s Powering Ideas: an Innovation Agenda for the twenty-first Century states that innovation is the key to making Australia more productive and more competitive, ‘by improving the things we make and the way we make them – the services we deliver and the way we deliver them’ (Australian Government 2009, 1). So how do we get out of our innovation crisis?

This exploratory investigation of the current state of SC integration in Australia has some obvious limitations. In particular, the sample size and makeup mean that the results obtained cannot readily be considered representative of the total population of Australian value streams, and the question remains whether other industry sectors are similarly weakly integrated. Mollenkopf and Dapiran (2005) for example report in their quantitative study that world class supply chains do exist in Australia, hence further research is needed to more comprehensively explore the level and nature of SC integration within Australian companies. Further, Childerhouse and Towill (2011) report that there is not a set level of integration for all supply chains, rather it depends on the environment and value streams that are being focused on.

Further research should focus on the identification of levels of integration for various industry sectors in the Australian/ New Zealand context to enable a more comprehensive understanding of supply chain maturity practices “down under”. The audit method in itself has potential to investigate improvement and innovation pathways via longitudinal field studies.

**ACKNOWLEDGEMENTS**

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References


Figure 1 - Supply Chain Integration Maturity in Australia
Figure 2 – The Supply Chain Uncertainty Circle (Mason-Jones and Towill, 1998)
Figure 3 – Simplified QSAM process flow
Figure 4 – SC Maturity in Australia
<table>
<thead>
<tr>
<th>Company</th>
<th>Data collection</th>
<th>Value adding activities</th>
<th>Researcher Days</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distributor</td>
<td>Nov. 2013</td>
<td>design, engineering, procurement, assembly, distribution</td>
<td>42</td>
</tr>
<tr>
<td>Printing House</td>
<td>Dec. 2013</td>
<td>plating, printing, folding, stitching</td>
<td>42</td>
</tr>
</tbody>
</table>

*Table 1 - Data collection overview*
<table>
<thead>
<tr>
<th>Common Barriers</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lack of policy and procedure</td>
<td>Despite both companies being ISO9000 certified; the companies did not have well documented policies and procedure in place for their core processes. High levels of tacit knowledge remain.</td>
</tr>
<tr>
<td>Lack of key performance indicators</td>
<td>Little process outcome measures were present. Moth decisions were based on gut feeling.</td>
</tr>
<tr>
<td>High level of fire fighting</td>
<td>Strong problem solving mentality in place; however root causes seldom tackled.</td>
</tr>
<tr>
<td>Poor strategic alignment</td>
<td>Different functions had different strategic goals pulling the companies in different directions and as in one case – pulling it apart.</td>
</tr>
</tbody>
</table>

*Table 2 – Commonly observed barriers*