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Theory and Practice of Procurement Flexibility: A Model for Suppliers and Manufacturers

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Abstract

This paper is designed to extend knowledge of flexibility in manufacturing supply chains through examination of procurement entity relationships, flexibility classifications and their commonalities as used by practitioners. Data were collected from procurement, supply chain, logistics and manufacturing managers in Australian companies in 17 Standard Industry Classification categories. The research findings suggest that Australian manufacturing organisations have not sufficiently integrated their manufacturing strategies with their organisational strategies and, more importantly, suppliers to manufacturers do not have sufficient flexibility in their supply activities. One limitation pertains to the possibility that targeted respondents may not have the assumed intimate knowledge of their organisation's procurement activities, or are biased regarding their view of the quality of the organisation's procurement performance. The major contributions of the study are the development of a definition of procurement flexibility (ProcFlex), a conceptual model for use as a benchmarking tool to measure procurement flexibility, and the presentation of an integrated model of ProcFlex for use by manufacturers and their suppliers to be more responsive and increase competitive advantage.

Introduction

In today's highly competitive manufacturing environment, it is critical that manufacturers have a regular supply of procured materials and components. Consequently, in order for suppliers to remain competitive and respond rapidly to environmental uncertainties, they require organisational and supply flexibility to respond in real time (Perry & Sohal, 1999; Chan, Bhagwat & Wadhwa, 2009). Researchers such as Upton (1994) and More and Babu (2009) contend that flexibility is multi-purposed to characterise different qualities and improve the process capabilities of a system. The concept of flexibility as critical is in line with research by Beamon (1999) who considers that uncertain environments require vital supply chain flexibility.

Similarly, Barnes-Schuster, Bassok and Anupindi (2002) argue that supplier flexibility enables buyers to respond to changes in the environment. This paper extends research into flexibility capability of suppliers to Australian manufacturers from the buyer's perspective and establishes manufacturer flexibility for contingency actions. Buyers, in this case, are Australian manufacturers who are also the research respondents.

Strategic alliances with suppliers improve competitiveness and enhance competitive advantage; however, alliances do not necessarily provide flexibility or certainty in ensuring constant supply of materials in real time. Therefore, developing and maintaining a responsive flexibility could be the difference between the survival and the demise of a firm and the continued survival of other entities in the supply chain network.

Wadhwa, Mishra and Saxena (2007) and Chandra and Grabis (2009) promote the idea that the best forms of response strategy to uncertainties in manufacturing are flexibility and agility, as shown by Harris *et al.* (1999) in Quick Response research and by Perry *et al.* (1998) in Efficient Customer Response studies. Other researchers suggest that the future of business competition will be between supply chains rather than between individual companies or brands (Christopher & Ryals, 1999). Consequently, it appears that for supply chain networks to achieve a high level of competitive advantage, they need to develop the capacity to respond the quickest.

Supply chain networks, however, are complex and supply chain flexibility is even more complex and multi-dimensional (Garavelli, 2003) with both factors adding to the problem of identifying appropriate flexibility dimensions. Each supply chain network consists of several independent entities whose corporate objectives and goals are secular, creating a conflict of objectives which leads to: delays; excessive or lack of inventories; uncertainty in production capacity/capability; distribution problems; wasted resources, and, finally, poor service to the network customer. Also, the level of complexity reduces coordination activities among entities and constricts flexibility.

Because of these complexities, the researchers focussed specifically on supplier-buyer procurement flexibility (ProcFlex) activities where the buyer is the manufacturer and the suppliers are first-tier suppliers and the supplier-buyer relationship role is repeated along the supply chain between every entity in the network. All entities along a supply chain buy, value add and sell. Although some activities between various supply chain entities may be different and independent of each other, the desirable ProcFlex dimensions and elements remain the same. Therefore, the supplier-buyer dimensions and elements are repeated along the supply chain but, in different situations, are exposed to sundry environmental uncertainties.

In addition, the current research was narrowed to ProcFlex in manufacturing and has proposed a generalisable model for use in measuring ProcFlex in any environment or situation in the economy. An extant literature search produced very few publications that promote ProcFlex, though one example is Aprille, Garavelli and Giannoccaro (2005) who conclude that ProcFlex contributes to supply chain flexibility

and provides supply chain performance. Another is Swafford, Ghosh and Murthy (2006) who believe that in order to achieve ProcFlex a firm must understand and maximise its options in terms of materials and quality of services such as delivery, quantity and lead time.

There is, however, insufficient research in the Australian manufacturing sector in terms of supplier capabilities or procurement activities. The current research was developed to fill that gap by identifying the various constraints and shortcomings in strategic procurement activities of Australian manufacturers.

Background of Procurement Flexibility

Although strategic procurement management has been promulgated as an effective business approach (Cox, 1996) and a necessary business strategy in many organisations (Tassabehji & Moorhouse, 2008), the constant changes in customer preferences are forcing manufacturers to change their procurement sources, find new suppliers or encourage their suppliers to develop flexible supply attributes. Not only is flexibility in supply activities essential, it is also necessary to understand, define and identify its meaning and capability. Gupta and Goyal (1989) believed that a single all-encompassing identification of flexibility remained to be developed, and two decades later the argument remains current (Gong, 2008). Researchers like Crum *et al.* (1998) and Jarrell (1998) agree that good generalisable measures of flexibility have been inadequate and that there is a lack of established measures of flexibility in procurement relationships.

The present paper narrows the identified gap by proposing a generalisable concept of ProcFlex. The theoretical underpinnings of the flexibility concept are examined and used to define and identify dimensions of ProcFlex and its practical responses to supply uncertainty.

Confusing definitions and different meanings have been attached to the term procurement. Lysons and Farrington (2006) define procurement as 'the process of obtaining goods or services in any way, including borrowing, leasing and even force and pillage' (p. 6). This sounds primitive. They contend that procurement is a wider term than purchasing, unlike Van Weele (2005) who considers that procurement is the function of purchasing raw materials, supplies and other consumables. An alternative view is provided by Burt, Dobler and Starling (2003) who suggest that 'the terms purchasing and procurement are used interchangeably although somewhat imprecisely' (p. 23). In a similar way, and more recently, Waters (2009) provides a more simplistic definition that 'procurement is responsible for acquiring all materials needed by an organisation' (p. 304) and that procurement consists of activities to get the goods and services into the organisation from suppliers. A slightly different approach is taken by Baily *et al.* (2008) who provide a comprehensive explanation of the procurement cycle that explains all the activities required for the procurement of goods and services rather than a single, specific definition.

Research Objectives

Although supply chain management entails management of the supply chain from end to end, the current authors contend that it is difficult to conduct research on supply chains from the initial raw materials stage to the final stage of the manufactured goods due to the occurrence of complexities resulting from most current supply chains having global, national or inter-state elements. Moreover, supply chains transcend several market economies, industry sectors, jurisdictions, legal systems, geographical conditions and so on, with each supply chain consisting of many independent entities required to act cooperatively and interdependently.

The independence of supply chain entities make it difficult, if not almost impossible, to manage the overall supply chain efficiently or effectively. Each entity has its own corporate goals and strategic plans for survival that do not necessarily incorporate the interests of other entities or create synergy with them. Hence, there is no one single, responsible or accountable owner along any supply chain able to manage the buy/value-add/sell activities within their own purview.

Since a supply chain transcends different market economies and industry sectors, the external economic influences impacting upon it at various stages are different and result in varied outcomes. The complexity and dynamism of economic influences on the supply chain suggest that investigating activities between two supply chain entities has more value and robustness for academics and practitioners. Consequently the authors propose the idea of investigating and creating a generalisable framework for ProcFlex—a framework that may be applicable at any stage of a supply chain and between any two adjacent entities along it.

Literature Review

Due to the lack of published literature on ProcFlex, process-based operational flexibility literature was investigated. A high percentage of this literature was based on supply chain and manufacturing flexibility. Extant research indicated that supplier and strategic integration were important components in supply chain strategies, and so the components were used in the development of the current survey instrument. The Li and Qi (2008) framework for assessing supply chain flexibility suggested three aspects of flexibility were identifiable: robustness, self-adaptability and network alignment. Also identified were five components of supply chain flexibility—operations, logistics, information, network and supply—which were included as part of the current survey. Added to the current research framework were the components of time dimension (especially lead time) as a critical concept in the environment of competitive advantage, as was the first to market concept (Handfield & Bechtel, 2002).

Although entities along a supply chain may not be streamlined towards the end customer, time-based competition does provide a certain amount of synergy (Askenazy *et al.*, 2006; Thomas, 2008). Entities along a supply chain need to deliver their products in a timely fashion even where they are not optimally connected to all other entities in

the supply chain. Kotler (1989) and Kotha (1995) noted that increasing demand for product variety and customisation, shortened product life cycles and expanding industrial competition require a more highly flexible manufacturing strategy. They also make procurement time a critical flexibility dimension.

Contemporary research indicates similar trends to Skinner's 1969 research which identified that organisations fail to integrate their organisational strategies with their manufacturing strategies. Furthermore, Fisher *et al.* (1997) supported Skinner's (1969) contention that most manufacturers do not tailor their production systems to performance tasks which are critical to corporate success. Fisher *et al.* (1997) also found that manufacturing supply chain management was inefficient because of the mismatch between production strategy and supply chain strategy. More recently, Swink *et al.* (2005) found that high levels of strategy integration are needed to complement effective manufacturing practices.

Existing research on internal operational aspects of Australian manufacturing firms has not addressed the linking of manufacturing strategy with procurement strategy. Rather, it has primarily focused on manufacturing quality, competitiveness and performance (with many publications now outdated) or on logistics, supplier relations, performance and quality, indicating similar non-congruent strategies in manufacturing (Kiridena, Hasan & Kerr, 2009). As a consequence, the current research has hypothesized that Australian organisations have not streamlined nor integrated their supply chain strategy with their organisational strategy.

The point has been made that for a supply chain to have total flexibility from end to end, all the entities and links along the chain—the operational activities of Source Make Deliver of and between entities—must be flexible (Garavelli, 2003). Given Garavelli's (2003) identification of source as the starting point of procurement activities, sourcing performance metrics such as scheduling, information exchange, delivery, process integration, organisational strategy, transportation and sourcing (Lockamy & McCormack, 2004) were used in the study.

Although many businesses have adopted world's best practices in manufacturing (Perry & Sohal, 1999; Sohal *et al.*, 1999; Samson & Ford, 2000; Beaumont, 2005; Quesada-Pineda & Gazo, 2007; Boyle & Scherrer, 2009; Gurumurthy & Kodali, 2009), that itself is considered insufficient as procurement best practices are also necessary. Therefore, it is timely that the advantages of ProcFlex are evaluated and used to further enhance their competitive edge.

In a study of value chain agility, Swafford, Ghosh and Murthy (2006) conclude that for manufacturing to benefit there must be ProcFlex because manufacturing flexibility correlates strongly with ProcFlex. Thus, their procurement determinants of lead time, capacity, contracts, order sizes and quantity were used in the current research.

Extant literature on manufacturing strategies has focused only on manufacturing process and seldom ventured outside manufacturing firms. Some literature has linked competitiveness with manufacturing strategy, but little research links strategy with procurement activities. A study by Hodgson *et al.* (1998) found the trends of shortening product life cycle and increasing complexity of product components required greater agility as well as higher procurement skills in partnerships and alliances. Therefore, the current study was designed to link manufacturing strategy with procurement activities.

Definition of Procurement Flexibility

Due to the lack of published literature on procurement and manufacturer relationship flexibility, the authors have applied manufacturing flexibility knowledge to the supplier-buyer procurement concept since both have similar process-based activities. An external supply chain is similar to internal business processes between departments. Beach *et al.* (2000) suggested that manufacturing flexibility remains in the realm of operations management and is closely associated with process technology. Similarly, the researchers felt that the same theoretical constructs may be applied in the procurement arena which is very process-orientated and adopts classifications related to operational relationships.

A comprehensive review of manufacturing flexibility literature was undertaken vis-a-vis the overall supply chain system, including definitions, objectives, general principles and properties of flexibility. In various modes, flexibility has been defined as reflecting an organisation's ability to respond to changes (Gupta & Goyal, 1989; Upton, 1995; Kumar *et al.*, 2006) as a reactive strategy to environmental uncertainty (De Meyer, 1989; Suarez *et al.*, 1995) and as a multi-dimensional concept (Sethi & Sethi, 1990; Upton, 1994). However, Evans (1991) and DeLeeuw and Volberda (1996) have dissenting views and conclude that the meaning of flexibility is still ambiguous.

While flexibility has been described as a capability or ability or reactive action (Upton, 1995; DeLeeuw & Volberda, 1996; Monteiro & Macdonald, 1996), in this paper it is assumed these attributes are a strategic reaction. Flexibility has also been viewed as polymorphous with different meanings and contexts (Evans, 1991) so it is difficult to provide a fixed definition for flexibility to fit all scenarios and situations. Thus, the definition of ProcFlex is considered situation-dependent necessitating a generalisable framework applicable to any stage along a supply chain.

Due to the lack of a precise definition, in this paper ProcFlex is:

> *the ability to respond strategically to changing internal and external environments to ensure that the sourcing, purchasing and supply of raw materials, components and parts are continuous, to sustain the value adding process.*

Procurement Activities

Relevant activities of procurement include sourcing, purchasing and receiving. Sourcing includes identifying required materials, specifying requirements, identification of suppliers, supplier selection, item search, item selection, requisition approval, quality verification and contract development. Purchasing includes order generation, information exchange, scheduling, order variation, contract negotiation, order tracking, pricing, transportation, supplier integration and transit storage. Receiving includes logistics, docking, warehousing, inventory, invoicing, checking, payment and sometimes reverse logistics and faulty returns.

Other strategic procurement elements which have an overall impact on procurement activities but which are not part of the focus of the paper are transaction costs analysis, spend analysis, total cost analysis, category management, forecasting, procurement ethics, governance, risk management, sourcing strategy, procurement strategy, partnerships, alliances, green procurement, outsourcing, information systems, product development, tender and organisational structure. It is suggested that these elements provide an opportunity for future research, especially in the Australian environment.

The current research focused only on the suppliers' physical activities for maintaining the continuous supply of materials and which are directly related to the manufacturing process. This approach identifies activities linked to supplied materials' attribute modification, information management, supplier attributes, delivery flexibility, logistics and manufacturers' organisational strategy.

Procurement Flexibility Dimensions

Manufacturing flexibility literature indicates that discussion of flexibility contains a very large number of dimensions and elements and can, therefore, be considered multi-dimensional. A summary of flexibility dimensions found in literature includes range, cost, time, mobility, uniformity, adaptability, heterogeneity and ease. Based on pilot research through personal interviews with practitioners and on examination of research findings, the authors adopted the three flexibility dimensions (Slack, 1987) of range, uniformity and mobility. Within these three dimensions, the constructs of range, quality, time, ease and cost were noted as critical in the pilot research interviews with practitioners and measurement items derived for each of the constructs.

Range was used to measure the: flexibility constructs of a physical number of products, components and sub-assemblies; number of spare inventory; choice of alternate routes; size of goods; strategic plan; and amount of information exchange. Uniformity was used to measure constructs with the same level of quality and time taken consistent within all levels of mobility. The uniformity constructs consisted of: criticality, accuracy, reliability and timeliness of information exchanges; component materials of consistent quality; modified product components; new product design; time taken to implement product design changes; capability of short delivery schedule

changes; supplier switching; changes in routes or transportation costs; and backup strategies. Mobility was used to measure the flexibility constructs of capability of easiness and cost within that range and uniformity. The mobility construct consisted of: compatibility information of management platforms; information exchange and human intervention; easy and cheap exchange of procurement information; new components and materials; design changes and product mixes; change to different suppliers; modification of transportation routes; organisational strategy; and responses.

Research Methodology

The major objective of the research was to evaluate flexibility capabilities of the suppliers for Australian manufacturers. The Dun and Bradstreet (2005) database was accessed to evaluate suitable respondents. A variety of manufacturing firms was included in the study. A postal survey, using a 7-point Likert scale, was used to provide an appropriately large sample size of responses because it was faster, cheaper and able to target a selective sample reflective of the identified population. The manufacturing firms represented 17 Standard Industry Classification (SIC) groups within the manufacturing sector and the SIC code was derived from Dun and Bradstreet's (2005) *Business Who's Who of Australia* database. The number of respondents and their SIC codes are listed in Table 1.

The research format was designed in accordance with Churchill's (1979) paradigm for developing better measures of scale development and content validity. Interviews (in the form of a focus group) of procurement managers, practitioners and manufacturing managers were used to generate, test and purify scale items of the constructs.

Due to limited published literature on procurement dimensions, elements and their flexibility, it was decided to conduct preliminary research. From operations management, supply chain management and strategic management literature, 352 questions regarding supplier relationships in the manufacturing sector were compiled. From this list, duplication questions were filtered out. Only those questions pertaining directly to supplier-buyer operational relationships were retained, resulting in 156 items. Face-to-face interviews with practitioners and academics were used to further consolidate the survey instrument which was reduced to 94 items. These were then subjected to the Q-sort technique (Sachs, 2000; Wright & Mechling, 2002) and 15 industry practitioners and consultants in the logistics and procurement area further refined the instrument. Finally, the Q-sort technique provided 57 items which were used in the design of the postal survey instrument.

The Q-sort technique was deemed appropriate to match proposed items with suitable flexibility elements, having been proven to be effective in investigating differences between people and in testing theories on small sets of individuals carefully chosen for their knowledge, mostly in psychometric research (Ozer, 1993; Sachs, 2000), health studies (Stenner *et al.*, 2003), marketing (Ekinci & Riley, 1999;

Rosenbaum, Ostrom & Kuntze, 2005), health (Cross, 2005; Baker, Thompson & Mannion, 2006) and operations management (Koste & Malhotra, 2000; Thomas & Watson, 2002). Q-sort technique was deemed to provide a practical perspective on the Australian manufacturing industry's procurement experience and made the survey questions more relevant to respondents.

Table 1: Standard Industry Classification Codes and Responses

SIC code	Industry	Cases	Percentage
34	Fabricated metal products	55	19.6
20	Food and kindred products	50	17.8
28	Chemicals and allied products	27	9.6
35	Industrial and commercial machinery	21	7.5
36	Electronic and electrical equipment	21	7.5
30	Rubber and misc. plastics	18	6.4
32	Stone, clay, glass and concrete products	12	4.3
33	Primary metal industries	12	4.3
24	Lumber and wood products	12	4.3
37	Transport equipment	11	3.9
25	Furniture and fixtures	10	3.6
26	Paper and allied products	10	3.6
27	Printing, publishing industry	10	3.6
31	Leather and leather products	4	1.4
38	Measuring analysing and controlling equipment	3	1.1
39	Pharmaceutical products	3	1.1
40	Textile products	1	0.3
	TOTAL	**280**	**99.9**

Source: Original table.

In-depth information was sought with regards to a firm's procurement characteristics. This data were not publicly available so a postal survey approach was used to collect responses. The difficulty of obtaining confidential quantitative data such as cost or time estimates meant respondents were requested to provide general descriptive information and answer questions using a 7-point Likert scale (1 = low to 7 = high) based on capabilities, abilities and performance of the suppliers. Although face-to-face and telephone interviews can provide complete and more accurate data, it is much more costly and time consuming (Forza, 2002). Owing to the number of questions, sample size and likely telephone charges, a postal survey was selected using prepaid return envelopes.

Basic univariate analysis established the distribution of respondents, categories of SIC classification, respondents' positions, type of business, annual sales, industry type,

number of employees and company profile. Multivariate analysis tested whether there were distinct groupings on non-metric variables as a basis for identifying the respondents as leaders and laggers in ProcFlex capability. The survey data were also analysed using principal component analysis to identify the inter-relationships among the large number of variables explaining the common underlying dimensions.

Sampling Frame

Representative population samples were determined from the Dun and Bradstreet (2005) on-line database. Initial assessment of the database revealed more than 11,000 business registrations under the SIC codes. Therefore, to determine a manageable sampling framework, a few criteria were used. Since previous research publications indicated low responses in the area of operations management, a target list of 2,000 respondents was chosen.

The first criterion was that the procurement activities must be substantially large enough to warrant an investigation. Second, the targeted organisation must have a procurement manager/officer position with, at the least, a similar job description. Also, the annual procurement volume must be more than AUD10m with the organisation having more than 70 employees. It was assumed that the larger the procurement volume and activities, the less likely the bias or the guessing in responding to the questionnaire items.

Initial filtering reduced the likely sample to 2,083 companies. On detailed investigation and analysis, it was found that some companies were duplicated in multiple SIC codes and so these duplications were traced and deleted. On further analysis, it was found that some companies did not have their manufacturing base in Australia, so these were also deleted. The list was refined further with the final target of 1,300 companies in 17 SIC categories.

Personalised survey instruments were sent to position titles such as Procurement Manager, Supply Chain Manager, Logistics Manager, Manufacturing Manager and Purchasing Manager. One hundred and eighty-four follow-up telephone calls were made to randomly selected non-respondents to potentially increase response rates and determine whether non-respondents were different from respondents.

Assumptions and Limitations

It is acknowledged that there were limitations to the study. It was assumed the targeted respondents would have intimate knowledge of the procurement activities of their organisation. Nevertheless, they might be biased regarding their view of how their organisation performs, or might not be fully knowledgeable of procurement activities. Also, it is recognised that the 57 items in the questionnaire did not cover all the areas of procurement activities, nor are all Australian manufacturers registered on the Dun and Bradstreet (2005) database.

Determination of Procurement Flexibility

Initially, the five flexibility dimensions in the survey were examined in relation to the three elements of range, uniformity and mobility. The results in Table 2 show the extended five constructs of range, uniformity as quality and cost, and mobility in terms of ease and time. The higher the mean score, the greater the flexibility achieved by the 252 manufacturers. On the 7-point scale the means varied from 3.34 to 4.85; a close to average indication of flexibility.

Table 2: Mean Scores of Flexibility Characteristics

Flexibility Dimension	Element	Mean	Standard Deviation
Information Exchange	Range	3.98	0.91
	Quality	4.85	0.83
	Cost	3.34	1.26
	Ease	3.88	1.04
	Time	4.49	1.19
Supplier Integration	Range	4.48	1.39
	Quality	4.81	1.25
	Cost	3.67	1.69
	Ease	3.65	1.23
	Time	3.82	1.17
Materials/Components	Range	4.36	1.43
	Quality	4.53	1.14
	Cost	3.62	1.04
	Ease	3.70	1.09
	Time	3.55	1.11
Supplier Logistics	Range	4.25	0.96
	Quality	3.89	0.66
	Cost	3.67	1.19
	Ease	4.26	1.41
	Time	4.15	1.44
Organisation Structure	Range	4.41	1.02
	Quality	3.90	0.93
	Cost	4.17	0.61
	Ease	3.80	1.05
	Time	3.60	1.12

Source: Original table.

The main objective in the research was to determine a generalisable framework of ProcFlex. The objective was accomplished by using means of the 57 flexibility items from the survey instrument's 7-point Likert scale. ProcFlex was categorised into five levels of flexibility: extremely flexible, highly flexible, moderately flexible, low flexibility

and no flexibility (Table 3). The means value encompassed within each level of flexibility has been assigned somewhat arbitrarily and could be the subject of future research involving industries other than manufacturing to further test the suggested framework.

Table 3: Procurement Flexibility Scaling

ProcFlex value	Level of flexibility
6.00+	Extremely flexible
5.00–5.99	Highly Flexible
4.00–4.99	Moderately flexible
3.00–3.99	Low flexibility
<3.00	No flexibility

Source: Original table.

Data Analysis and Results

Of the 1,300 targeted respondents, 297 responses were received, 17 deemed unusable and 280 usable, resulting in a usable response rate of 21.5 percent. 104 were *returned to sender* due to the post box being closed or no longer at that address. This could mean that manufacturing operations had ceased or moved, or that the nomenclature of relevant procurement personnel had changed.

The valid data were analysed using univariate analysis, correlation analysis, multiple regression analysis and principal component analysis. The possibility of non-response bias was analysed by comparing early and late responses using a t-test and Levene's Test for equality of variances. No significant differences were found except for five items whose two-tailed sig. values were below 0.05. However, the mean difference for these five items did not show significant difference nor did the subsequent chi-square test. Since this was exploratory research, the researchers deemed that the difference was not large enough to affect the empirical nature of the research study. Cronbach's alpha score for internal consistency of more than 0.93 was regarded as highly reliable, especially as the general accepted lower limit is 0.7 and in exploratory studies 0.6 is acceptable (Hair *et al*., 1998).

Correlation Analysis

An analysis of the correlation strength showed that 0.8 percent of the correlation had an *r* value of more than 0.7 and that 83 percent of the correlation had an *r* value of less than 0.3. It was therefore concluded that there were no significant relationships between the 57 flexibility items. Four variables had negative correlations, all indicating that the cost would be too great for the supplier to modify routes, implement strategies, extend flexibility and increase responsiveness.

Multivariate Analysis

Multivariate analysis was used to establish causality and determine the operationalisation of ProcFlex. Due to the exploratory nature of the research, multiple regression was used first followed by principal component analysis. The variables in the five dimensions were subjected to multicollinearity, outlier, normality, homoscedacity and independence of residuals testing. The model of the five dimensions appeared both accurate and generalisable to the population. Principal component analysis (PCA) was used because multivariate analysis did not fully explain all the results and objectives of the research. PCA also identified the empirical structure of relationships among the 57 variables in the flexibility framework.

A scree plot extraction using Kaiser's criterion, with an eigenvalue of more than 1.0, revealed 15 components which explained 71.3 percent of the variance. Based on the Hair *et al.* (1998) recommendation that each component should have at least four or five variables, a forced extraction of eight components was applied. This was conducted with varimax rotation suppressing absolute values less than 0.3 for better visual representation.

Close analysis of the eight components revealed that there may be eight dimensions to ProcFlex rather than the five dimensions initially proposed by the researchers. The 57 flexibility items did not group together as initially thought and under PCA they grouped differently. Therefore, the 57 items were converted into eight new dimensions of ProcFlex with their own individual attributes, as tabulated in Table 4.

Table 4: Dimensions of New ProcFlex Model

	Dimension	Elements
1	Product Mix	Product design and modification
2	Information Management	Information exchange accuracy and reliability
3	Organisational Response	Organisational structure
4	ERP System	Connectivity, compatibility and automation
5	Supplier Inventory	Capability, capacity and quality
6	Routing and Logistics	Selection and modification
7	Supplier Selection	Time ease and changeover cost
8	Procurement Costs	Implementation and risk

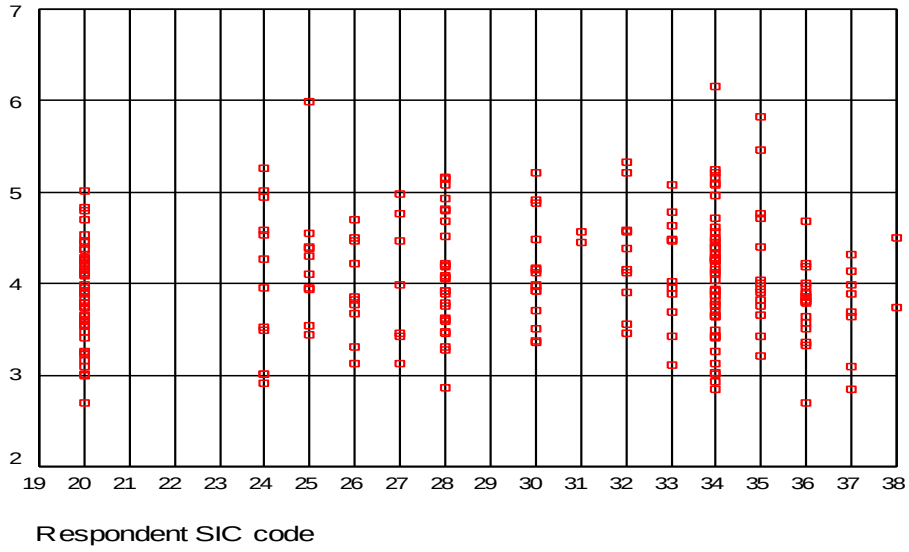
Source: Original table.

Industry Leaders and Laggers

The present researchers decided to determine whether or not there were any patterns among manufacturing leaders and laggers and their capability of ProcFlex within the Australian manufacturing industry sector. The major aim was to determine which industry supplier had the highest level of ProcFlex. Figure 1 shows a plot of

supplier flexibility level against SIC codes to differentiate the flexibility capabilities among different manufacturing categories. The flexibility was categorised into five levels. The highest category was extremely flexible with a ProcFlex value of 6.00 and above. Highly flexible, with a ProcFlex between 5.00 and 5.99, was the next level followed by moderately flexible with a ProcFlex between 4.00 and 4.99. Low flexibility was attributed to those cases with a ProcFlex value between 3.00 and 3.99. Cases with a ProcFlex less than 3.00 were considered as having no flexibility. SIC codes with less than five cases were removed from the analysis.

Figure 1: ProcFlex - Leaders and Laggers



Source: Original figure.

There was only one case which was scaled as being extremely flexible with a ProcFlex value of more than 6.00. This case was from the Fabricated Metals Products Industry (SIC 34). In the highly flexible category (ProcFlex value 5.00–5.99) there were a total of 19 cases, most of which were from the Fabricated Metals Products Industry. Others were in the Chemical and Allied Industry (SIC 28), Lumber and Wood Products Industry (SIC 24), Stone, Clay, Glass and Concrete Industry (SIC 32) and Industrial and Commercial Machinery Industry (SIC 35). The moderately flexible category, with ProcFlex values between 4.00 and 4.99, had 95 cases, mostly in the Fabricated Metal Products and Food and Kindred Products Industries (SIC 20). The low flexibility cases numbered 116, with most in the Fabricated Metal Products and Food and Kindred Products Industries. The remaining eight cases reported as having no flexibility.

Extremely and highly flexible procurement cases (5.00+) were considered leaders, with laggers having a mean less than 3.00. From Figure 1 there did not seem to be any

distinct leaders or laggers in ProcFlex. ProcFlex capabilities were spread evenly across all industries in the moderate and low flexibility scales, suggesting that, overall, there is very little range in flexibility among suppliers to Australian manufacturing industries.

Conclusion

Although many articles are published by both practitioners and academics on collaboration efforts between suppliers and buyers, there is still a lack of empirical research regarding ProcFlex dimensions and how they fit into the overall supply chain strategy. In this paper, an integrated conceptual model for measuring ProcFlex has been presented. ProcFlex dimensions and elements have been identified, thereby filling the identified knowledge gap. The research also confirms Skinner's (1969) identification of organisations not integrating their manufacturing and organisational strategies nor tailoring them to performance tasks that are critical for corporate success.

Results from this research have provided important insights into a practical model of flexibility which highlights the necessity to increase the understanding of ongoing procurement activities within a supply chain network. The researchers realise that further research and data collection are required to keep improving and developing the model. Similarly, it is suggested that the model could be tested on other types of Australian industry.

As manufacturing firms generate supply chain management strategies, procurement flexibility will continue to play a major role in the relationships between the different entities in the supply chain network. The success of procurement flexibility measurement and its implementation will lead to the creation of synergies among the various entities in a supply chain network and streamline their activities towards the common consumer at the end of the supply chain.

References

Albino, V. and Garavelli, A.C. (1998) Some effects of flexibility and dependability on cellular manufacturing system performance. *Computers and Industrial Engineering*, 35 (3-4) pp 491-4.

Askenazy, P., Thesmar, D. and Thoenig, M. (2006) On the relation between organisational practices and new technologies: The role of (time-based) competition. *The Economic Journal*, 116 pp 128-54.

Aprille, D., Garavelli, A.C. and Giannoccaro, I. (2005) Operations planning and flexibility in a supply chain. *Production Planning and Control*, 16 (1) pp 21-31.

Baily, P., Farmer, D., Crocker, B., Jessop, D. and Jones, D. (2009) *Procurement Principles and Management (10th Edition)*. Prentice Hall, Essex.

Baker, R., Thompson, C. and Mannion, R. (2006) Q methodology in health economics. *Journal of Health Services Research and Policy*, 11 (1) pp 38-45.

Barnes-Schuster, D., Bassok, Y. and Anupindi, R. (2002) Coordination and flexibility in supply contracts with options. *Manufacturing and Service Operations Management*, 4 (3) pp 171-207.

Beach, R., Muhlemann, A.P., Price, D.H.R., Paterson, A. and Sharp, J.A. (2000) Manufacturing operations and strategic flexibility: Survey and cases. *International Journal of Operations and Production Management*, 20 (1) pp 7-30.

Beamon, B.M. (1999) Measuring supply chain performance. *International Journal of Operations and Production Management*, 19 (3) pp 275-92.

Beaumont, N. (2005) Best practice in Australian manufacturing sites. *Technovation*, 25 pp 1291-7.

Boyle, T.A. and Scherrer-Rathje, M. (2009) An empirical examination of the best practices to ensure manufacturing flexibility: Lean alignment. *Journal of Manufacturing Technology Management*, 20 (3) pp 348-66.

Burt, D.N., Dobler, D.W. and Starling, S.L. (2003) *World Class Supply Management - The Key to Supply Management (7th Edition)*. McGraw-Hill Irwin, New York, NY.

Chan, F.T.S., Bhagwat, R. and Wadhwa, S. (2009) Study on suppliers' flexibility in supply chains: Is real-time control necessary? *International Journal of Production Research*, 47 (4) pp 965-87.

Chandra, C. and Grabis, J. (2009) Role of flexibility in supply chain design and modelling. Introduction to the special issue. *Omega*, 37 pp 743-5.

Christopher, M. and Ryals, L. (1999) Supply chain strategy: Its impact on shareholder value. *The International Journal of Logistics Management*, 10 (1) pp 1-10.

Churchill, G.A. (1979) A paradigm for developing better measures of marketing constructs. *Journal of Marketing Research*, 16 pp 64-73.

Cox, A. (1996) Relational competence and strategic procurement management. *European Journal of Purchasing and Supply Management*, 2 (1) pp 57-70.

Cross, R.M. (2005) Exploring attitudes: The case for Q methodology. *Health Education Research*, 20 (2) pp 206-13.

Crum, M.R., Johnson, D.A. and Allen, B.J. (1998) A longitudinal assessment of EDI use in the US motor carrier industry. *Transportation Journal*, 38 (1) pp 15-28.

DeLeeuw, A. and Volberda, H. (1996) On the concept of flexibility: A dual control perspective. *Omega, International Journal of Management Science*, 24 (2) pp 121-39.

DeMeyer, A., Nakane, J., Miller, J.G. and Ferdows, K. (1989) Flexibility: The next competitive battle - the manufacturing futures survey. *Strategic Management Journal*, 10 pp 135-44.

Dun and Bradstreet. (2005) *Business Who's Who of Australia* - User Guide, Dun and Bradstreet Marketing Pty Ltd. Available at: <http://www.library.uow.edu.au/eresources/databases>

Ekinci, Y. and Riley, M. (1999) Measuring hotel quality: Back to basics. *International Journal of Contemporary Hospitality Management*, 11 (6) pp 287-94.

Evans, J.S. (1991) Strategic flexibility for high technology manoeuvres: A conceptual framework. *Journal of Management Studies*, 28 (1) pp 69-89.

Fisher, M., Hammond, J., Obermeyer, W. and Raman, A. (1997) Configuring a supply chain to reduce the cost of demand uncertainty. *Production and Operations Management*, 6 (3) pp 211-25.

Forza, C. (2002) Survey research in operations management: A process based perspective. *International Journal of Operations and Production Management*, 22 (2) pp 152-94.

Garavelli, A.C. (2003) Flexibility configurations for the supply chain management. *International Journal of Production Economics*, 85 pp 141-53.

Gong, Z. (2008) An economic evaluation model of supply chain flexibility. *European Journal of Operational Research*, 184 pp 745-58.

Gupta, Y.P. and Goyal, S. (1989) Flexibility of manufacturing systems: Concepts and measurements. *European Journal of Operational Research*, 43 pp 119-35.

Gurumurthy, A. and Kodali, R. (2009) Application of benchmarking for assessing the lean manufacturing implementation. *Benchmarking: An International Journal*, 16 (2) pp 274-308.

Hair, J.F., Anderson, R.E., Tatham, R.L. and Black, W.C. (1998) *Multivariate Data Analysis*. Prentice Hall International, Upper Saddle River, NJ.

Handfield, R.B. and Bechtel, C. (2002) The role of trust and relationship structure in improving supply chain responsiveness. *Industrial Marketing Management*, 31 (4) pp 367-82.

Harris, J.K., Swatman, P.M.C. and Kurnia, S. (1999) Efficient consumer response (ECR): A survey of the Australian grocery industry. *Supply Chain Management*, 4 (1) pp 35-42.

Hodgson, A., Li, G. and Weston, R.H. (1998) Manufacturing strategies and next century enterprises. *International Journal of Business Performance Management*, 1 (1) pp 90-109.

Jarrell, J.L. (1998) Supply chain economics. *World Trade*, 11 (11) pp 58-61.

Kiridena, S., Hasan, M. and Kerr, R. (2009) Exploring deeper structures in manufacturing strategy formation processes: A qualitative inquiry. *International Journal of Operations and Production Management*, 29 (4) pp 386-417.

Koste, L.L. and Malhotra, M.K. (2000) Trade-offs among the elements of flexibility: A comparison from the automotive industry. *Omega*, 28 pp 693-710.

Kotha, S. (1995) Mass customization: Implementing the emerging paradigm for competitive advantage. *Strategic Management Journal*, 16 (Summer) pp 21-42.

Kotler, P. (1989) From mass marketing to mass customization. *Planning Review*, 17 (5) pp 10-13.

Kumar, V., Fantazy, K.A., Kumar, Y. and Boyle, T.A. (2006) Implementation and management framework for supply chain flexibility. *Journal of Enterprise Information Management*, 19 (3) pp 303-19.

Li, Q. and Qi, Y. (2008) A framework for assessing supply chain flexibility. *International Conference on Information Management, Innovation Management and Industrial Engineering 2008*. IEEE Xplore, pp 12-15.

Lockamy III, A. and McCormack, K. (2004) Linking SCOR planning practices to supply chain performance: An exploratory study. *International Journal of Operations and Production Management*, 24 (11-12) pp 1192-218.

Lysons, K. and Farrington, B. (2006) *Purchasing and Supply Chain Management (7th Edition)*. Prentice Hall, London.

Monteiro, L. and Macdonald, S. (1996) From efficiency to flexibility: The strategic use of information in the airline industry. *Journal of Strategic Information Systems*, 5 pp 169-88.

More, D. and Babu, A.S. (2009) Analysis of the dynamics between supply chain flexibility and key management ratios. *International Journal of Business Innovation and Research,* 3 (2) pp 199-227.

Ozer, D.J. (1993) The Q-sort method and the study of personality development. In D.C. Funder, R.D. Parker, C. Tomlinson-Keasey and K. Widaman (Eds) *Studying Lives Through Time: Personality and Development*. American Psychological Association, Washington, DC.

Perry, M. and Sohal, A.S. (1999) Improving service quality within the supply chain: An Australian Study. *Total Quality Management*, 10 (4-5) pp 673-9.

Perry, M., Sohal, A.S. and Rumpf, P. (1998) Quick response supply chain alliances in the Australian textiles, clothing and footwear industry. Faculty of Business and Economics, Monash University, Melbourne.

Quesada-Pineda, H. and Gazo, R. (2007) Best manufacturing practices and their linkage to top-performing companies in the US furniture industry. *Benchmarking: An International Journal*, 14 (2) pp 211-21.

Rosenbaum, M.S., Ostrom, A.L. and Kuntze, R. (2005) Loyalty programs and a sense of community. *Journal of Services Marketing*, 19 (4) pp 222-33.

Sachs, J. (2000) Using a small sample Q-sort to identify item groups. *Psychological Reports*, 86 pp 287-94.

Samson, D. and Ford, S. (2000) Manufacturing practices and performance: Comparisons between Australia and New Zealand. *International Journal of Production Economics*, 65 pp 243-55.

Sethi, A.K. and Sethi, S.P. (1990) Flexibility in manufacturing: A survey. *The International Journal of Flexible Manufacturing Systems*, 2 (4) pp 289-328.

Skinner, W. (1969) Manufacturing - Missing link in corporate strategy. *Harvard Business Review*, 3 pp 136-44.

Slack, N. (1987) The flexibility of manufacturing systems. *International Journal of Operations and Production Management*, 7 (4) pp 35-45.

Sohal, A.S., Gordon, J., Fuller, G. and Simon, A. (1999) Manufacturing practices and competitive capability: An Australian study. *Technovation*, 19 (5) pp 295-304.

Stenner, P.H.D., Cooper, D. and Skevington, S.M. (2003) Putting the Q into quality of life: The identification of subjective constructions of health-related quality of life using Q methodology. *Social Science and Medicine*, 46 pp 1569-85.

Suarez, F.F., Cusumano, M.A. and Fine, C.H. (1995) An empirical study of flexibility in manufacturing. *Sloan Management Review*, 37 (1) pp 25-32.

Swafford, P.M., Ghosh, S. and Murthy, N.N. (2006) A framework for assessing value chain agility. *International Journal of Operations and Production Management*, 26 (2) pp 118-40.

Swink, M., Narasimhan, R. and Kim, S.W. (2005) Manufacturing practices and strategy integration: Effects on cost efficiency, flexibility, and market-based performance. *Decision Sciences*, 36 (3) pp 427-57.

Tassabehji, R. and Moorhouse, A. (2008) The changing role of procurement: Developing professional effectiveness. *Journal of Purchasing and Supply Management*, 14 (1) pp 55-68.

Thomas, R. (2008) Exploring relational aspects of time based competition. *International Journal of Physical Distribution and Logistics Management*, 38 (7) pp 540-50.

Thomas, D.M. and Watson, R.T. (2002) Q-Sorting and MIS Research: A primer. *Communications of the Association for Information Systems*, 8 pp 141-56.

Upton, D.M. (1994) The management of manufacturing flexibility. *California Management Review*, 27 (4) pp 72-89.

Upton, D.M. (1995) What really makes factories flexible? *Harvard Business Review*, 73 (4) pp 74-84.

Van Weele, A. (2005) *Purchasing and Supply Chain Management: Analysis, Strategy, Planning and Practice (4th Edition)*. Thomson, London.

Wadhwa, S., Mishra, M. and Saxena, A. (2007) A network approach for modelling and design of agile supply chains using a flexibility construct. *International Journal of Flexible Manufacturing Systems*, 19 pp 410-42.

Waters, D. (2009) *Supply Chain Management - An Introduction to Logistics (2nd Edition)*. Palgrave MacMillan, London.

Wright, C.M. and Mechling, G. (2002) The importance of operations management problems in service organizations. *Omega, The International Journal of Management Science*, 30 pp 77-87.

Yamin, S., Gunasekaran, A. and Mavondo, F.T. (1999) Relationship between generic strategies, competitive advantage and organisational performance: An empirical analysis. *Technovation*, 19 (8) pp 507-18.