School of Management

Procurement Dimensions in the Australian Manufacturing Sector: Flexibility Issues in a Supply Chain Perspective

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Declaration

This thesis contains no material which has been accepted for the award of any other degree or diploma in any university.

To the best of my knowledge and belief this thesis contains no material previously published by any other person except where due acknowledgment has been made.

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ABSTRACT

The manufacturing sector is a highly dynamic environment subject to continuous change and environmental uncertainty as parts, components and materials are procured and sourced globally. To be competitive, manufacturers must respond to such uncertainties rapidly and with the greatest flexibility in order to procure and maintain the supply of raw materials resources to sustain their manufacturing operations. Thus, the understanding and measuring of the procurement flexibility are key steps in maintaining a competitive advantage. So, the present study examined the theoretical concepts of procurement flexibility and proposed a generalisable measurement scale for manufacturing procurement flexibility. The scale was based on five supplier-manufacturer procurement dimensions of information exchange, supplier integration, product and component delivery, logistics and organisational structure. Further, each of these dimensions was divided into three flexibility elements of range, uniformity and mobility.

A measurement scale was developed from a review of extant literature on flexibility relationships, purchasing, procurement and supply chain management using Q-Sort methodology. A mail survey of the major industry groups in the Australian manufacturing industry was undertaken. Principal component analysis and multiple regressions were used to examine the relationships between the flexibility dimensions and their elements.

The results indicate that there is still much theory formulation and research to be conducted on procurement flexibility measurement scales. The results also revealed that Australian manufacturers have a limited experience with the flexibility issue and in some cases do not have even a procurement strategy. These results provide important practical information and establish a range of relevant implications for the Australian manufacturing sector and its future competitiveness. This study also provides a basis for the continued development and distillation of procurement flexibility measures.

One of the interesting outcomes of the Supplier Manufacturer Procurement Flexibility (ProcFlex) dimensions and the implication for overall Supply Chain Management (SCM) objectives and strategies is that ProcFlex is cumulative. Any inflexibilities and constrictions, like excess and lack of inventory, in procurement activities is accumulated and increases along the supply chain. It is like a 'stock-whip' effect that runs from suppliers to customers as to the reverse of the 'bull whip' effect.

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CHAPTER 1

INTRODUCTION

1.1 OVERVIEW

In today's competitive environment, it is critical that businesses have organisational flexibility in real time to respond to environmental uncertainties. The manufacturing environment is highly competitive in addition to facing significant and continuous uncertainty. It is widely argued (Aggarwal 1997; Perry & Sohal 1999) that in order to be competitive, it is critical that businesses respond to such uncertainties as rapidly as possible. Further, researchers like Upton (1994), who contended that flexibility is used for many purposes each characterising a different quality or capability of a system, have raised the concept of flexibility being necessary. Aggarwal (1997) was concerned also that the need for flexibility exists at every point in the supply chain.

To be competitive and enhance their competitive advantage, manufacturers also create strategic alliances; i.e., relationships with their suppliers and buyers via vertical and/or horizontal integration, which result in strategic supply chain networks. For supply chain networks to respond to environmental uncertainties, they have to be flexible enough to be responsive in real time. Consequently, developing and maintaining flexible and responsive supply chain networks could make the difference between survival and demise for manufacturing firms and, consequently, the supply chain networks' future competitiveness and the continued survival of the entities within them.

Flexibility and agility have been proven to be the best forms of response strategy to uncertainties in the manufacturing sector (Gerwin 1993; Gupta & Somers 1996; Swamidass & Newell 1987). Similarly, this has also been proven many times by Quick Response and Efficient Customer Response studies (Harris *et al.* 1999; Perry *et al.* 1998). As a result of a study in the Australian environment, Rahman (2002)

suggested that the understanding of the dynamic nature of supply chains through cause and effect relationships is critical to the formulation of supply chain growth strategies.

In the light of such consistent arguments, the future of business competition also has been proposed to be between supply chains rather than between individual companies or brands (Christopher & Ryals 1999). Consequently, the supply chain network (SCN) that has the flexibility to respond the quickest has the highest competitive advantage.

Creating and managing flexible supply chains (SC) is one response to deal with the rapidly changing and uncertain business environment. If an organisation is flexible and possesses a set of alternative strategic options, it can respond more effectively to dynamic competitive environments (Sanchez 1995). As such, the competitive capability of flexibility is widely recognised by managers (Cox 1999; De Meyer *et al.* 1989; Upton 1995). A study of manufacturing organisations in Japan, North America and Europe also reflects this managerial emphasis, proclaiming flexibility as the 'next competitive force' (De Meyer *et al.* 1989).

The complexity of a SCN further adds to the problem of identifying its flexibility elements. The term Supply Chain Management (SCM) was introduced in the 1980s and the concept has changed little in the past two decades. Its function has always been procurement, manufacturing, distribution, marketing and after sales service. Nevertheless, there always have been several players with conflicting objectives in every supply chain network. The conflicting objectives of such players have led to delays, excessive inventory, lack of production capacity, distribution problems, poor customer service and wasted resources. Furthermore, according to Clemons & Row (1993) the negative issues arise because there was a lack of sufficient information exchange between the various players in a SCN, thereby reducing co-ordination efforts to increase relationship flexibility between its players.

The present researcher contends that the supplier-buyer relationship role is repeated along the SCN between the various entities. Although the activities between the various entities along the SCN are different and independent of each other, desirable

flexibility elements and dimensions remain the same; hence, the supplier-buyer flexibility elements and dimensions are repeated along the SCN, but in different environments and situations.

Because of the complexity of a SCN, the present research is focused on the supplier-buyer relationship flexibility, where the buyer is the manufacturer and the supplier is a first tier or raw material supplier. To further conceptualise the current research study, the present researcher narrows that focus to detail the procurement flexibility in a manufacturing environment.

1.2 BACKGROUND TO RESEARCH PROBLEM

Strategic procurement management has been promulgated as an effective business strategic approach (Cox 1996). Cox (1996) has argued that firms need to constantly change in order to respond to consumer preferences. Therefore, flexibility is necessary. The strategic value of flexibility has been recognised (De Meyer *et al.* 1989; Gerwin 1993; Gupta & Somers 1996), but the concept of flexibility itself is not well understood especially in supplier-buyer relationships and supply chains. The first step in understanding and improving flexibility capability is the ability to define and identify it. Unfortunately, a single all-encompassing identification of flexibility has yet to be developed (Gupta & Goyal 1989). Also, as stated by other researchers (Crum *et al.* 1998; Jarrell 1998) the availability of good, generalisable measures of flexibility also have been inadequate. Similarly, in procurement relationships there is a lack of established generalisable measures of flexibility. The current research study moves in that direction to narrow the identified gap.

To understand the issues of flexibility, the present research study is designed to enable examination of the theoretical underpinnings of the flexibility concept. Then, this theory is used to define and identify the flexibility dimensions of supplier-buyer procurement flexibility, and its practical responses to environmental uncertainty.

Research into the flexibility dimensions of an entire supply chain network is beyond the scope of a single research thesis as it is too complex and requires a high degree of

resources. Therefore, the intention in the present study is to investigate the supplier-buyer procurement relationship flexibility in the Australian manufacturing sector. In the research, the supplier-buyer entities are termed as supplier-manufacturer relationship flexibility. In effect, to expedite the practical feasibility of the research study, the aspects of supplier-manufacturer operational relationships are confined to the five procurement flexibility dimensions of information flexibility, logistics flexibility, material flexibility, integration flexibility and organisational flexibility as described in Chapter 2.

1.3 RESEARCH OBJECTIVES

The primary objective of this research was to develop an understanding of a conceptual framework of supplier-manufacturer procurement flexibility (SMPF) dimensions and its elements. The secondary objectives were to identify generalisable dimensions of procurement flexibility and to undertake an exploratory study of best practices and the relationships between the procurement dimensions and to determine how managers use SMPF to respond to uncertainties in the Australian manufacturing sector. The following research questions are indicative of objectives that were investigated:

1. How are the definitions of SMPF dimensions best articulated?
2. Which SMPF dimensions are most critical in the Australian manufacturing sector?
3. Which environmental uncertainties are critical in the Australian manufacturing sector?
4. How do SMPF dimensions and environmental uncertainties interact in the Australian manufacturing sector?
5. How do manufacturers and suppliers respond to flexibility and uncertainty?

The present researcher examined existing literature on manufacturing flexibility and built on to that knowledge base the limited literature available on procurement flexibility. A comprehensive review of the limited SC flexibility and agility literature was also undertaken in an effort to identify the constituent dimensions and elements of procurement flexibility. This allowed the researcher to build on existing knowledge and generate a more holistic understanding of the complex concept of supply chain and procurement flexibility.

1.4 EXPECTED CONTRIBUTION TO ACADEMIC RESEARCH AND BUSINESS

The present research was undertaken to contribute additional knowledge designed to reduce the existing gaps in academic literature related to supplier-manufacturer procurement flexibility (SMPF). The identification and definitions of SMPF elements added to the limited knowledge of SMPF and the relationships between its elements. Also, a measurement scale for the SMPF was developed for use in generating SMPF performance measurements

The relationships between the SMPF elements and flexibility dimensions also provided insight into the development of SMPF flexibility in the manufacturing sector. This operational level investigation enabled the benchmarking of SMPF standards among manufacturing industries in Australia. The benchmarking identified the strengths and weaknesses of the organisations and provided a direction for future developments in SMPF capabilities. The development of a reliable and generalisable measure of SMPF added to the ongoing research in SCM by providing a much needed tool to be used to examine the flexibility capabilities of existing and potential supply chain partners to ensure compatibility.

The present researcher identified areas for improvement to enable Australian manufacturers to be more competitive and responsive to environmental uncertainties. The review of literature suggested that there were significant possible problems in the Australian manufacturing sector, similar to those in North America and Europe. It was postulated that these could be reduced or eliminated, and thereby, that competitiveness would be improved.

From a business perspective, there is great potential to apply the research findings in the Australian manufacturing sector. The findings of this research shall be made available to the Australian manufacturing lobby groups and industry representative bodies to help the Australian manufacturing industry to increase its domestic and global competitiveness as well as improve the relationships within the Australian manufacturing sector.

Similarly, it was considered that the present research study would provide more information on the following:

- key supplier-manufacturer relationship flexibility dimensions
- critical success factors in dealing with environmental uncertainties
- manufacturing management's successful adoption of SMPF concepts

1.5 EXPECTED RESULTS AND BENCHMARKING

Traditionally, efforts in enhancing manufacturing capability have focused on improving manufacturing operational effectiveness (Beach *et al.* 2000). These efforts occurred within the four walls of a manufacturing company and its processes, but the present research was based on the view that it was timely to integrate all these measures and programs into the broader concept of the supply chain network (Jayanthi *et al.* 1999; Towill & McCullen 1999). This idea is in concert with the identified and urgent need for manufacturing firms to link their business strategy into manufacturing strategies and to SCM strategy for increased competitive advantages. For these strategies to take on a competitive focus, other aspects of SCM strategy must be investigated and enhanced. One of these is the procurement strategy.

Using cluster analysis, a 'leaders and laggers' chart (Chart 4.11) has been formulated from the respondent data to provide useful bench marking of the Australian manufacturing sector as to the varying degrees of success of companies in procurement flexibility. This type of assessment can act as a stimulus to future closer examination of SMPF in specific case studies.

The present researcher notes that the findings of the present research study complement other Australian studies (Kayis 1998; Power & Sohal 2000; Power *et al.* 2001; Rahman 2002; Sohal & Egglestone 1994, Sohal *et al.* 1999) and can contribute to the success and ability of manufacturing companies to be global players by adapting to external environmental uncertainties with increased procurement flexibility and strategic manufacturing practices.

1.6 SCOPE AND LIMITATIONS

Measurement may have problems like definitions of output and technical issues like its time period. The purpose of the survey and its benefits were explained in the cover letter to respondents. Nevertheless, generally it was assumed that all companies were in a position to provide data that was relatively similar in definition to that of other manufacturers.

It was assumed also that data requested in the research questionnaire was readily available in companies. Furthermore, there was considerable effort made to ensure that no 'commercial in confidence' data was requested, because in spite of assurances of confidentiality, companies would be loath to release data of a sensitive nature.

Tompkins and Ang (1999) considered that the greatest challenge related to SC performance measurement was how well one was able to embrace, manage and utilise key information. Similarly, in the present research study the limitations depended on how well the respondents were able to provide the information requested in the questionnaire. It was assumed that respondents could provide appropriate and accurate information only if they themselves were measuring it or had knowledge of it and the ability to measure it.

Although some studies indicated that Australian manufacturers are highly competitive and have implemented quality practices (Kayis 1998; Power *et al.* 2001; Samson & Terzioski 1999; Sohal *et al.* 1999) together with lean production methodologies (Sohal & Egglestone 1994), the current study takes the manufacturing sectors' capabilities even further into the global competitive arena.

It was assumed also that most Australian manufacturing firms have knowledge of their suppliers' attributes and supply chain network. If they had no knowledge or even intermittent blind spots, they might not have been in a position to respond to the research questionnaire. To cover these possibilities, and to increase the response levels, the questionnaire was followed up where necessary with qualitative requests for information as to the reasons why the survey was not responded.

1.7 RESEARCH METHODOLOGY

To develop a generalisable framework of supplier-manufacturer flexibility, a variety of manufacturing firms were included in the study. A postal survey, using a seven-point Likert scale, was used to provide an appropriate large sample size of responses as it is faster, cheaper and targets a selective and wider reflection of the identified population. The manufacturing firms that participated represented 17 Standard Industry Classification (SIC) groups within the manufacturing sector.

A Q-Sort technique was used to perform identification of those items that could be grouped together (Ekinci 2001; Sachs 2000). Q-Sort is appropriate to match proposed items with the appropriate flexibility elements. The research also followed Churchill's (1979) paradigms for scale development and content validity. Focus groups and interviews with procurement managers and manufacturing plant managers were used to generate, test and purify scale items of the constructs.

The survey data was analysed using factor analysis (Bryman & Cramer 1997) to identify the interrelationships among the large number of variables and explain the common underlying dimensions without losing vital information. Basic univariate analysis was used to establish the distribution of respondents, categories of SIC classification, respondents' position, type of business, annual sales, industry type, number of employees and company profile.

Multivariate analysis was used to test whether there were distinct groupings on non-metric variables and as a basis for distinguishing the respondents into 'leaders and laggers' in procurement flexibility capability.

1.8 OUTLINE OF THESIS

The presentation of the research study is divided into five chapters. Chapter 1 provides the general introduction and overview of the research and its objectives. Chapter 2 establishes the background by reviewing literature concerning the main concepts of supply chain management, flexibility element issues, environmental uncertainty and co-ordination of procurement activities between the different suppliers and manufacturers. Chapter 3 outlines the research methodology, major research questions and research model. Chapter 4 contains analysis of the data and lists the results. Chapter 5 provides an overall summary, conclusions, a comment on limitations and recommendations for future research.

CHAPTER 2

LITERATURE REVIEW

2.0 INTRODUCTION

This chapter is used to introduce relevant literature on manufacturing supplier-buyer relationships, its flexibility and the issues of uncertainty. It also outlines the concepts, definitions and framework of this study. A comprehensive review of literature involving flexibility is undertaken. It includes the strategic concepts of flexibility capabilities pertaining to supplier-buyer relationships and overall SC competitiveness. Prior to this review, however, a discussion of some general principles of overall manufacturing supply chain concepts and procurement flexibility in-line with business strategic competition is warranted. The chapter concludes with a hypothetical SMPF model derived from extant literature and which formed the basis for the examination of procurement flexibility in manufacturing industries.

In this chapter also, is built an understanding for theoretical review of the need for supplier-buyer procurement flexibility as described in literature on manufacturing and competitive strategies. The various forces of influence impacting on manufacturing firms are considered, and the strategic options implemented by global manufacturers as identified by various researchers. An investigation is conducted into the complexities surrounding supplier-buyer relations and integrating manufacturing strategies within the supply chain. In addition to the investigation of the properties, nature, characteristics, classification, dimensions and capabilities of flexibility, the researcher established reasons for the need for a generalisable framework of procurement flexibility and the reasons for the focus of the research study.

The present researcher recognised that a supplier-buyer relationship exists between each and every entity along a supply chain. Therefore, it is considered that the

findings in this research may be applicable across the many entity relationships along the supply chain as multiples of supplier-buyer relationships.

To support theory building and add to the exploratory and empirical research findings, the present researcher focused on the upstream section of the supply chain; i.e. the manufacturers' supply chain network. Lambert *et al.* (1998) established that there is a need for theory and developing normative tools and methods for successful SCM practice. They also pointed out that there has been little guidance from academia, and private practitioners are leading understanding and change in this area. This applied to the procurement arena as well.

Current management practices are focused on customer response and organisational optimisation to achieve successful SCM practice. Due to the limited availability of supplier-buyer or supplier-manufacturer operational procurement relationship literature, the present researcher determined to extract established knowledge from literature of operational management, marketing management, supply chain management and strategic management. Hence, it is considered appropriate that overall supply chain management discussion is warranted.

2.1 SUPPLY CHAIN MANAGEMENT COMPLEXITY AND STRATEGY

The term Supply Chain Management (SCM) was introduced over twenty years ago (Frazelle 2002) and the concept has changed little since that time. Its functions have always been procurement, manufacturing, distribution and marketing, although there are several definitions of SCM. Generally definitions incorporate the end-to-end activities among a variety of players within the SC. Some definitions differ in perspectives according to the author who is defining it. Table 2.1 provides examples of the variety of definitions of a SC and SCM.

It can be seen from the definitions of SCM and SC that the activities involve many different aspects of purchasing, manufacturing, selling, marketing, after-sales service and management of various relationships with suppliers and customers. As these activities are beyond the scope of this research study, the present researcher focused

on the procurement relationship aspects only. Procurement relationship activities are repetitive in that they are undertaken several times along a SC whenever there is a transaction between a seller and buyer.

Table 2.1 Definition of Supply Chain and Supply Chain Management

Authors		Definitions
Ballou *et al.* 2000	SCM	The supply chain refers to all those activities associated with the transformation and flow of goods and services, including their attendant information flows, from the sources of raw materials to end users. Management refers to the integration of all these activities, both internal and external to the firm.
Beamon 1999	SC	A supply chain is an integrated process wherein raw materials are manufactured into final products, then delivered to customers via distribution, retail or both.
Bhaskaran 1998	SC	A supply chain is a series of manufacturing plants that transform raw materials into finished product.
Cooper *et al.* 1997	SCM	SCM is the integration of business processes from end user through original suppliers that provides products, services and information that add value for customers.
Frazelle 2002	SC	A supply chain is a network of enterprises, individuals, facilities and information/material handling systems that connect our supplier's supplier to our customer's customer
Lee & Billington 1992	SC	SC is a network of manufacturing and distribution sites that procure raw materials, transform them into intermediate and finished products, and distribute the finished products to customers.
Levi *et al.*, 2000	SCM	Supply chain management is a set of approaches utilised to effectively integrate suppliers, manufacturers, warehouses and stores, so that merchandise is produced and distributed at the right quantities, to the right locations, and at the right time, in order to minimise system wide costs while satisfying service level requirements
Tan *et al.*1999	SCM	The simultaneous integration of customer requirements, internal processes, and upstream supplier performance.

In the past decade, SCM has gained in popularity due to growing global competition and business performance pressures. Another major contributing factor is the shift in customer demand and expectations in virtually all market sectors (Frazelle 2002, Levi *et al.* 2000). Price, quality, design and product attributes are now taken for granted by customers who expect even better response, flexibility, customisation and support from all manufacturers and suppliers (Blackwell & Blackwell 1999, Cohen *et al.* 2000).

Today, customers require even more specialised and customised products and services to meet their needs. The needs mean that mass customisation; make-to-order and assemble-to-order manufacturers are under increasing pressure for smaller lot sizes and shorter delivery lead times. As a result, these manufacturers are looking at strategies that emphasise flexibility, quick delivery, high quality, low costs and small batch production. The pressure for quality results has led to integration among the various tiers in a manufacturing supply chain.

In recent years there has been an increase of mathematical modelling frameworks of SCM optimisation, planning and decision making under uncertainty. This is because of a huge variety of variables, complexity and size of SCs, stochastic parameters and a wide variety of possible alternatives (Bhaskaran 1998; Escudero *et al.* 1999; Holweg & Bicheno 2002; Petrovic *et al.* 1998; Swaminathan *et al.* 1998; and Vorst *et al.* 2000). Some examples of simulation studies are provided in Table 2.2 below. Because of the difficulty of conducting studies of a SC, some researchers simulate its environment. The main difficulties perceived by the present researcher are due possibly to the geographical isolation/distance of the various entities in a SC and the uncooperativeness of some entities within a SC.

Table 2.2 Simulation Studies in Supply Chain Management

Authors	Dimensions and variables
Bhaskaran 1998	Manufacturing supply chain.
Donselaar *et al.*, 2000	Simulation using truck manufacturer data - type of demand information used influences the stability of the planning in the SC.
Holweg & Bicheno, 2002	Information deficient - distortion and amplification of both demand and supply patterns.
Vorst *et al.*, 2000	Comparison of case study and simulation models in food supply chains.
Petrovic *et al.*, 1998	Forecasting model on value of information sharing.

Problem elements of optimisation used by Escudero *et al.* (1999) were planning horizon, end-product, sub-assembly, product, component, raw materials, transferable component, stock, lead-time, cycle time, bill of material, production period, standard mode, back log, prime components, product groups, demand, delivery lag time,

supply lag time, resource capacity, production level, stock level, volume, holding costs, procurement costs, production costs, volume of product, volume of raw components, volume of demand, volume of back log, etc. This shows that to be able to adapt to changing external and internal environments, flexibility becomes a core challenge of supplier-buyer relationships, hence the supplier-manufacturer relationship.

Petrovic *et al.* (1998) described the modelling and simulation of a SC to assist decision-making in an uncertain environment. They combined two types of models – the generative model which determines optimal order up to appropriate levels, and the evaluative model which determines selected order up to levels of inventories. They also developed two fuzzy models incorporating two different SC control strategies – decentralised control and partially co-ordinated control taking into account inventory levels and customer demand uncertainty. These fuzzy models show the necessity for flexibility in the SC to be able to handle uncertainties.

Similarly, there are always several players with conflicting objectives in the supply chain itself. These conflicting objectives of each player have led to difficulties such as delays, excessive inventory, lack of production capacity, distribution problems, poor customer service and wasted resources; they also created severe obstacles for a research study as constructs and variables can expand to an unmanageable number which would require enormous resources.

The most well defined SC research method is a case study of a single manufacturer following the path of the SC from their initial suppliers to their end consumers. This method also is too resource consuming; as well it creates a framework for a single SC within a single industry, rather than a generalisable framework. Therefore, the present researcher narrowed the research focus to that of the supplier and buyer procurement relationship in a manufacturing environment. As this supplier-buyer relationship is repeated by all entities along a supply chain network it enables development of a generalisable framework of a manageable dimension which can be applied to a SC in an iterative fashion (Dolgui & Ould-Louly 2002). Since the research focused on manufacturers, within this research thesis it is described as the supplier-manufacturer procurement flexibility (SMPF) relationship.

SC integration also can be attributed to advancements in computer technology and telecommunications; these shifts have a major impact on how businesses and industries operate and will continue to impact on their future operations (Kanji & Wong 1999). To further enhance SC integration, the contention is that SC flexibility management is vital to effectively and efficiently operationalise the integration processes.

2.2 SUPPLY CHAIN INTEGRATION AND PROCUREMENT FLEXIBILITY

Every time there is a change in the environment or increase in uncertainty, the SC or the supplier-manufacturer relationship cannot be redesigned from the beginning to suit the prevailing situations and conditions. Reutterer and Kotzab (2000) used conjoint analysis to measure preferences in SC design and concluded that the design is dependent on the environmental influences of the respective business. Nevertheless, the design also depends on the size of the firm in terms of sales and number of employees and not the position of the firm in the SC. Reutterer and Kotzab (2000) also emphasised that to compete effectively at all times, firms must design a flexible and responsive SC.

A study on causal linkages in SCM by Narasimhan and Jayaram (1998) found that supplier integration and strategic integration are important components of supply chain strategy. These components were considered in the development of the survey instrument because they were relevant to the objectives in this study.

One of the most difficult tasks in integrating a supply chain or procurement activities, is that of determining how to modify the organisational structure (Anderson & Rask, 2003; Cousins & Spekman 2003; Gupta & Lonial 1998). Some of the factors to consider are centralisation or decentralisation, strategic or operational focus, and the danger of loss of control within the various links of the supply chain. The present researcher did not delve into the concept of organisational structural design but tried to establish the existing compatibility and capabilities of the existing organisational structure with regard to its procurement flexibility.

Time based competition ensures that every link in the supply chain must be considered simultaneously in order to optimise the activities within the context of the organisation. It is also necessary for all the organisations involved in the supply chain to think alike and ensure their links are connected smoothly (Handfield & Bechtel 2002). Therefore, every link in a SC must have the flexibility to modify and change to suit the required conditions and environment at the appropriate point in time; thus, flexibility must be responsive in real time so as to capture the competitive advantage.

Similarly, from marketing literature (Kotha 1995; Kotler 1989), it is argued that increasing demand for product variety and customisation, shortening product life cycles and expanding industrial competition require a higher flexible manufacturing strategy.

2.3 GENERAL PRINCIPLES OF MANUFACTURING STRATEGY

Skinner (1969), in his ground-breaking article, identified the failure of organisations to integrate manufacturing and organisational strategies. Similarly, in 1986, he identified the fact that most manufacturers do not tailor their production systems to performance tasks that are critical to corporate success. Fisher *et al.* (1997) found that SCM was bad because of the mismatch between production type and SC strategy. Voss & Blackmon (1998) and Olhager *et al.* (2001) determined that many firms have no formal manufacturing strategy; instead they opted for a blend of short term, low cost and acceptable, customer service. This points to the fact that manufacturing organisations must look outside the four walls of their manufacturing facility to increase flexibility and enhance their competitiveness. Looking outside the manufacturing facility is imperative because modern competition is also based on collaborative strategies that require close attention to the internal and external environments.

Business management has entered a new era of inter-network competition and the networks' success depends on management's ability to integrate their company's

intricate network of business relationships for competitive advantage. Thus, the future of business competition is a case of SC verses SC. Araujo *et al.* (1999), Bowersox (1997) and Christopher (2000) suggested that in modern business management, individual businesses no longer compete as solely autonomous entities, but rather as SCs.

Porter (1985) proposed and identified five competitive forces: buyers, suppliers, new entrants, substitute products and rivals. These forces are accepted as environmental uncertainties in this research study. Other researchers with opinions similar to Porter (1985) are Dess & Davis (1984) and White (1986). All suggest that forming alliances with suppliers contributes to lower costs by minimising SC costs between suppliers and manufacturers. They suggest, also, that one should differentiate from other manufacturers by more efficient and effective SC dynamics in the SCN.

Strategic information systems (SIS) alignment forms the linkage between manufacturing and business plans (Allen & Boynton 1991; Barut *et al.* 2002; Bonney *et al.* 1996). Perceptual differences and lack of communications can hinder efforts at obtaining strategic alignment and may lead to a mismatch between SIS and business strategy. From Porter's (1980) competitive model, Kearns and Lederer (2000) derived ideas such as: strategic information systems practices and organisational performance constructs can be operationalised in forms such as lower production costs, product differentiation, bargaining power of suppliers and customers and imposing barriers to new market entrants.

Hamel and Prahalad (1989) pointed out that imitating competitive strategies does not lead to competitive revitalisation as it becomes transparent to the very competitors who are emulated, as the competitors themselves have already mastered that strategy. Even then, these competitors are becoming more competitive and innovative as they are continuously evolving themselves. Some of the competitive advantages identified by Hamel and Prahalad (1989) are lower labour costs, rationalising product lines, economics of scale, quality circles, and Just In Time operations.

Therefore, based on their individual operational environment, it is vital that a generalisable framework of flexibility concepts be derived that can be implemented

by any organisation or SCN. The view of Bozarth and Berry (1997) was that measurement methodology of manufacturing strategy and congruence between market needs and manufacturing capabilities defined the domain of analysis and they identified eight competitive priorities: low cost, high performance quality, consistent quality, fast delivery, on time delivery, development speed, customisation and volume flexibility.

In a study on manufacturing strategy, Hodgson *et al.* (1998) found that there were a growing percentage of companies seeking agile and responsive mechanisms to market and environmental conditions. They also found trends in the upstream side of a SC that were shortening product life cycles and increasing complexity of product components. These trends required a higher involvement of suppliers in the product design stages, more out-sourcing from external suppliers as well as more partnerships and alliances. Hodgson *et al.* (1998) identified uncertainties such as business ownership structures, trade environments, product demand and technological innovation. Therefore, a review of uncertainties is warranted to identify its effect on the supplier-buyer operational relationship. This is addressed later in the chapter.

Hamel and Prahalad's (1989) concept of 'strategic intent' among resources and opportunities and strategies can encourage and enable competitiveness in terms of lowest cost and differentiation. They also found that typical competitor analyses were short term and narrow focused. It was intended that the present research investigate the procurement 'strategic intent' of Australian manufacturers.

In previous Australian studies (Beaumont & Schroder 1997; Perry & Sohal 1999, Power & Sohal 2000; Samson & Ford 2000; Samson & Terzioski 1999; Sohal *et al.* 1999; Sohal & Egglestone 1994; Sohal & Ng 1998; Warnock 1996; Yamin *et al.* 1999) it has been found that most Australian manufacturers have adopted world's best practices in manufacturing as well as in business networks. Therefore, it is timely that this competitive advantage is evaluated and further enhanced to maintain the competitive advantage.

2.4 FORCES INFLUENCING MANUFACTURING STRATEGY AND OPTIONS

Six main forces have been identified as impacting on the future of SCM; there are also other minor forces like organised labour and transportation. The six primary forces are consumer demands, globalisation, competition, information and communication, government regulation and environment (Daniels 1999; Gattorna 1998; Larson & Rogers 1998; Levi *et al.* 2000; Shi & Gregory 1998).

2.4.1 Consumer demand

There has been a shift in power from the supplier to the customer, sometimes described as Demand Chain Management (Childerhouse *et al.* 2002; Heikkla 2002; Williams *et al.* 2002). This means mass customisation with instant availability of inexpensive customised products with a high level of service. Expectations of choice, service, speed and lower costs are rising and products are required to be better, cheaper and available faster. Companies like Dell Computers, Amazon.com, UPS, FedEx and AusPost have proven it. For example, the 2004 Toyota Camry and Ford Taurus are better equipped and less expensive than the 1997 models taking into consideration consumer price index and inflation. Customers are now expecting a similar performance in all segments of the economy.

2.4.2 Globalisation

Globalisation of Multinational Companies (MNCs) based in Europe and the United States has been accompanied by the discovery of out-sourcing advantages and attractiveness of parts and products from China, Mexico and other emerging third world economies. These economies can deliver cheaper parts and products compared with the MNC's traditional sources.

2.4.3 Competition

Tougher competition will continue to spur SC innovation. Competition is enabled by advances in industrial and manufacturing technology, increased globalisation, increasing improvements in information availability and sharing, and capital

(Gattorna 1998). The traditional pursuit of market share is no longer sufficient to ensure sustainable profitability (Warnock 1996); thus, companies are redefining their competitive and profit zones. The internet has allowed virtual and small companies in far away countries to become global phenomena almost overnight. Competition also is influenced by cheaper labour in third world countries; it is forcing Australian manufacturers to reduce manufacturing costs and eliminate wastage of resources along their supply chains (Sohal *et al.* 1999).

2.4.4 Information and Communications

The internet is dramatically affecting the way products are bought and distributed (Anderson & Lee 2001; DeCovny 1998). It allows consumers to shop around, examine all facets of a product and buy from on-line catalogues, ultimately leading to direct buying. Information modelling tools and techniques like i2 Technologies and Manugistics are optimising SC decision support by harnessing consumer and business data.

2.4.5 Government Regulation

Government tariffs and regulations, and international trade agreements are affecting the way global SCs function (Kasarda & Rondinelli 1998). Legal issues require that Supply Chains must be able to adapt to these changes in tariffs and regulations in the shortest possible time. Trade Agreements are influencing the procurement and purchasing choices for manufacturers.

2.4.6 Environment

Environmental concerns like recycling, sustainable eco-efficiency, waste elimination and minimisation are beginning to affect SC design (Arnold *et al.* 1997; Curkovic 2003; Handfield *et al.* 1997). European Union packaging regulations require cardboard boxes to be removed from consumption sites and recycled resulting in a rapid switch from disposable to returnable containers for auto production parts. This process is termed as reverse logistics. For reverse logistics to be implemented efficiently and effectively, the supply chain must be designed to incorporate the new policies and processes. This requires flexibility in the various stages of the supply chain, especially in the up-stream stages of production. The flexibility would also

facilitate the changes and modifications of implementation processes in the future as government environmental policies are implemented.

Currently the world's organisations have an external environment that has a great degree of uncertainty. The recent spread of the SARS virus (www.who.inf), terrorism and indiscriminate suicide bombing (www.dfat.gov.au) virtually brought the airline industry to a standstill. Such uncertainties are affecting the manufacturing industry's global supply relationships.

2.5 FLEXIBILITY

In this section, existing research on the concept of flexibility was examined in relation to manufacturing and the SC. Because there was limited literature on supplier-manufacturer operational procurement relationship flexibility, the present researcher was keen to apply manufacturing flexibility literature knowledge into the supplier-manufacturer procurement arena.

A comprehensive literature review of flexibility definitions was undertaken including manufacturing shop floor issues and systems; and their adaptation into the overall supply chain system. The review begins with a discussion of the definition, classification, general principles and properties of flexibility.

The terms agility and flexibility have been used inter-changeably in extant literature. Christopher (2000) points out that agility is the ability to respond quickly to changes in customer and competitive demands. He also believed that agility is based on a number of factors like market sensitivity, supplier relationships, information sharing and collaboration.

2.5.1 Definitions of Flexibility

Flexibility has been defined in different ways; in general, it reflects an organisation's ability to respond and adapt to changes (Gupta & Goyal 1989; Upton 1995).

Flexibility is often seen as a reactive strategy to environmental uncertainty (Swamidass and Newell 1987; Gerwin 1993; Suarez *et al.* 1995; DeMeyer 1989). Flexibility is also a multidimensional concept wherein the need for each dimension may vary (Gerwin 1993; Gupta & Somers 1996; Sethi & Sethi 1990). A key dimension of SC performance is flexibility yet the definition of flexibility depends on the situation and the problems involved. Upton (1994) shared similar reasoning that the definition depends on the situations. DeLeeuw and Volberda (1996) agreed with Evans (1991) and concluded that the meaning of flexibility is still ambiguous.

Others described flexibility as an ability (Monteiro & MacDonald 1996) or capability (DeLeeuw & Volberda 1996) or reactive (Upton 1995). However, Suarez *et al.* (1995) argued that flexibility is multi-dimensional in that some organisations are more flexible than others. These ideas are supported by Evans' (1991) view that flexibility is polymorphous, having different meanings in different contexts. Further, Upton (1994) argued that multiple types of flexibility need to be identified so as to be divided into several components which may be measured and improved. Table 2.3 below provides general definition of flexibility by various authors.

Table 2.3 General definitions of flexibility

Authors	Definition
Aggarwal 1997	Ability to meet the needs of the market without excessive costs, time, organisational disruption or loss of performance.
Braglia & Petroni 2000	Ability to deploy and redeploy resources effectively in response to changing environmental and internal conditions.
Das 1995	The ability of an organisation to respond to changes in the environment in a timely and appropriate manner with due regard to the competitive forces in the marketplace.
Muhlemann *et al.* 2000	Ability to adapt to their changing environment.
Nagarur 1992	The ability of the system to quickly adjust to any changes in relevant factors like product, process, load and machine failure.
Narasimhan & Das 1999a	The ability to respond quickly and profitably to customer and market demands is critical to succeed in today's competitive environment.
Upton 1994	The ability to react or change with few penalties in time, effort, cost or performance.

The present researcher defines procurement flexibility from the above flexibility definitions as 'the ability to respond strategically to changing internal and external

environments to ensure that the procurement and supply of raw materials, components and parts are continuous, to sustain the value-adding process'.

2.5.2 Classification of procurement flexibility

Before classifying procurement flexibility, it is necessary to discuss manufacturing flexibility, as there is a lack of literature in procurement and purchasing strategies and supplier-buyer operational relationship flexibility. The present researcher makes use of procurement flexibility classifications from manufacturing flexibility classification literature.

De Meyer *et al.* (1989) predicted that the next competitive battle in the manufacturing industry was flexibility. They analysed the results of the 1986 Manufacturing Futures survey by comparing the European, North American and Japanese manufacturing management techniques and priorities. They concluded that the Japanese were far ahead of the rest of the world in responding to competitive threats due to quality issues. The Japanese had overcome manufacturing quality issues and were focusing then on other competitive issues like flexibility, whereas the European and North American manufacturers were still focusing on quality issues.

The difficulty in classifying flexibility also has been compounded by the larger number of dimensions in manufacturing. Because of the large number of manufacturing flexibility dimensions, researchers have attempted to classify them in various ways. Parameters that have been used to analyse flexibility include labour, personnel, production, strategy and organisational structure.

Gerwin (1993) described the nature of flexibility as either reactive or proactive. The reactive element allows an organisation to respond to market conditions such as uncertain product demand and competitive marketing strategies of competitors. The proactive element enables firms to take a futuristic approach to manage and redefine market conditions and uncertainties before they become apparent. Gerwin (1993) took a strategic perspective of manufacturing flexibility as having six dimensions of

flexibility; viz., mix, changeover, modification, volume, re-routing and material flexibility.

Browne *et al.* (1984) identified eight characteristics of manufacturing flexibility. They were machine, process, product, routing, volume, expansion, process sequence and production flexibility. Other researchers (Beach *et al.*, 2000; Braglia & Petroni 2000; Gerwin 1993; Kara *et al.* 2002; Koste & Malhotra 1999; Narasimhan & Das, 1999b; Suarez 1995) have commonly used the Browne *et al.* classification as the reference.

One of the most thorough classifications of manufacturing flexibility was by Sethi and Sethi (1990). They identified eleven dimensions of flexibility, which involved machine, material handling, operation, process, product, routing, volume, expansion, program, production and market flexibility. These classifications have also been commonly referred to by other authors (Suarez *et al.* 1995; Gupta & Somers 1996).

Suarez *et al.* (1995) identified three types of manufacturing flexibility. They were mix, product and volume flexibility. Their study had a narrow focus on printed circuit board manufacturing plants; however they identified several factors related to implementation of flexibility. They were production technology, production management techniques, the relationship between suppliers and sub contractors, human resource management and product development process.

Evans (1991) defined flexibility as having two dimensions – temporal and intentional. Golden and Powell (2000) identified it as having four dimensions – temporal, range, intention and focus. Temporal is the time taken to adapt; range is the number of options for change; intention is proactive or reactive; focus is internal or external to the organisation.

In a review of manufacturing flexibility, Beach *et al.* (2000) suggested that manufacturing flexibility remains in the realms of operational management and is most closely associated with process technology. Similarly, the same theoretical constructs can be applied in the SCM area because it is very process orientated.

In the present research, the researcher attempted to adopt procurement flexibility classifications that pertain to supplier-manufacturer operational relationship.

Table 2.4 Flexible activities along a Supply Chain

Suppliers	Manufacturer	Buyers	Marketing	Information
Flexibility in modifying product/component	Flexibility in modifying product quantity	Flexibility in modifying product configuration	Flexibility in modifying marketing and sales activities	Flexibility in modifying customer information details
Flexibility in modifying supply quantity	Flexibility in modifying product quality	Flexibility in modifying destination of products	Flexibility in modifying stock quantities	Flexibility in requesting details of environmental information
Flexibility in changing location of destination	Flexibility in modifying location of destination		Flexibility in implementing after sales service levels	Flexibility in implementing data mining processes
Flexibility in changing scheduling of supplies	Flexibility in modifying scheduling of products		Flexibility in modifying functions and size of wholesale/retail activities	Flexibility in accessing customer complaints data
Flexibility in changing supplier sources	Flexibility in involving suppliers in R&D			
Flexibility in influencing suppliers of safety stock levels				

From Table 2.4 above, it can be seen that procurement activities involve product components' design modification, configuration, quantity, quality, destination stock, inventory, scheduling, sourcing, supplier management, product development and research. Other activities not listed in Table 2.4 are agreements, contracts, documentation, alliance, joint ventures, process improvement, information exchange, system connectivity, cost sharing, collaboration, planning, joint strategies, etc. The present researcher has combined all these activities into five dimensions; viz., Information Exchange, Supplier Integration, Supplier Product & Delivery, Supplier logistics and Organisational Strategy. The flexibility of these five dimensions shall be the focus on the present study.

2.5.3 Degree of Flexibility

Some literature on flexibility (Suarez *et al.* 1995; Upton 1995) raised the issue of the amount of flexibility in terms of actual verses potential flexibility. The identified difference means that the perceptions of managers or shop floor operators in terms of the degree of flexibility of a system or process which could result also in measurement difficulties and bias in measuring flexibility. This not only creates ambiguity in accuracy of responses but also knowledge of flexibility capabilities within an organisation.

Empirical researchers have based their study on actual flexibility in the manufacturing shop floor where the operators know the exact minimum and maximum performance of which their machines and processes are capable (Gupta & Somers 1992, 1996; Suarez *et al.* 1995; Upton 1995). This concept is very difficult to apply to an external relationship, as the relationship is process orientated and different entities are involved. The ability of one entity to comment on the flexibility capabilities of another upstream entity is beyond a firm's control. Therefore, the present research investigated the flexibility dimensions from the manufacturers' buying perspective.

Empirical studies of flexibility also have compared manufacturing flexibility between different plants within the same industry (Suarez *et al.* 1995; Upton 1995). These studies provide a benchmarking for the range and scope of flexibility. They provide a basis for measuring actual flexibility capabilities and give an actual physical measurement of flexibility which can be compared to a firm's performance within the particular industry. Similarly, in the present research, flexibility measurements can be used as a benchmark in supplier-manufacturer relationships.

The measurement of actual relationship flexibility can determine the strategic nature of flexibility in determining a relationship's performance in terms of speed, quality, quantity and cost. This can lead to a relative comparison of competitors' positions which enables the development of a leaders/laggers chart.

2.5.4 Elements of Flexibility

Having discussed the definitions, classification and degree of flexibility above, it is appropriate that the elements of flexibility are addressed. Flexibility can be divided further into various constituent elements. Upton (1994) and Koste & Malhotra (1999) have defined three elements of manufacturing flexibility; viz., range, mobility and uniformity.

Koste and Malhotra (2000) also stressed the fact that the flexibility dimensions and elements vary in accordance with the strategies employed within various firms and manufacturing environments. Therefore, by intention and design various industries will have a different emphasis on the dimensions and elements. The present research adopts these elements of range, mobility and uniformity as the flexibility elements in supplier manufacturer procurement relationships.

The first element of range (Upton 1994) is defined as the different states of operation for any system. Upton (1994) defined it as the number of viable positions or some metric distance between extremes.

The second element is mobility; i.e. the ease of movement from one state to another state (Upton 1994). Time and cost are considered as variables related to the mobility element because they are interdependent in regard to performance, e.g. if it takes more time to change to another state then it becomes more costly to be flexible. Upton (1994) also described such costs as 'transition penalties', whereby the higher the transition penalty the less flexible a firm.

The third element is uniformity; which describes the performance of output within the range of a flexibility dimension. Flexibility must be uniform in any state or condition of performance, therefore, when performance changes, flexibility must remain uniform. If the flexibility dimension of uniformity is not constant then that performance may not be effective or efficient. Thus, higher flexibility with the same performance level is desirable.

There are other elements of flexibility described by other authors like Golden and Powell (2000). They suggest elements such as efficiency, responsiveness and robustness. However, the present researcher proposed that the former three elements of flexibility, viz., range, mobility and uniformity are suitable for application within a supplier-manufacturer operational relationship environment. In the supplier-manufacturer operational relationship environment, range indicates the operational state of the relationship in terms of logistics, product and product components, organisational information exchange and partnership flexibility. Mobility indicates the transition penalties of cost and time; and uniformity indicates the performance outputs of costs, quality and time in terms of the difference in operations and processes.

In the present research the researcher adopted these three elements of range, uniformity and mobility which constitute activities that contradict each other in the practical applications in the real world. For example, uniformity may provide a higher flexible capability, but in terms of achieving a quicker time factor it may be at the additional cost of resources like machines and money. So, the flexibility of time is at the expense of cost and machine. The term 'machine' also refers to workers operating that machine. Therefore, achieving a quicker and more flexible time factor may be at the sacrifice of additional workers, plant and money. Thus, trade-offs are a part and parcel of flexibility dimensions and may not be eliminated easily. The trade-off issue is discussed in more detail in Chapter 4.

2.6 ORGANISATIONAL PERFORMANCE AND FLEXIBILITY

Organisational performance is an important aspect of competitiveness. Performance flexibility is critical in enabling rapid response to uncertainties in competitive capability (Aggarwal 1997). Organisational performance refers to the internal processes of an organisation that react to environmental uncertainties. Sethi and Sethi (1990) suggested that strategic flexibility creates and deploys organisational processes that increase a firm's capacity to generate the variety of responses required to maintain stability in a dynamic environment. Schoemaker (1992) is of the same opinion; viz., that strategic flexibility can achieve a state of dynamic equilibrium in

the midst of organisational change when it routinely responds to a turbulent competitive environment.

In a study of managing strategic flexibility, Das (1995) found that strategic flexibility must complement corporate and business strategies. He defined strategic flexibility as the ability of an organisation to respond to changes in the environment in a timely and appropriate manner with due regard to the competitive forces in the market place. He also identified relevant internal factors as comprising manufacturing flexibility, modular product design, employee flexibility and organisational structure.

Upton (1994) took a hierarchical approach. He characterised flexibility into three types - operational, tactical and strategic. Operational flexibility is the ability to change day-to-day or within a day as a matter of course. Tactical flexibility is the ability to occasionally change or adapt about every quarter, and to make changes which on average demand some effort and commitment. Strategic flexibility is the ability to make one way, long-term changes every few years which, in general, involve significant change or commitment of capital. Upton (1994) also identified the elements of flexibility as range (size, volume), mobility (time, cost) and uniformity (quality).

Gupta and Somers (1996) used a conceptual framework of business strategy influencing manufacturing flexibility and, thereby, providing improved organisational performance. As with Upton (1994), Gupta and Sommers (1996) defined business strategy at three levels - corporate level strategy, business level strategy and functional level strategy. Corporate level involves scope and resource deployment. At the business level, the scope and boundary of each business unit and the operational links were specified. At the functional level, the objectives support the desired business strategy that will provide a competitive advantage in marketing, manufacturing and R&D. Similarly, the present research thesis proposed that supplier-manufacturer operational flexibility improves organisational performance. The research was designed to explore the relationship of organisational flexibility to supplier-buyer operational relationships during times of environmental uncertainties.

2.7 UNCERTAINTY

There is much uncertainty in the current economic and global environment. The SARS virus is crippling the airline industry (www.who.inf). The bomb threats by militant groups (www.dfat.gov.au) are preventing business and social travel to specific destinations thereby encumbering business deals and supply of critical components and materials for the manufacturing sector, the high exchange rate of the Australian dollar is tempting manufacturers to shift their manufacturing base overseas. Uncertainty also affects the internal and external business environment in which firms compete and is changing continuously. Traditional approaches to strategy under uncertainty have been argued to be downright dangerous (Courtney *et al.* 1997), which means that flexibility is a necessary part of the game.

When demand is sporadic and irregular, managing uncertainty is a complex issue as well as a relatively unexplored one. There is a lack of methods to handle uncertainty when demand is sporadic (Bartezzaghi, Verganti & Zotteri 1999). Demand is a multi-dimensional phenomenon generated by different market characteristics; namely, numbers of customers, heterogeneity of customers, frequency of orders, variety of customer requests and the co-relationships of customer behaviour. The effective management of this uncertain and sporadic demand may be a substantial source of competitive advantage.

Davis (1993) identified uncertainty as a major influence on the behaviour of a SC especially because it is not adequately handled by managers. He identified supplier performance, manufacturing processes and customer demand as sources of uncertainty. Dolgui & Louly (2002) studied the effect of lead-time uncertainty and noted the importance of the planned lead-time which minimised the expected backlogging and holding costs.

Petroric *et al.* (1999) identified uncertainty as customer demand, supply deliveries along the SC and external market supply in the external environment. Within the SC they identified uncertainty as being evidenced in judgement, a lack of evidence and the lack or certainty of evidence in customer demand and production supply. They also were concerned that each entity in a SC must deal with uncertain demand

imposed by succeeding entities and uncertain delivery of the preceding entity in the SC. Li *et al.* (2001) identified four uncertainties – exchange rates, demand, changing production costs and processing time.

Consequently, the present researcher adopted the assumption that any passive or active action or reaction that influences or affects the supplier-manufacturer relationship in terms of the five dimensions of logistics, product component, information, partnership and organisation are considered as uncertainties for this research study. Some examples of uncertainty are the sudden and unexpected changes in customer demands, competitors' actions, a break in logistics links, loss of supply sources, changes in supply arrangements and changes in procurement.

Miller and Droge (1986) concentrated on the measurement of five dimensions of external uncertainty. They were volatility in marketing practices, product obsolescence rate, unpredictability of competitors, unpredictability of demand tastes and change in production modes. Cachon (1999) identified four causes of demand variability. They were unsynchronised orders, inflated retail orders, incorrect retail demand and price fluctuations. These were similar to those of Lee *et al.* (1997) who identified that the bullwhip effect was caused by demand forecast, order batching, price fluctuation and rationing. Wilding (1998) identified late deliveries, order cancellations and inventory buffers as causes of external uncertainty.

A study by Escudero *et al.* (1999) in the automotive sector identified a variety of manufacturing elements in the assembly and distribution SC. The basic categories of external demand variations were product demand, component supply and delivery time.

Petrovic *et al.* (1998) conducted modelling and simulation of a supply chain in an uncertain environment. They identified uncertain data as resulting from customer demand, inventory control and external supply of raw material in relation to quality and quantity.

One dissenting piece of research was that by Pagell and Krause (1999) who found no relationship between environmental uncertainty and operational flexibility and no

relationship between a firm's performance and operational flexibility in the U.S. manufacturing sector. The present researcher hypotheses otherwise for the Australian manufacturing sector.

Vickery *et al.* (1999) conducted an empirical study on 65 furniture manufacturers; viz., of their supply chain flexibility and the relationship with environmental uncertainty. Their research questions related to environmental uncertainty, supply chain flexibility and company performance. They used five dimensions of flexibility; namely product, volume, launch, access, and responsiveness to target market. Their research questions related to the perceived environmental uncertainty's emphasis on one or more SC flexibilities; performance and influence of one dimension of SCF on other dimensions; emphasis of SCF on level of performance on each dimension; SCF dimension's performance influence on overall firm performance; entity responsibility for dimensions of SCF; and organisational functional performance relationship on the various dimensions of SCF.

They focused on five dimensions of flexibility namely – product, volume, launch, access and responsiveness to target market. Respondents rated the strategic importance of items and responsibilities of the various functional departments.

They also measured environmental uncertainty on the dimensions of marketing practices volatility, product obsolescence rate, unpredictability of competitors, customer demand and tastes, and changes in production modes. Respondents were also requested to rate business performance and profitability measures of ROI, ROI Growth, Market Share, Market Share Growth and Return on Sales.

The results indicated that only volume and launch flexibility are potential responses to environmental uncertainty; performance in target market responsiveness and volume flexibility were related; other dimensions of flexibility were independent of each other. Volume flexibility was also highly related to Market Share and Market Share Growth; launch flexibility was significantly related to overall firm performance of ROI, ROI Growth, Market Share Growth and Return on Sales Growth; product flexibility is a key measure of financial performance of ROI.

Although this research focused on the internal functional areas, their results also found that product design and development; marketing and manufacturing are all key contributors to SCF and teamwork across functional departments contribute to higher firm performance.

The present research also acknowledges that the definitions of flexibility elements defined by these researchers (Vickery et al. 1999) are not the same as the present research definitions of the various dimensions, therefore it is difficult to make direct comparisons of the final results.

Other researchers like Lee *et al.* (1997) suggested three remedies for counteracting the bullwhip effect; i.e. by use of information sharing, channel alignment and operational efficiency. Bullwhip effect is a well-researched uncertainty of consumer demand that is amplified along the SC from the downstream end to the upstream entities. In order to reduce uncertainty they recommended that down stream information must be transmitted to the upstream players in a timely fashion, channel alignment must be co-ordinated with pricing, transportation and inventory planning, and operational efficiency activities used to reduce lead times and costs.

Some of the traditional methods of managing uncertainty involve materials management, materials co-ordination, materials planning requirements, protective stocks, time phased orders and location of inventories (Bartezzaghi, Verganti & Zotteri 1999; Donselaar *et al.* 2000). The present researcher intends to investigate whether this is still true in present day manufacturing competition in Australia.

Some of the earlier suggestions regarding managing uncertainty (Bourgeois 1985) are that firms need to focus on the external environment like customers, competitors, suppliers, regulatory agencies and attributes of external forces in terms of their complexity, dynamism, munificence and managerial perceptions about these environmental attributes.

Uncertainties are also found in the procurement and purchasing areas (Anderson & Rask 2003; Buvik & Gronhaug 1999; Cox 2001; Houghton *et al.* 2002; Marquez & Blanchar 2004; Ottesen & Gronhaug 2002; Wynstra *et al.* 2003). Uncertainties in the

purchasing and procurement activities ripple through the downstream part of the supply chain affecting all the activities. Therefore, uncertainty management in the procurement and purchasing functions are critical and the present researcher intends to explore this gap in literature.

It is critical that manufacturing firms are able to manage and implement flexibility measures to reduce environmental uncertainties. The present researcher intends to explore the relationship of SMPF dimensions to environmental uncertainties in the Australian manufacturing sector. A brief taxonomy of uncertainty conceptualisation is provided in Table 2.5 below.

Table 2.5 Operationalisation and Conceptualisation of Uncertainty

Authors	Conceptualisation
Buvik & Gronhaug, 1999	Inter-firm dependence, vertical co-ordination with supplier relationships
Cox, 2001	Supplier power and buyer relationships
Dolgui & Louly, 2002	Lead time, safety stock
Houghton *et al.*, 2002	Procurement strategy and supply management
Li, Porteus and Zhang, 2001	Exchange rate, demand production cost and processing time
Lee *et al.*, 1997	Demand forecast, order batching, price fluctuation and rationing
Marquez & Blanchar, 2004	Procurement contracts, security and flexibility
Miller and Droge, 1986	Marketing practices, product obsolescence rate, unpredictability of competitors, unpredictability of demand tastes and change in production modes
Ottesen & Gronhaug, 2002	Uncertain supply; and customer needs and wants
Petroric *et al.* 1999	Customer demand, supply delivery
Wilding, 1998	Late deliveries, order cancellations and inventory buffers
Wynstra *et al.*, 2003	Integration of purchasing and product development process

2.8 CO-ORDINATION BETWEEN SUPPLY CHAIN ENTITIES

Co-ordination between firms in a Supply Chain (SC) is the basis for a successfully integrated supply chain and it is expected that an integrated SC is very beneficial for all the players. For this to be true, all the players must develop a close and highly interdependent relationship with each other.

Information Technology (IT) literature over the past decade has promoted the benefits of IT which includes EDI, web based data transfer, ERPs etc. The benefits should also apply between two entities in a SC; however, there does not seem to be much IT success in achieving more effective SCs (Garcia-Flores *et al.* 2000, Webster 1995). Although there is ample literature promulgating the advances in effectiveness and efficiency of IT in integrating SCs, not all technological advances seem to be enablers of SC integration/optimisation (Jayaram *et al.* 2000; Singh 1997; Wynstra *et al.* 2003). Dave Nelson, vice president of Honda America, is reported as saying that there was 30% waste in their SCs (Doyle & Parker, 2001).

Other authors have reported that the growth of IT has not yet affected the management of relationships (Leek *et al.* 2002). Consequently, the key to increasing and improving SC performance is in getting the various players to align their objectives and re-engineer their SCs across the extended enterprise resource planning (EERP) systems rather than increasing the visibility or computational power of IT applications and the latest computers.

Much literature can be found on IT/IS companies marketing their SCM and customer relations management (CRM) application software as providing more real time data, better algorithms, more connectivity, a bigger IT budget and more powerful computers capable of controlling their extended enterprise free of market imperfections. Nevertheless, there is no published literature that establishes the fact that the new software provides the flexibility to enhance competition.

The value of strategic information systems (SIS) is an important tool for competitive advantage. The alignment of SIS with business strategy as well as mutual information exchange between business partners is critical (Choe 2002). This concept is shared by Barut *et al.* (2002) and Thonemann (2002). Some of the other studies that promote IS as a tool providing competitive advantage during times of uncertainty are Bal *et al.* (1999); Closs *et al.* (1998) and Sabherwal & King (1992).

Since all the entities in a SC are both suppliers and buyers who add value along the supply chain, co-ordination activities obviously are involved. Therefore, procurement activities take place between suppliers and buyers. The present researcher views

these procurement activities as being repeated along the SC. Although, all the activities might not be similar in nature, it is the contention of the present researcher that to build a conceptual framework of procurement flexibility dimensions, the common activities are selected to represent the flexibility dimensions.

To operationalise the common procurement activities among the various entities in a SC, the present researcher has derived a list of activities from the literature review (see Table 2.4 above, page 37). These activities are adopted into the research model for operationalisation.

2.9 SUPPLIER-BUYER DIMENSIONS

Global time-based competition, technological development and innovations have changed the way in which firms operate in procurement and purchasing activities. Focusing on customer needs and desires have become the major driving forces for change in the late 1990s and early 21st century. The new economic realities of innovation and technological advancement are forcing firms to concentrate on their core competencies and outsource non-core activities. This leads to collaboration with external suppliers in order to develop shared technological capabilities (Anderson & Christensen 2000).

Strategic collaboration provides risk sharing and synergy by using external stakeholders' expertise and specialised skills (Kanter 1994), but alliances have failed because of inter-partner diversity (Parker 2000; Parkhe 1993). Gentry (1996) suggested that strategic partnerships can be enhanced by integrating more organisations within the upstream supply channel to improve quality and operating efficiencies. The increasing involvement of third party carriers may allow additional opportunities for cost savings, service improvements and increased utilisation of resources like labour and equipment for both partners. Strategic collaboration also improves the manufacturing process of product development.

Successful product launch is challenging in an uncertain environment of multiple and escalating product choices and shortening product life cycles. Manufacturers are

pushed to make new products viable financially and technically. Bowersox *et al.* (1999) pointed out that the determinants of new product success are very dependent on response based logistics as well as other factors. They promote the idea of lean launch strategy based on the principles of postponement and supply chain management, Hence this researcher focuses on the supplier-buyer operational relationships to investigate the flexibility dimensions of supplier involvement in new product development.

Joint skill development, skills sharing and learning have become important attributes in buyer-supplier relations (Anderson & Christensen 2000; Seth & Sharma 1997). Other researchers have described the move towards collaborative relationships (Araujo *et al.* 1999; Weele & Roszemeijer 1996). These researchers pointed out that there was a feeling of uncertainty over the conditions and benefits from such collaborative relationships. Furthermore, Seth & Sharma (1997) speculated that future competitive advantage depended on the type of relationships with suppliers. Since manufacturers have a multitude of suppliers, each with its own attributes and characteristics, it complicates all the existing operational processes.

Today, manufacturing firms' strategic agendas mainly concern quality, cost, innovation and responsiveness (Bozarth & McDermott 1998; Demeter 2003; Joshi *et al.* 2003; Kathuria *et al.* 1999). Traditionally, these goals were pursued through adoption of advanced technologies and manufacturing practices such as concurrent engineering, JIT and sometimes worker empowerment (Burgess *et al.* 1997; Warnock 1996) and the out-sourcing of certain functions like logistics.

Manufacturing firms regard the role of logistics providers as critical to global competitiveness (Gilmore *et al.* 1995; Tracy 1998). Therefore, logistics between suppliers and buyers is critical especially to manufacturers where JIT and other time-based competitions are critical to satisfy market demands.

A research study by The Centre for Advanced Purchasing Studies (Carter *et al.* 1998) identified 17 areas of concern in purchasing and supply. They are shown in Table 2.6 below.

Table 2.6 Areas of concern in Purchasing and Supply

Complexity management	Negotiation strategy	Strategic supplier alliances	Competitive bidding and negotiations	Source development
Virtual supply chain	Third party purchasing	Global supplier development	Process uncoupling	Performance management
Relationship management	Demand pull purchasing	Purchasing strategy development	Tactical purchasing	SC partner selection and contribution
Strategic sourcing	Strategic cost management	Electronic commerce		

Carter *et al.* CAPS 1998

The present researcher concedes that the above 17 concerns fall into the category of supplier-buyer relationship. However, it is the contention of the present researcher that increased flexibility capabilities would enable the reduction of uncertainties and problems in these areas. In this research study it is intended to investigate only the operational relationship issues identified in Table 2.6 above.

2.10 PROCUREMENT / PURCHASING

There is no commonly accepted definition of procurement. Most authors describe procurement as a set of activities or as a part of supply/supplier management or materials management. Cox (1996) described procurement management as a set of internal and external contractual relationships which is based on asset specificity of the relationships. Virolainen (1998) described it as a transformation from materials management to supply management and not just buying raw materials, parts or services. Virolainen (1998) went on to divide procurement management into three levels - competition related, procurement system related and performance related. Vaart *et al.* (1996) described the procurement system as the process of obtaining materials from outside suppliers which includes activities like requirements planning, supply sourcing, negotiation, order placement and supplier co-ordination. Some literature has used the term purchasing to describe procurement activities or a sub-set of procurement. Therefore, in this thesis, the present researcher accepts purchasing as part of procurement activities.

Historically, purchasing was seen as a passive administrative role in an organisation. Then it became a source of competitive advantage in the 1980s (Virolainen 1998) and monitoring the supply market, interpreting the trends and creating supply options became popular. As world class manufacturing practices and continuous improvement developed in terms of cost reduction, quality, delivery and new products, purchasing became a strategic option (Warnock 1996). With the increasing popularity and understanding of SCM, procurement is becoming more important.

Purchasing competence and supplier integration is found to be related to all dimensions of manufacturing performance (Narasimhan & Das 1999a). Purchasing competence is the capability to develop and manage the supply base with the manufacturing strategy (Freeman & Cavinato 1990). Purchasing integration enables the fit and alignment between purchasing practices and the business objectives of the firm by linking the purchasing plans, policies and actions to incorporate cross-functional priorities (Arnold *et al.* 1997; Wynstra *et al.* 2003). Therefore, supplier-manufacturer flexibility becomes a critical aspect of purchasing competence.

2.11 FORCES CHANGING BUYER-SUPPLIER RELATIONS

Several researchers have identified various forces influencing supplier-buyer relationships. They are described below.

2.11.1 Innovation and technology

The new economic realities of innovation and technological advancement are forcing firms to concentrate on their core competencies and outsource non-core activities. This leads to collaboration with external suppliers in order to develop shared technological capabilities (Anderson & Christensen 2000). Therefore, procurement activities must take advantage of these innovations and new technology to enhance the effectiveness and efficiencies of procurement activities.

2.11.2 Strategic collaboration

Strategic collaboration is critical for SC success, especially in entity relationships (Burnes & New 1997; Jap 1999). It provides risk sharing and synergy by using external stakeholders' expertise and specialised skills. Alliances also fail because of inter-partner diversity. Strategic partnerships can be enhanced by integrating more organisations within the upstream supply channel to improve quality and operating efficiencies. The increasing involvement of third party carriers may allow additional opportunities for cost savings, service improvements and increased utilisation of resources like labour and equipment for both partners.

In this sense, procurement activities must be able to adapt to changing strategic collaboration relationships while maintaining flexibility. It is also possible for manufacturers' procurement activities to be flexible without being involved in strategic collaboration with their suppliers.

2.11.3 New product launch

Successful product launch is challenging in an uncertain environment of multiple and escalating product choices and shortening product life cycles. Manufacturers are pushed to make new products viable financially and technically. Bowersox *et al.* (1999) pointed out that the determinants of new product success are very dependent on response based logistics as well as other factors. They promoted the idea of lean launch strategy based on the principles of postponement and supply chain management, Hence this researcher focuses on the supplier-buyer operational relationships to investigate the flexibility dimensions of supplier involvement in new product development.

2.12 NATURE OF RELATIONSHIPS

Partnerships are key elements in a SC. Every stage in a SC has a minimum of two parties – supplier and buyer. In this present research, the buyer becomes the manufacturer and good relations and close operations with the supplier provides

better quality service and products. Kanji and Wong (1999) advocated using better supplier partnerships to improve inter-organisational relationships and operations in order to leverage resources of the manufacturer's supplier to improve their own competitive edge.

Leveraging also leads to supplier quality contributions which develop integrated processes with the supplier so as to obtain and exchange information in continuous improvement activities. This concept of leveraging is supported by researchers like Gulati (1999) and Lambe *et al.* (2002).

Suppliers differ widely in their capabilities to generate benefits for their buyers. These may be in terms of cost rationalisation, ideas and practices. However, these benefits would be dependent on the closeness, or the degree of involvement of the buyer and supplier. Consequently, the higher the involvement and co-ordination of activities, the more resource demanding the relationship will be. Therefore, in maintaining the relationship there needs to be a balance between investment of resources and benefits gained. The contention is that there needs to be flexibility in the relationship.

The focus of relationships provides an understanding of the dynamics of exchange in the sense as to whether it is the evaluation of the suppliers' current offer or the suppliers' capabilities and what value they may further add to the buyers' business (Araujo *et al.* 1999). Thus, the present researcher focuses on the flexibility of the suppliers' capabilities.

The importance of long term relationships between manufacturing firms and their suppliers has been emphasised in SCM literature. To sustain a relationship, the co-ordination efforts should enhance the profitability of not only the supplier but also the manufacturer. This argument is supported by Doyle and Parker (2001) and Spekman *et al.* (1998).

An effective supplier relationship can also contribute to improving operational performance and other supplier selection attributes like quality, delivery and price (Ingene & Parry 1995; Joshi *et al.* 2003; Salvador *et al.* 2001).

Relationships and co-ordination can also be defined as the process of managing dependencies among activities. Associated dependencies could be shared resources, task assignments and design for manufacturability. Supplier innovation could also relate to improvements in supplier quality, yield, delivery time and cost (Croom 2001; Monczka & Lee 1993).

The use of power in relationships can enhance effective procurement and supply management strategies, according to Cox (2001) who goes on to explain that procurement and supply management strategies are indications of internal and external supply competence. Similarly, Carr and Smeltzer (1999) indicated that the power of purchasing skills is related to strategic purchasing and firm performance.

2.13 COMPETITIVE ADVANTAGE

A firm's competitive advantage resides not only within the boundaries of what it owns or controls, but also in idiosyncratic interfaces it develops and maintains with other stakeholders like suppliers and customers (Dyer & Singh 1998). Carter and Carter's (1998) empirical survey complemented the views of Porter (1985) that purchasing managers must take a value-chain perspective by co-ordinating closely with other internal and external functions in order to better access the impact of downstream members of the SC. Graham and Ahmed (2000) proposed that if a value chain is fully articulated, critical strategic decisions become clearer. Using SCM as the competitive advantage tool in increasing organisational effectiveness, better realisation of organisational goals, better customer care, enhanced competitiveness and increased profitability is supported by other authors (Croom & Batchelor 1997; Gunasekaran *et al.* 2001).

Dyer *et al.* (1998) undertook a comparison survey of auto-makers in America, Korea and Japan. They found that to meet the challenges of new global competition effective supplier management has become increasingly important to a firm's competitiveness by optimising purchasing effectiveness. They proposed that firms should strategically segment those suppliers who provide high value input and play

an important role in differentiating the buyers' final product into strategic partners and maintain high levels of communication with these suppliers, provide managerial assistance, make relation specific investments, exchange personnel and help them attain world class capabilities.

A survey of relationships and company performance by Groves & Valsamakis (1998) revealed that relationship practices depended on the type of partnerships and indicated that there is potential for better performance for manufacturers who develop closer working relationships with major suppliers and customers.

2.14 CHARACTERISTICS OF SUCCESSFUL PARTNERSHIPS

Some of the characteristics of successful partnerships are – free exchange of information in terms of sharing costs and demand data, co-ordinated decision making, reduction in inefficiencies, mutual trust and long term commitment (Anderson & Weitz 1992; Mirani *et al.* 2001; Mohr & Spekman 1996). Other common characteristics of strategic partnerships described by other authors (Gentry 1996; Ellram 1991; Spekman *et al.* 1998) include increased quality emphasis, cost reduction programs, continuous improvement, exchange of information, open communication and sharing of risks and rewards. Major benefits of partnerships are increased market share, lower inventory, improved delivery service, improved quality and shorter product development cycles.

Inter-firm collaboration is also required in new product development (Andersen & Buvik 2001; Campbell & Cooper 1999; Maylor 2001; Parker 2000) to give the SCN a competitive advantage.

2.15 TAXONOMY OF BUYER-SELLER RELATIONSHIPS SURVEYS

Table 2.7 below provides taxonomy of inter-firm co-ordination studies and despite the large number of studies it can be seen that there is a gap due to insufficient

studies on operational relationship flexibility. It is intended to use the present research to narrow this gap by investigating the operational relationship flexibility dimensions and their elements. Overall, investigations into seller-partner relationship flexibility are also limited and research on co-marketing alliances has been scant and conceptual (Barclay & Smith 1997).

Table 2.7 Inter-firm co-ordination studies

AUTHORS	APPROACH	DOMAIN	SURVEY TYPE	OBJECTIVES
Andersen & Buvik, 2001	Inter-firm co-ordination TCA	Co-ordination Asset specificity Environmental and behaviour uncertainty	Mail survey Industrial buyers	1.there is positive association between asset specificity and inter-firm co-ordination 2.increased asset specificity induces higher inter-firm co-ordination 3.Increased environmental uncertainty induces higher inter-firm co-ordination
Andersen & Christensen, 2000	SCM	Partnership learning	Case study	Trust building in the shared skill managing process. Organising cross-skill development processes and division of work.
Araujo *et al.* 1999	Marketing	Managing supplier interfaces	Case study	Analyse the character and consequences of different types of relationships via notion of customer-supplier interfaces
Barclay & Smith, 1997	Marketing	Dyadic relationship effectiveness	Mail survey	Trust in selling
Burnes & New, 1997	Collaboration	Customer–supplier relationships	Case Study	Operational cost and pricing
Buvik & Gronhaug, 1999	Management	TCA & Resource dependence theory	Mail survey	Asset specificity Environmental uncertainty Vertical co-ordination
Carr & Smeltzer, 1999	Purchasing skills	Strategic purchasing, financial performance and supplier responsiveness	Mail survey interview	Skills Firm performance Supplier responsiveness
Carter & Carter, 1998	Interorganisational forces	Determinants of environmental purchasing	Mail survey	Reduction, recycling, reuse and substitution of materials
Carter, Carter, Monczka, Slaight & Swan, 1998	Purchasing & Supply	Areas of concern for purchasing executives	Focus groups	Future trends in economic, demographic, societal, competitive and technological trends
Narasimhan & Das, 1999b	Manufacturing performance	Purchasing competence & integration	Mail survey	Manufacturing cost, quality, delivery, new product introduction, customisation
Dyer *et al.* 1998	SCM	Communication Managerial assistance Exchange personnel Relation specific investment Help improve capabilities	Interview	Elements of partnership : 1.High levels of communications 2.provide managerial assistance 3.exchange personnel 4.make relation specific investments 5.ensure suppliers have world-class capabilities
Gentry, 1996	SCM	Three party alliances between suppliers, carriers and buyers	Mail survey	Role of transportation providers, role of carriers and performance improvements in meeting operational

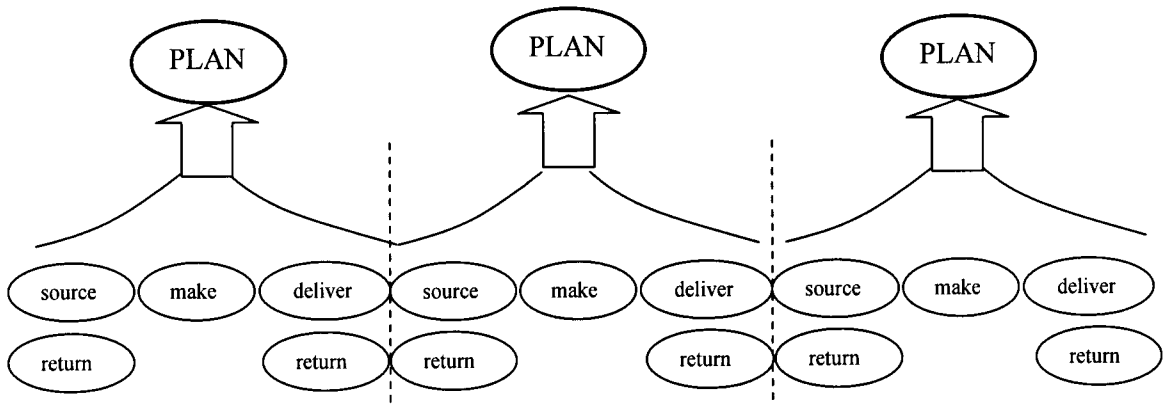
				goals
Gonzalez-Benito, Martinez-Lorente & Dale, 2002	TQM	Buyer-supplier purchasing management system	Mail survey	Relationships of purchasing system variables, quality management measures of the purchasing function
Griffiths & Margetts, 2000	Manufacturing	Supply of parts	Case study	Production schedule variations
Groves & Valsamakis, 1998	Manufacturing	Relationship framework	Mail survey	Suppler-customer relationships and company performance
Janda *et al.* 2002	Manufacturing	Manufacturer-supplier relationships	Mail survey	Quality, acquisition costs, possession costs, satisfaction and relational orientation of supplier flexibility, assistance, information exchange and monitoring
Jap, 1999	Marketing	Dyadic relationships	Mail survey	Collaborative process of environmental factors, co-ordination factors, trust and profit
Jayaram & Vickery, 1998	Procurement	Performance antecedents and overall performance	Mail survey	Human resources initiatives, procurement lead-time performance, business performance
Johnson & Sohi 2001	Marketing	Inter-firm relationship	Mail survey	Isolate and evaluate important firm level predisposition of strategic intent and relational proclivity
Krause *et al.* 1998	Management	Suppler development process	Mail survey	Supplier performance, continuous improvement, goal setting, audits, training and certification
Marcussen, 1996	Network	Effects of EDI on buyer-seller relationships	Case study	Issues of how and why EDI changes buyer-supplier relationships
McGinnis & Vallopra, 1999	Process	Purchaser and supplier involvement in process improvement	Mail survey	Strategic importance of process development, purchasing involvement and supplier involvement
Monczka, Petersen, Handfield & Ragatz, 1998	SCM	Strategic supplier alliances	Mail survey	Attributes: partnership success, trust, co-ordination, information sharing, interdependence, information quality, participation joint [problem solving and conflict resolution
Shin *et al.* 2000	SCM	Supplier/buyer performance	Mail survey	Operational performance: cost, quality, delivery and flexibility
Turner, LeMay, Hartley & Wood, 2000	Marketing	Buyer-suppler relationships	Mail survey	Interdependence and co-operation – substitutability, goal compatibility, essentiality and formalisation
Wisner & Tan, 2000	Purchasing	Supply chain management and its impact on purchasing	Mail survey	Identify problems with SCM from a purchasing perspective
Zaheer *et al.* 1998	Trust	Strategic value of buyer-supplier relationships	Mail survey	Determinants and outcomes of trust

2.16 SUPPLY CHAIN MODEL

Porter's (1985) value chain model extenuates the business activities of the use of resources, as well as knowledge, information and routines. Hence, the present researcher proposes that the same supplier-buyer operational relationship flexibility measurement may be implemented between the various entities along a supply chain.

It is the contention of the present researcher that the supplier-buyer activities are repeated along the supply chain. Porter's 1985 model of the value chain concentrated on the linkages between activities rather than simply the resources per se (Graham & Ahmed 2000). This concept has been promulgated by Porter's (1985) value chain model and the SCOR Model (Supply Chain Operations Reference Model – Supply Chain Council). The SCOR model (Figure 2.1) is reproduced below to illustrate its concepts. The SCOR model states that every entity in a SC Plan, Source, Make and deliver. Make also means value adding to product or services. Therefore Plan and Source are the main procurement activities.

Figure 2.1 SCOR Model



2.17 FLEXIBILITY DIMENSIONS OF PROCUREMENT

Manufacturing flexibility has been proven to have major advantages in a firm's strategic and competitive advantage (Muhlemann *et al.* 2000; Narasimhan & Das 1999a). Similarly, the same concepts and principles can be applied into a supplier-manufacturer procurement relationship environment. Therefore, these flexibility dimensions can be planned and managed to become a competitive and strategic weapon in procurement activities.

The supplier-buyer relationship is repeated between every entity and player along a SC. The present researcher's contention is that investigating the flexibility of supplier-manufacturer relationship would reflect similar relationships along the SC. Brill and Mandelbaum (1989) suggested that SC flexibility should be examined from an integrative, customer orientated perspective. Bechtel and Jayaram (1997) in their review of SCM literature between 1985 and 1995, promoted the idea that the key to long term competitive advantage in today's marketplace is flexibility to evoke customer response.

Therefore, the manufacturing flexibility dimensions, with modifications, are adapted to be used in this research thesis study. It is beyond the scope of the present research to study all the dimensions identified, so selected dimensions of flexibility are discussed below as being suitable for this research study into supplier-manufacturer relationship flexibility. The present study attempts to align the procurement flexibility dimensions within the definition of supply chain management.

It can be determined that flexibility must maximise the supplier-manufacturer relationship potential to deliver the right quantities, to the right geographical locations at the right time with a minimum cost and at the same time ensuring high customer satisfaction levels at all levels of uncertainties.

The primary thesis of this research study is that: the flexibility of the supplier-manufacturer procurement relationship ensures that the suppliers deliver the right product to the correct location in the correct quantity at the agreed time at the lowest

cost with high buyer satisfaction by integrating the five flexibility dimensions among suppliers and manufacturers at all levels of uncertainty.

The five procurement dimensions defined in this research are information exchange flexibility, supplier integration flexibility, product and material delivery flexibility, supplier logistics flexibility and organisational strategy flexibility. They are explained in more detail below. The specification of the domain of these five dimensions is further explained in Chapter 3 using Churchill's (1979) paradigm.

2.17.1 Information exchange flexibility

Competitive market demands like customer satisfaction and varying demands are forcing companies to schedule their production mechanisms to meet these needs. One of the methods proposed by Griffiths and Margetts (2000) is increased flexibility in production mechanisms. They suggested that suppliers need to be flexible to cater for the increased flexibility in their buyers' production schedules by increasing the visibility of customer demand to first tier suppliers. They also identified that there is very rarely any information transfer to second or higher tier suppliers.

Researchers have suggested that Information Technology (IT) can reduce co-ordination costs, leading to increased co-ordination and co-operation among buyers and suppliers. A growing body of literature suggests that IT can have a dramatic effect on relationships between firms (Bhatt & Stump 2001; Evans *et al.* 1993; Humphreys *et al.* 2001; Leek *et al.* 2002; Sabherwal & King 1992). Therefore, part of the present research is also to investigate the relationships between SC entities, namely sellers and buyers, from an IT perspective.

Many researchers have concluded that information sharing among players in up and down stream activities is common in responding to all types of uncertainties (Clemons 1993; Germain & Droge 1995; Humphreys *et al.* 2001; Jayaram *et al.* 2000; Mason-Jones & Towill 1998; Zsidisin 2000). Information sharing is also used to improve effectiveness and efficiencies of supply chains.

Based on these factors, the current researcher feels that information sharing flexibility should be a key dimension of this procurement flexibility study; so the intention is to find out how flexible are Australian manufacturers in sharing information.

Some of the problems faced by firms in a supply chain are to know what, when and how much information is to be shared. Other ethical factors related to which information is confidential and its misuse by competitors. Trust between supplier and buyers is another factor concerned with information sharing. Software industry leaders stress the importance of information sharing and IT compatibility in process orientated manufacturing industries. Lawrence Evans, founder and CEO of Aspen Tech, estimated that US$200-$300 billion of annual economic value could be gained by optimising manufacturing enterprises' IT systems in the process industries. This IT strategy involves the electronic management of information and products in a manufacturing plant well by their buyers and suppliers. There must be direct links of customer orders details to manufacturing shop floor from suppliers and buyers. Therefore, information sharing in procurement activities is vital for its efficiency and effectiveness.

Information systems and Information Technology are the enablers of Supply Chain (SC) co-ordination and optimisation. They provide the co-ordination framework and structures within a firm as well as between firms. The ability for management decision-making is based on current and relevant data and information (Goodhue *et al.* 1992). Therefore, the flexibility of the SC depends entirely on the flexibility of the IT system/s in the SC. The problems and complexity arise when the various IS and IT systems of the various entities in a SC are connected with each other (Johnson & Sohi 2001). This therefore directly affects SC flexibility.

Deveau (1999) predicted that according to SCM Software Report, 1998-2003 by Boston's AMR Research, the SCM market world-wide reached US $2.6 billion in 1998, an increase of 46% from 1997. The report also predicted that from 1998 to 2003, SCM total revenue will grow to $18.6 billion. That is a 48% compound annual growth rate. With this growth, the savings in improving the effectiveness and efficiencies of SCM and especially procurement activities is increased.

Goodhue *et al.* (1992) have provided a very good example of lack of IS co-ordination and integration in a case study at Devlin Electronics. On time delivery of electronic semi-conductor parts fell to 70%. However, there are still a number of reasons that hinder the development of fully integrated business processes, as for example, the lack of understanding of the complexity of the organisations and the high cost of acquiring and translating organisational and engineering data (Garcia-Flores *et al.* 2000). Results of case studies by Stefansson (2002) indicate that effective data sharing between different parties in the SC is more of a vision than a reality especially with SMEs.

The 'bull-whip' effect (Lee et al. 1997) also contributes to information exchange flexibility. The downstream information must be shared by all the SC entities in the upstream section of the SC. The real time information provides channel alignment and operational efficiency together with efficient and effective co-ordination to reduce lead-time and costs. This is further reiterated in the emergence of e-commerce and e-business applications (Lee & Whang 2001) where the integration of information sharing, synchronised planning and workflow co-ordination leads to streamlining of front-end and back-end operations of a SC.

2.17.2 Supplier Integration flexibility

Gentry (1996) suggested that strategic partnerships can be enhanced by integrating more organisations within the upstream supply channel to improve quality and operating efficiencies. More hubs in a wheel don't necessarily make it run better, but the increasing involvement of third party carriers may allow additional opportunities for cost savings, service improvements and increased utilisation of resources like labour and equipment for both partners.

A survey of relationships and company performance by Groves and Valsamakis (1998) revealed that relationship practices depended on the type of developed partnerships and indicated that there is potential for better performance for manufacturers who establish closer working relationships with major suppliers and customers.

The identified major benefits of partnerships are: increased market share, lower inventory, improved delivery service, improved quality and shorter product development cycles. Dyer *et al.* (1998), Gentry (1996), Ireland *et al.* (2002), Monczka *et al.* (1998), Spina & Zotteri (2001) described the common characteristics of most strategic partnerships in terms of increased quality emphasis, cost reduction programs, continuous improvement, exchange of information, open communication and sharing of risks and rewards.

Manufacturers need to tap into supplier technologies and expertise in product design and development (Dowlatshahi 1998; Nellore 2001; Ragatz *et al.* 2002; Wynstra *et al.* 2003). However, there is little research linking this to procurement flexibility and performance.

Therefore, operationalisation is defined in terms of procurement flexibility of manufacturers to improve partnerships in their manufacturing performance. Operationalisation of partnership integration flexibility would be in terms of range, uniformity and mobility. These constructs would be designed in the survey instrument to reflect the ability to respond, in real time, to external uncertainties. The extent of flexibility of suppliers to reduce lead-time of in bound supplies and deliveries; and the extent of involvement of suppliers and customers in the procurement process was built into the survey instrument.

2.17.3 Product and component supply flexibility

Product flexibility is the ability to handle various types of products in terms of size, colour, options and features; product also includes product components and sub-assemblies to complete the final output.

The measure of flexibility would determine how easy or difficult it is for the supplier to accommodate the manufacture of different products as well as delivery reliability and speed (Handfield & Pannesi 1992). The customisation would be the ability to handle difficult and non-standard orders to meet special customer requirements and specifications. This dimension sometimes requires the collaboration of customers,

suppliers and manufacturers from the initial stages of design to the final stages or manufacturing.

Collaboration between suppliers, buyers, marketing, product design and production staff in responding to external uncertainties in terms of products with short life cycle is critical in manufacturing activities. New products must be released in time to take advantage of consumer sentiments and demands. The timely procurement of materials, components and parts is vital for the manufacturing process to produce the final product in time for marketing campaigns.

Therefore, procurement flexibility is critical in ensuring that suitable supplies are sourced in time. Also, suppliers must have the flexibility to produce and supply mixed materials, components and parts in a limited time.

2.17.4 Supplier logistics flexibility

Logistics flexibility includes the ability to adjust and modify the delivery of supplies. It includes location and routing to buyers, distribution, warehousing, inventory management and transportation. As the majority of buyers and suppliers out source their distribution activities, logistics control becomes an important element during uncertainty. Some researchers (Narasimhan & Das 1999b) have identified this as delivery flexibility – the delivery responsiveness of firms to customer needs.

In the Australian context, studies in logistics (Rahman 2003) have indicated that manufacturing/service organisations are ahead of logistics firms in the application of quality management practices in the logistics functions. Hence, part of the present research is to investigate how the logistics functions relate to procurement activities; viz., how do external uncertainties like transport workers' strikes affect the logistics functions in delivering materials, parts and components to Australian manufacturers.

2.17.5 Organisational flexibility

Organisational flexibility is not new. Economists have researched the concept in business for over 60 years. The early focus has been on production facilities (Golden & Powell 2000). Organisational flexibility is concerned with the structure of an organisation and making it responsive to uncertainties and changes in the environment (Armistead 1989; Kara *et al.* 2002). It concerns jobs, activities, internal communications, inter-departmental relationships, organisational culture, procedures and policies.

A highly responsive organisational structure is critical for success in a turbulent environment. Organisational structure is where information and decisions flow through quickly. These decisions are monitored and communicated to the organisational staff and frequently to external stakeholders. To be responsive to uncertainties, the organisational structure needs to respond as effectively and efficiently as possible. Therefore, the flexibility of an organisational structure is pertinent to the successful implementation of strategies.

The flexibility of an organisational structure also depends on its design, such as, is it mechanistic or organic in nature. This flexibility also depends on the procedures and policies of the organisational structure (Kara *et al.* 2002). Aggarwal (1997) recommended that to reap the greatest rewards from an organisational structure, the decision making function must be moved to the lowest levels possible.

The flexibility of the various players in a SC also impacts the organisational performance of firms within the supply chain. Kanji and Wong (1999) identified several inadequacies in current SC models. One important inadequacy was the human factor in intra-organisational relationships and operations. How flexible the human relationships are in relation to inter organisational relationships relates to procurement activities as well.

This research developed constructs to explore the reflected organisational components of flexibility to procurement. The following constructs will be identified: co-ordination between the different departments in relation to the supply

chain, established and availability of processes to respond in real time to external uncertainties, extent to which the organisational resources would be stretched to respond to external uncertainties. Organisational flexibility also includes inter-organisational strategic planning flexibility in line with other supply chain entities.

2.18 CONCLUSION AND CONCEPTUAL MODEL

Chapter 2 has introduced and discussed supply chain management, its complexities and external influences; the concept of flexibility; buyer-supplier relationships; and dimensions of procurement. It sets the framework for the importance of supplier-manufacturer procurement strategies.

Procurement is critical in the manufacturing sector as it maintains the continuous production of components, materials and products. If there is a disruption in the supply, the production process is hampered. Implications of production process disruption have many consequences like staff lay-off, customer dissatisfaction, lost customer contracts, etc.

Strategic procurement management is not only about negotiating lower prices, tendering, contracts and auctions. It is about managing the maximum use of supplier capabilities to enhance the manufacturer's competitive edge. It is also about procurement policy regarding demand rate and fixed lifetime (Hwang & Hahn 2000).

An initial hypothetical model (see Figure 2.2) was developed from the above literature review. The model represents a conceptualisation of the various supplier-manufacturer dimensions, reviewed above, from a manufacturing procurement operational flexibility perspective. The current researcher tests this hypothetical model within the Australian manufacturing sector. This hypothetical model is the main objective of the current research thesis.

The hypothesised model (Figure 2.2) also proposed to investigate if these five dimensions conceptualise the procurement operational relationship between manufacturing entities OR are there other subsets of these five dimensions.

From the conceptual model above (Figure 2.2), the present researcher generated the measurement items for the Q-sort technique discussed in Section 3.2.2. The definitions of the five procurement flexibility dimensions and its three elements used in this research are tabulated in Table 2.8 and Table 2.9 below.

The conceptual model of Figure 2.2 is operationalised in Figure 2.3 in the following page. All the items of the survey instrument derived from extant literature review are incorporated into this operationalised model. It also provides the dimensions, elements and the item numbers from the survey instrument. The methodology in Chapter 3 and data analysis in Chapter 4 are based on this operationalised model. From the definitions of the elements in Table 2.9, the details of the three elements and the related items in each of the constructs are tabulated in Table 2.10.

Figure 2.2 Proposed Procurement Flexibility Conceptual Model

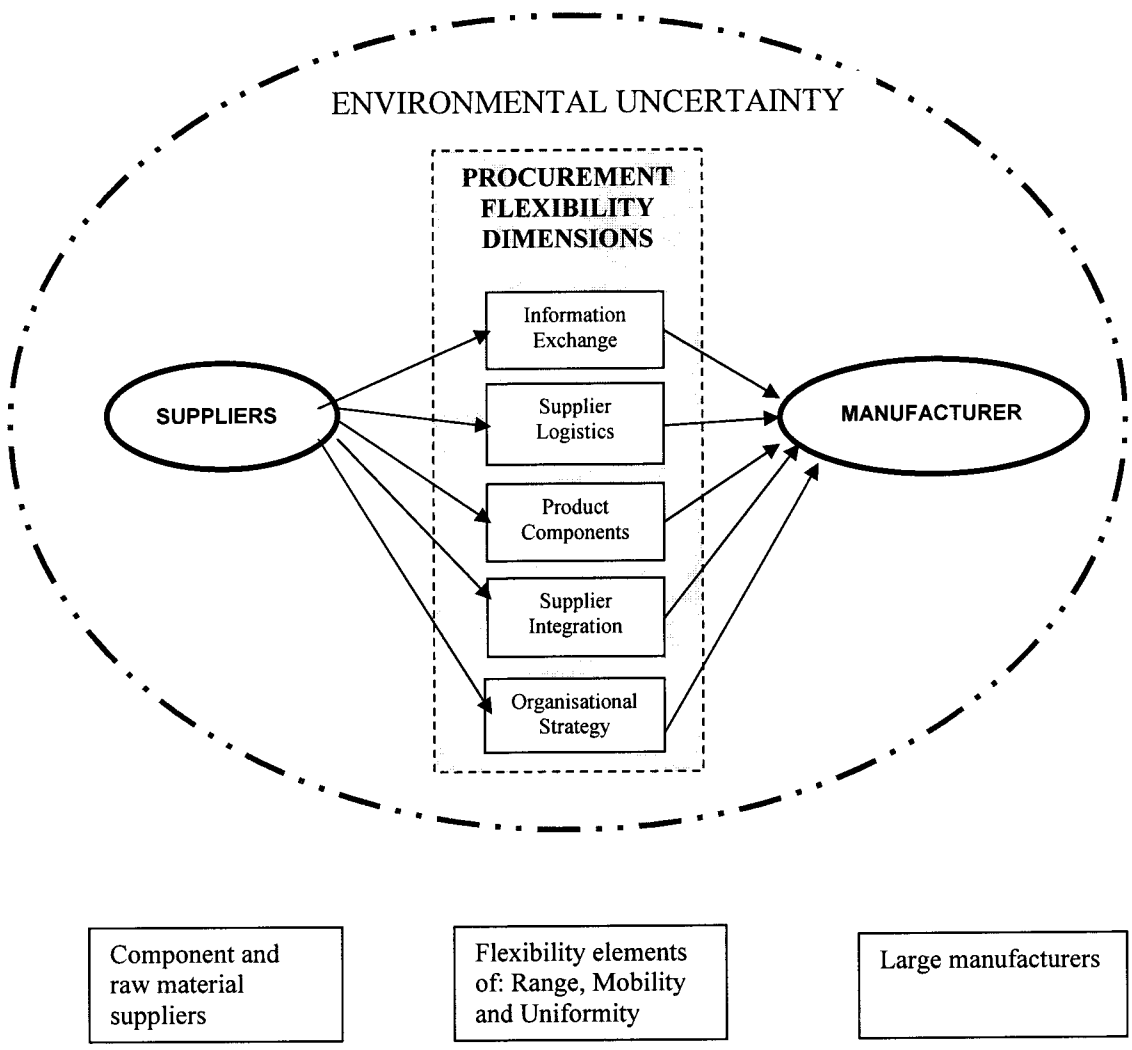


Table 2.8 Definition of Procurement Flexibility Dimensions

Information Exchange	Receive and transmit information to and from suppliers
Supplier Integration	Modify and establish integration into manufacturing process
Materials/Product/Components	Reconfigure suppliers' ability and capability to modify supplies
Logistics	Reconfigure transport, routing and materials handling
Organisational Structure	Realign and co-ordinate organisational strategies

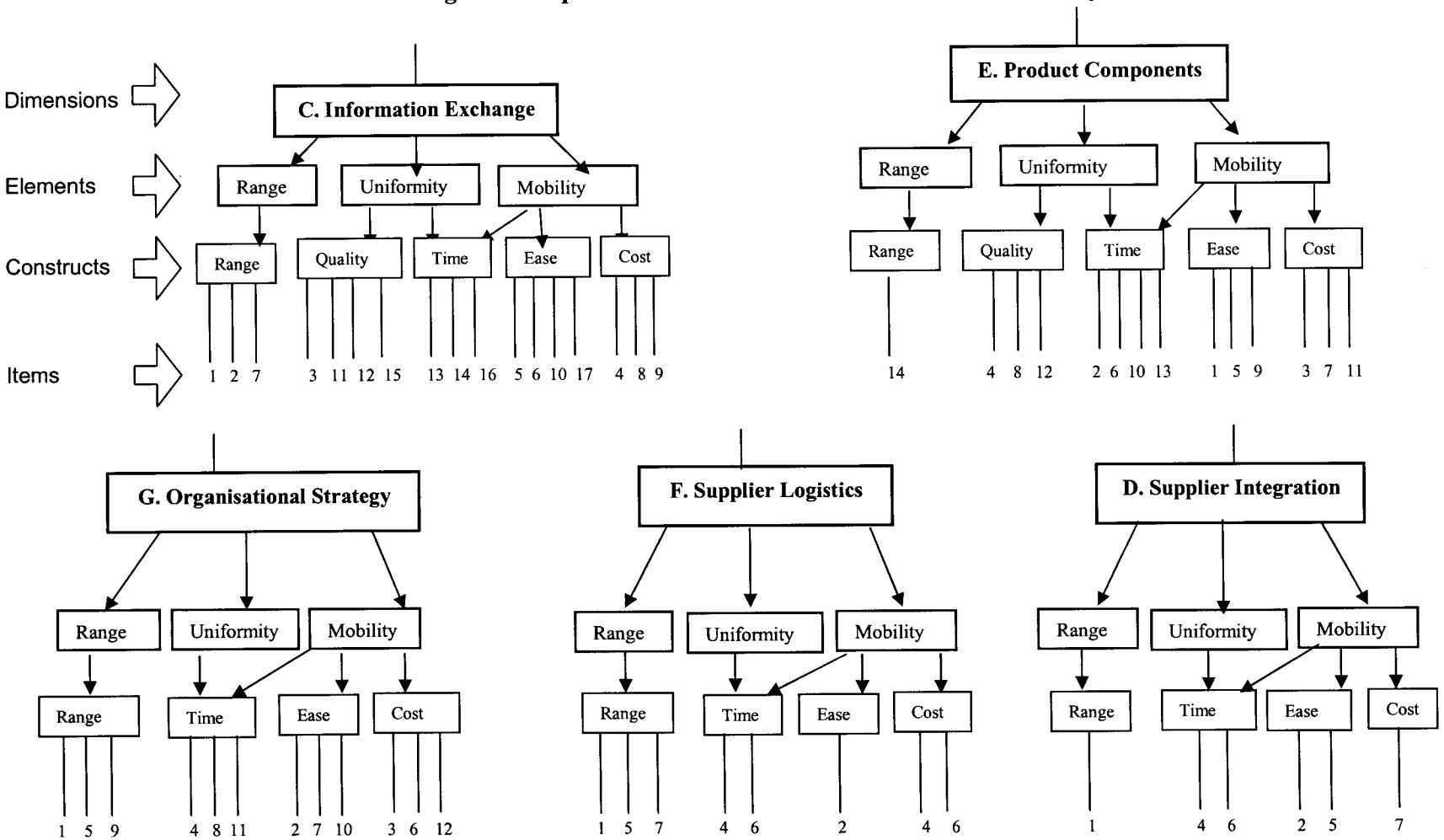
Table 2.9 Definitions of Procurement Flexibility Elements

Range	Different states or number of viable operational states
Uniformity	Performance of quality and time in any state or condition
Mobility	Ease of movement from one state to another state

Table 2.10 Construct Components of the Elements

Element	Constructs
Range	Range
Uniformity	Quality and Time
Mobility	Ease, Cost and Time

Figure 2.3 Operationalised Model of Procurement Flexibility



CHAPTER 3

RESEARCH METHODOLOGY

3.1 INTRODUCTION

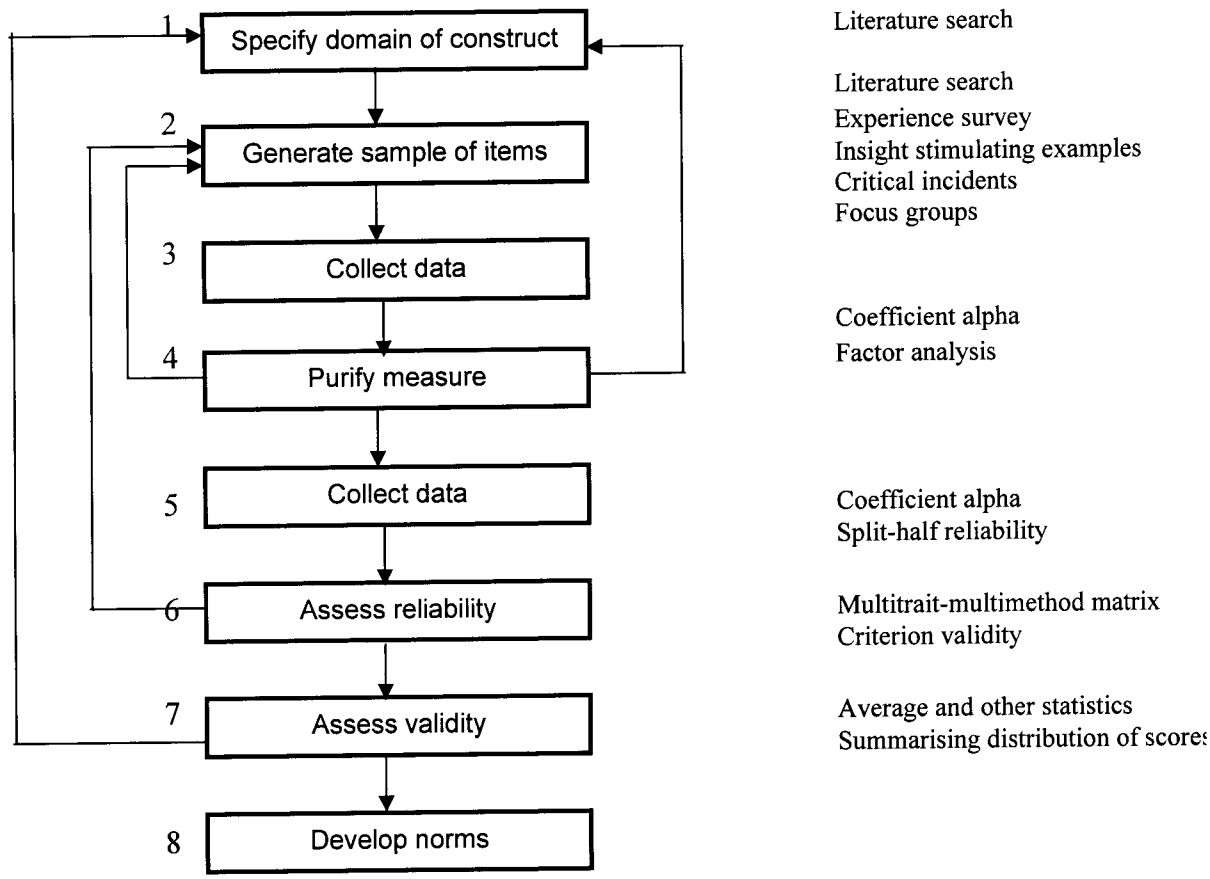
In this chapter there is a discussion of the methodology that was used to test the proposed model of supplier-manufacturer procurement flexibility (SMPF) dimensions and its elements. Initially, the basis for the survey instrument design is described, then various statistical tools and measures were set. There is exploration of existing literature in the use of measurement instruments used to test uncertainty and procurement flexibility, then a discussion of measurement instrument testing and validation is made. Next, are described the data collection and data analysis methods with the operationalisation of the constructs of the current research.

An explanation is provided as to the use of basic univariate analysis, multivariate analysis, multiple regression analysis, principal component analysis and cluster analysis. The chapter concludes with an outline of the assumptions, problems and limitations associated with the present research.

3.2 RESEARCH DESIGN

The research methodology used to answer the research questions is based on multi-method research and empirical data. The current research uses a quantitative strategy and follows Churchill's (1979) suggested paradigm for developing better measures of the variables as well as a qualitative research. This paradigm has been widely accepted and used by researchers in operations management research (Buvik & Gronhaug, 2000; Carter & Carter, 1998; Shin *et al.* 2000; Spriggs, 1994; Vonderembse & Tracey, 1999; Zhang *et al.* 2003). Similarly, the methodology chapter is designed to follow the cumulatively developed model of Churchill (1979). Figure 3.1 illustrates the general overview and steps involved in developing better measures.

Figure 3.1 Suggested Procedure for Developing Better Measures
(Churchill, 1979)



The research design consists of the literature review and Q-sort followed by a postal survey of the Australian manufacturing industry. It also uses a three-way triangulation methodology. The use of multiple research methods is a common research design in operations management (Beach *et al.* 2000; Narasimhan & Das 1999b; Pagell & Krause 1999; Parker 2000; Thomke 1997).

3.2.1 Construct domain

An extensive literature review revealed many items in SCM and procurement related activities: supplier-buyer relationships; dimensions and elements of flexibility. The present researcher compiled these items into the five dimensions of supplier-manufacturer procurement flexibility and adopted the three elements of range,

mobility and uniformity as explained in Chapter Two. The resulting fifteen constructs formed the basis for the survey instrument items (see Figure 2.3).

3.2.2 Items generation and purification

One objective of the research was to develop a conceptual framework and identify generalisable dimensions of supplier-manufacturer procurement flexibility. An initial list of three hundred and thirty two items was compiled during a review of literature; the items included perspectives from purchasing & supply management, production management, operational management, marketing, management science, operations management, procurement and supply chain management. The number of items was reduced by deleting duplication and those not directly related to supplier-buyer operational relationship, which resulted in a selected list of one hundred and fifty six items.

The one hundred and fifty six items were consolidated further by means of one to one interviews with a post-graduate procurement student, a procurement practitioner and an academic in the procurement field. From the deliberations and suggestions of these interviews, the number of items was further reduced to ninety-four. The ninety-four items were then applied to a Q-sort process to refine the items, which amounted to identification of fifty-seven relevant items. See Appendix 1 for details of the Q-sort item listings.

This validation process was to ensure that the items in the survey instrument were confined within the framework of the present research and focused on the proposed five dimensions. It was also to validate that the final instrument items were covered within the pertinent literature reviews.

The Q-methodology has been proven to be effective in investigating differences between people and in testing theories on small sets of individuals carefully chosen for their knowledge. It has mostly been used in psychometric research (Freedman 1997; Sachs 2000; Teske 1985), health studies (Stenner *et al.* 2003) and in marketing (Fairweather & Swaffield 2002).

The main efficacy of the Q-sort technique lies in the analytical possibilities of creating factors that represent common variations in perceptions held by people (Albanese 1993; Fairweather & Swaffield 2002; Funder *et al.* 2000; Hessler 1992) and the factor scores provide information also about which items identify and differentiate the factor clusters of people (Boscolo & Cisotto 1999). These factor scores, then, can be interpreted by identifying which variables are positively or negatively associated with the factor. Q-sort also helps to form clusters of descriptive categories and concepts, but in this research it was used to evaluate the importance of the various items in each cluster.

Therefore, the Q-sort methodology provided a practical perspective of the Australian manufacturing industry experience and made the survey questions more relevant to the practitioners that were the recipients of the questionnaire.

The Q-sort was administered to fifteen senior industry practitioners and consultants in procurement, logistics and purchasing. These fifteen respondents are members of the Australian Institute of Purchasing and Materials Management. Initially twenty practitioners were contacted and requested if they were willing to participate in the Q-sort process, only fifteen replied positively. They were then sent the list of ninety-four items.

The respondents were requested to nominate each of the identified ninety-four items into the five dimensional groups predefined from the literature review (shown in Table 3.1 below). If an item did not fit into a predefined dimensional group, the respondents were requested to nominate it into the '0' category. Items that were nominated into the '0' category were removed from the list. See Appendix 1 for a full list of the ninety-four items. Each of the respondents was requested to indicate the importance of each of the ninety-four items. Those items nominated more than 8 occurrences were retained to make up the final survey instrument.

Since there are no published studies on ProcFlex and it was difficult to establish the choice for 8 occurrences. The present researcher adopted Ekinci's (2001) 60% rule. Although Ekinci (2001) used the 60% rule for scaling the 41 subjects, the present researcher decided to lower that scaling to 55% because of the smaller number of

participants. The present researcher accepts that future similar studies in this area might be able to justify a more robust scaling.

The Q-sort technique revealed that the ninety-four items could be reduced adequately to fifty-seven items; the remaining thirty seven items were deleted. The fifty seven items were used, then, to make up the final survey instrument. The final survey instrument also included demographic data of respondents and their firms.

Table 3.1 Procurement Dimensions for Q-Sort Technique

1	*Partnership Integration*	Represents the extent of operational integration of suppliers with manufacturers. It is the collaborative and co-ordination activities to enhance the integration. It also includes sharing risks & rewards and synergy by supplier and manufacturer towards the mutual common end consumer. It also involves involvement in each other's processes.
2	*Components & materials*	Represents supply of materials/components/sub-components, product modification & product specifications. It also includes mixed product range.
3	*Logistics*	Represents supplier delivery, scheduling, inventory, warehousing and transportation to manufacturer. It includes adjustment and modification of delivery of supplies.
4	*Information systems*	Represents the exchange of information between supplier and manufacturer and compatibility of Information Systems.
5	*Organisational*	Represents the manufacturing organisation's structure, systems, processes, people and technology. It also includes organisational resources used in the procurement activities.
0	*None of the above*	

3.2.3 Scale development

Churchill (1979) recommended the use of multi-item measurement scales because firstly, they have low uniqueness or specificity. Secondly, they do not categorise items into very small groups. Thirdly, they have less measurement error compared to single item measurement scales. Multi-item measurement scales must have the properties of reliability and validity (Venkatraman 1989). Reliability is the degree to which the observed variable measures the true value and is error free. Validity is the degree to which a measure accurately represents what it is supposed to measure. Reliability and validity testing is explained in more detail later in the chapter.

To date, there is much literature on purchasing and supplier-buyer relationships, but to the researcher's knowledge there is no published comprehensive measurement scale for procurement/purchasing flexibility or supplier-manufacturer relationship flexibility dimensions. Arguably, it is reasonable to consider that it is timely that a generalisable and reliable scale for supplier-manufacturer flexibility dimensions and elements be designed. Such a scale would help to transcend the various entity relationships along a SC while substantially broadening the understanding of factors associated directly or indirectly.

A review of relevant literature enabled the present researcher to identify items that had been used in the past to operationalise various independent aspects of supplier-buyer relationships. After identifying these items, they were grouped into flexibility cluster dimensions. On examination of these clusters, the researcher formulated five dimensions and then sought to design a single instrument that was representative of the five dimensions; viz., logistics, product/component, organisational, information and partnership. A further review of literature enabled the present writer to conclude that these five dimensions needed further in-depth examination and that three elements of flexibility could be researched; viz., range, mobility and uniformity.
Since this research is exploratory in nature for the Australian manufacturing sector, the present researcher decided to use a Likert scale with seven responses for each item with scores ranging from 'strongly disagree' 1 to 'strongly agree' 7.

3.2.3.1 Procurement Flexibility Scale Development

One of the main objectives of the present research is to develop a measure of procurement flexibility. This single measure of Procurement Flexibility (**ProcFlex**) was developed from the Sum of Means score of all the 57 flexibility items in the survey instrument. The present researcher decided that any score of more than 5 is considered extremely flexibility, 4 to 4.99 moderate flexibility, 3 to 3.99 low flexibility and less than 3 no flexibility. This provided a measure of procurement flexibility that can be applied anywhere. This procurement flexibility is discussed in more detail in section 4.6.7.2

3.2.4 Use of triangulation

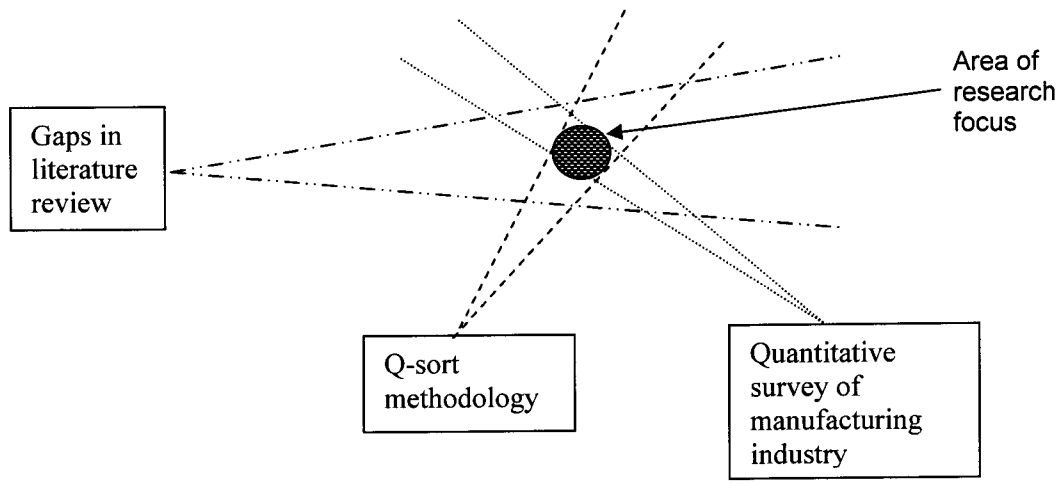
Literature review in procurement activities found that that there was inadequate published knowledge in procurement flexibility. One explanation for this could be that practitioners and academics have jumped on the band-wagon of SCM as it has captured world wide business enterprises' attention similar to Hammer and Champy's (1993) Business Process Reengineering (BPR) philosophy in the early 1990s, where the majority of enterprises embracing BPR failed in their attempts to re-engineer their organisations.

This business perspective of conforming to other market leaders and market demands of embracing new and current business philosophies of looking at the bigger picture left a void in perfecting the smaller operational steps and processes of the big picture. Many enterprises promote themselves as adopters of change and innovation but do not 'walk the talk'. This is evident by the lack of detailed research and published literature. Therefore, the present researcher took a step in that direction by investigating a small part of the SCM process in terms of procurement flexibility by using the triangulation method.

Triangulation is an accepted method in operations management. The triangulation methodology relies on information viewed from three different perspectives. Triangulation refers to the study of a topic using two or more different research methods which provide the benefits of a more in-depth and thorough study of a topic. This design has been well documented in research design (Boyer & McDermott 1999; Kaufman *et al.* 2000; Scandura & Williams 2000).

This design not only provides a more complete description of the topic being studied, but also facilitates a better understanding and higher accuracy of the conclusions that are drawn from the study. It also provides an expectation of a convergence of the research results. This methodology is suitable for studying a research topic that is in an early stage of development. It allows the establishment of empirical practices for further research.

Figure 3.2 Triangulation methodology



3.3 SUPPLIER RELATIONSHIP FLEXIBILITY DIMENSIONS

Supplier relationship importance was the first part of the survey instrument. Respondents were requested to indicate the importance of the five procurement dimensions in term of importance. Direct variables were nominated so as to investigate the five procurement relationship dimensions. They were variables of information exchange flexibility, supplier integration flexibility, materials/components flexibility, supplier logistics flexibility and organisational strategy flexibility.

3.4 UNCERTAINTY MEASUREMENT INSTRUMENT

In Chapter Two, various environmental uncertainties and forces influencing the manufacturing sectors were discussed. The review of literature indicated that the most common environmental changes in marketing practices were: rate of product obsolescence, predictability of competitors' actions, ease of predicting consumer tastes and demand, and the degree of change of production and service technology. Some of these researchers are Buchko 1994; Escudero *et al.* 1999; Miller & Droge 1986; Petrovic *et al.* 1998; Swamidass & Newell 1987. Details of the environmental uncertainty research are tabulated in Table 3.2 below.

Thus, in the present study, the researcher modified the factors into a manufacturing procurement perspective. From the review of current literature, seven variables were derived to measure environmental uncertainty in the Australian manufacturing sector; they were customer demand, imported substitute products; government-imposed regulation and tariffs, environmental concerns of recycling, product obsolescence rate, competitors' actions and supplier pricing.

Table 3.2 Item Measures for Environmental Uncertainty

Author	Dimensions	Elements
Anupindi & Akella, 1993	Suppliers	Raw materials - quality, delivery timeliness, cost
Bourgeois 1985	Strategic goals	Customers, competitors, suppliers, regulatory groups, technology.
Buchko, 1994	Automobile industry	Suppliers, competitors, financial markets, government and unions
Gullu *et al.* 1999	Supplier inventory	Machine breakdown, shortages, capacity and strikes.
Miller & Droge 1986	Organisational structure	Marketing practices, product obsolescence, competitors, customer demands, production technology.
Petrovic *et al.* 1998	Supply chain	Customer demand, lead times, supplier reliability, inventory, costs.
Priem *et al.* 2002	Executive perceptions	International competition, industry competition, production costs, human resources, government, society.
Swamidass & Newell 1987	Manufacturing strategy	Customers, competitors, government regulations, politics, unions.
Vickery *et al.* 1999	Furniture industry	Marketing practices, product obsolescence Competitors' actions, customer demands and taste, production modes.

The present researcher found that the postal survey instrument did not fully investigate the nature of the environmental uncertainties faced by Australian manufacturers, therefore an additional email survey using consisting of two questions. This questionnaire was sent by email to all the respondents who provided their business cards for a feedback of the survey results. This group of respondents was chosen because of their interest in the feedback and the present researcher expected a higher response rate. The qualitative survey asked the respondents to answer the following two questions:

1. How does your firm respond to environmental uncertainties affecting your procurement activities?

2. Which is the most critical uncertainty in the procurement activities of your industry?

3.5 FLEXIBILITY MEASUREMENT INSTRUMENT

The literature review described in Chapter 2, provided much information about flexibility research in supplier-buyer relationships and manufacturing flexibility. The flexibility dimensions adopted for this research study are supplier integration, materials/components, logistics, organisational strategy and information exchange. From the literature review there was information on the elements of flexibility, viz. range, uniformity and mobility. Combining the five dimensions and three elements (5x3) the present researcher derived fifteen constructs for inclusion in the research instrument.

Gupta and Somers' (1996) developed an instrument for measuring and analysing manufacturing flexibility. The present research study adopted the flexibility concepts from the survey instruments of Gupta and Somers (1996) and Vickery's *et al.* (1999) supply chain flexibility. Manufacturing flexibility and SC flexibility were determined to illustrate the same characteristics and dimensions as procurement flexibility, as pointed out in the review of literature in Chapter 2.

Gupta and Somers (1996) items included volume, programming, process, product, production, market, machine, routing, material handling and expansion. Although these were designed for the manufacturing process, most of them can be used in the procurement process. For example, volume, routing, programming and materials handing are applicable in procurement management and, therefore, relevant to the flexibility issue.

3.6 MEASUREMENT INSTRUMENT TESTING AND VALIDATION

The complexity and exploratory nature of this research thesis required various quantitative data analysis. Construct validity was supported by demonstration of answers to separate criterion questions; the criterion questions used a seven-point scale ranging from 1 'strongly disagree' to 7 'strongly agree'. Reliability was tested using a test-retest stability whereby the amount of error was determined by the Cronbach Alpha coefficient.

Since the primary objective of this research was to develop a conceptual framework of supplier-manufacturer relationship flexibility dimensions and its elements and the secondary objective was to undertake an exploratory study of the relationships between SMPF and their response to uncertainty in the Australian manufacturing sector, data analysis like correlation analysis, multiple regression and principal component analysis provided desirable measurement of relationships between the dimensions and elements of procurement flexibility.

A copy of the final version of the questionnaire was mailed to 1300 manufacturing firms in Australia in the manufacturing SIC code listing as shown in Table 3.3 below.

Table 3.3 Standard Industry Classification Codes

SIC code	Category
20	Food and kindred products
24	Lumber and wood products
25	Furniture and fixtures
26	Paper and allied products
27	Printing and publishing industry
28	Chemicals and allied products
30	Rubber and miscellaneous plastics
31	Leather and leather products
32	Stone, clay, glass and concrete products
33	Primary metal products
34	Fabricated metal products
35	Industrial and commercial machinery
36	Electronic and electrical equipment
37	Transport equipment
38	Measuring, analysing and controlling equipment
39	Pharmaceutical products

As it can be seen, only seventeen SIC categories were selected. Section 3.8 explains in detail why other categories were not sampled.

3.6.1 Scale unidimensionality

The present research was about dimensions of procurement flexibility, which means a number of dimensions. Thus, the set of measures for each given dimension had only one dimension. Therefore, to have unidimensionality means all items in each dimension must measure only that dimension and not any other (Hair *et al.* 1998). To establish that the indicators are reliable and valid measures of the specific dimension, unidimensionality was tested by statistical analysis.

In Principal Component Analysis (PCA) the underlying factors load into groups to reveal which items measure a particular concept. PCA is discussed in more detail in section 4.14. PCA is also useful in testing the structure (Venkatraman 1989). Unidimensionality was also built into the survey instrument by validating and testing it together with keeping the item questions short and simple with reference to a single dimension (Hessler 1992).

3.6.2 Decision criteria for the use of Structural Equation Modelling

Although Structural Equation Modelling (SEM) is used extensively in simulation models (Cribbie & Jamieson 2000) to test theoretical models, it is becoming a more widely used approach in empirical research for testing ambiguity. The present researcher was satisfied with the results of multiple regression and PCA analysis to develop the final model in this exploratory research and felt that the development of the proposed model with eight dimensions would be the basis for future research in procurement flexibility where SEM can be used to test field data more robustly.

This was further enhanced that PCA analysis with eigenvalue of 1 actually produced fifteen dimensions. Since the number of items in the higher order components extracted had very few items, the present researcher felt that the Q-sort process and survey instrument was not sufficiently robust to warrant SEM.

Further, the present researcher admits that not all the activities of procurement were included in this research, SEM would have limited value. It is however suggested that SEM would be an excellent and robust methodology where all the activities of procurement, like tenders, contracts, agreements, ordering, materials management,

inventory and invoicing are included in a comprehensive study. The present researcher also felt that this study is only a means to establish the fundamental and generalisable framework of a ProcFlex model for future research.

It must also be recognised that some researchers (Chin & Todd 1995; Segars & Grover 1993) have highlighted the dangers of inappropriate conclusions in SEM when there is an absence of well developed substantive knowledge in the area of research. The present researcher has identified the lack of research in this area of ProcFlex.

If one of the objectives of this research was to investigate the influences between the various dimensions of ProcFlex, then SEM would be the most appropriate analytical tool as reflected by some researchers (Bedeian, Day & Kelloway 1997; Petersen *et al.* 2000)

Since the present researcher's objective was to develop a generalisable model of ProcFlex, PCA was used to develop a set of uncorrellated components based on scores on the variables. These components empirically summarise the correlations among the variables. Since there is a lack of published literature, no hypotheses were developed prior to data collection, hence PCA is often the appropriate strategy (Tabachnick & Fidell 1989).

Most studies adopt SEM to verify the fitness of the hypotheses and the structural model (Byrne 2001; Oh & Seo 2001). The intention of the resent research was to develop a generalisable model and not to clarify any causal relationship among the dimensions. Therefore SEM was not considered as the preferred data analysis methodology in the present study.

3.7 PRETESTING

Since the survey instrument constructs and items are adopted from several sources of literature as mentioned in Chapter Two, preliminary efforts were undertaken to assess the reliability of the scales. The coefficient alpha for each scale and the item to total correlation for each item was assessed. Although the small sample size

prevented any firm conclusions, the analysis, however, high-lighted some problem items.

Reverse worded items had low or negative item to total correlation. However it was decided to retain these reverse worded items to check reliability of respondents actually reading these items in full and comprehending before answering. The Q-sort items were consulted before changes were made. Changes to the pre-test instrument are shown in Table 3.4 below.

Table 3.4 Item changes, additions and deletions to survey instrument

Dimension	*Old item*	*New item*	**Action**	**Justification**
Title	Manufacturing procurement survey	Supplier-manufacturer procurement relationship survey	amended	accuracy and objectivity
Environmental uncertainty	The rate at which products and services are getting obsolete in the industry is very slow	Our product obsolescence rate is very low	amended	simplicity
Supplier product delivery flexibility	Supplier total lead time	-	deleted	ambiguous
Supplier integration	Suppliers can adjust to changes in our demand schedules	-	deleted	ambiguous
Supplier product delivery flexibility	Suppliers can produce new components	Suppliers can deliver new components	amended	simplicity

Therefore, content validity of the instrument was assured by several methods. Firstly, the survey instrument was tested by fifteen part-time postgraduate students in a Master degree Strategic Procurement class and an academic in Procurement at Curtin University of Technology. These fifteen part-time postgraduate student were chosen because of their involvement in full-time work in the areas of purchasing, material management and procurement in various areas of the mining industry and government. In addition to completing the questionnaire, the respondents provided qualitative feedback, via notes and comments on the clarity of instructions and the survey items. The results of their input were used to ensure question clarity, completeness and the elimination of ambiguities. The final survey instrument is shown in Appendix 2

3.8 SAMPLING FRAME

The objective of the present research was to achieve a generalisable framework of supplier-manufacturer procurement flexibility in the Australian manufacturing sector. To achieve this it was decided to investigate a prospective sample population of the Australian Industry Group; the largest representative body of Australian manufacturers was approached initially with the research idea and a request for a membership list for correspondence. The request was denied due to confidentiality and privacy regulations. It was decided then to use the Dun & Bradstreet (Business Who is Who) on-line database.

Initial assessment revealed more than 11,000 business registrations under all the Standard Industry Classification (SIC) codes. Therefore, to enable a manageable sampling framework a few criteria were used. Because of the low response rates of previous similar studies (Table 3.5), it was decided to seek a target list of 2000 respondents. Therefore, the criteria for selection were firstly, the procurement activities must be large enough substantially to warrant an investigation, have a procurement officer, and an incentive to improve their procurement flexibility dimensions. So the respondent selection criteria were annual procurement volume in terms of dollars must be more than 10 million AUD and have a staffing of more than 70. It was assumed that these criteria would suggest that the larger the volume and

staff would mean that the larger the procurement activities, the less likely the bias and less guessing in responding to the questionnaire. There was no published literature available to check if these criteria were field tested before.

These initial filters reduced the likely sample to 2083 companies. On detailed investigation and analysis, it was found that some of these companies were duplicated in multiple SIC codes. These duplications were traced and deleted. On detailed analysis of operation activities, it was also found that there were many companies which were classified as manufacturing companies yet they did not have their manufacturing base in Australia. Such companies were deleted from the initial list.

A further refinement of actual business activity was undertaken by analysing each and every company as to their business activities. There were some companies, especially in the SIC codes of 27 (Printing, Publishing & Allied Industries) and 36 (Electronic, Electrical Equipment) for which core business was not manufacturing, but consulting and activities of a similar nature. These companies were also deleted from the sample list. The resulting sample list contained more than 1600 companies.

The next criteria was that each SIC code must have at least 50 companies in the sample population. This criterion is to enable the extraction of the leaders and laggers of procurement flexibility within the Australian manufacturing industry as a secondary objective. This would be obtained by separating the various SIC codes into cells. The filtered sample of the 2083 companies revealed that the sample size within the various SIC codes were unequal. Tabachnick (1989) suggests that unequal cell sample size would cause problems. Hair *et al.* (1998) suggest that as a general rule the sample size must be five times the variables to be analysed. This would have meant that certain SIC codes would have to be deleted from statistical analysis and also would have further reduced the representative manufacturing population.

The present researcher strived to employ the most parsimonious approach by taking the practical and conceptual considerations for deriving a generalisable framework of procurement flexibility. The practical considerations and an initial conceptual

mapping of the Australian manufacturing sector's procurement strategies outweighed the preferred sample size.

The practical considerations were that the expected response rate for each SIC code was unknown for Australian manufacturing sector and the accuracy of Dun & Bradstreet data base was unverifiable.

The main conceptual consideration was to derive a generalisable framework of procurement flexibility and the leaders and laggers was a secondary objective. Therefore a sample size of 50 was determined by the present researcher as sufficient.

However, the present researcher decided to take additional care in ensuring the robustness of the statistical analysis using the following guidelines suggested by Hair *et al.* and Tabachnick (1989):

- There are sufficient number of correlations greater than 0.30
- Minimum number of samples as a whole for the flexibility framework
- Statistically checking the homogeneity, multicollinearity, normality, homoscedasticity and residual effects in multiple regression analysis.

So, this list was further refined by checking the number of companies in each SIC code and the estimated response rate of 20%, to warrant the sample size for various data analyses. It was found that SIC codes 21(tobacco), 22 (textile), 23 (apparel) and 29 (petroleum) did not have enough sample numbers. These were deleted from the target list. SIC code 39 (miscellaneous) also was deleted as the manufacturing classification was unclear. This made the final target list to be 1300 companies.

Using this final sample, the 1300 respondent companies were sent a survey instrument. Postal questionnaires were sent to the manufacturing firm's position titles like Procurement Manager, Purchasing Manager, Supply Chain Manager, Manufacturing Manager, and Logistics Manager. Managing Directors were targeted if no more specific position title was indicated in the Dun & Bradstreet database. Rather than selecting a random sample, targeting all the identified firms provided a true total population from which to derive a generalisable flexibility framework.

3.9 TARGET RESPONDENT

The respondents were targeted as officers who would possess adequate knowledge to accurately complete the survey instrument. In any organisational hierarchy, the individuals at the lower level with hands on operational skills and knowledge would possess relevant information regarding flexibility at their level. However, they may not possess an understanding of strategic knowledge and capabilities of flexibility. It was also not possible to personally target such individuals with a personalised cover letter from the Dun & Bradstreet database.

Since the contents of the survey instrument falls within the realms of operations and organisational strategy, it was decided to target middle and senior management, with the prescribed middle managers as the first choice.

To increase the response rate of the 1300 target samples, it was decided to address the personalised cover letter to the above positions if known. If not, the cover letters would address 'The General Manager' or 'Managing Director'. It was also envisaged that the targeting of senior managers had the potential to limit response rates as the targeted respondents may feel time constraints and an antipathy towards divulging confidential company information. This was confirmed when follow-up telephone calls were made to non-respondents. Reasons for non-response are discussed more in section 3.10 where there is a discussion, also, on means used to reduce the non-participation rate.

3.10 MAIL SURVEY METHODOLOGY

The present researcher believes that mail surveys are an essential tool not only in industrial marketing research but also in industrial operations management. Much literature has been written about industrial mail surveys in marketing and business research journals. Some of the suggestions in the literature were used to increase response rates.

All respondents with names identified from the database were sent a personalised covering letter indicating the importance of the survey and its resultant feedback to the Australian manufacturing community (see Appendix 3 for a copy of the cover letter). Also it was indicated that if the targeted respondent was unable to complete the questionnaire due to various reasons, the questionnaire may be completed by someone knowledgeable of the organisation's procurement activities.

Questionnaires were posted as two batches. Six hundred and fifty were posted on a Friday morning so as to reach the respondents on the following Monday morning. The second batch of six hundred and fifty was posted on the following Monday morning so as to reach the respondents on Wednesday morning. Research using the survey-on-survey approach (Greer *et al.* 2000) to study business respondents' reaction to mail surveys found that the day of the week had no effect on the likelihood of the person responding to the mail survey. However, it was considered important that the survey was conducted in September because the respondents would be between the hectic end of financial year activities and the Christmas rush; similarly, at that time, the procurement volume in the previous financial year would be known.

In the present research, the mail survey was the most suitable methodology due to budget constraints, geographical limitations and width of sampling frame. The present researcher is located on the western coast of Australia in Perth, commonly regarded as the most isolated Capital City in the world. The vast majority of the manufacturing firms are located along the eastern seaboard of Australia and mail was the cheapest method to reach them.

Since the target population involved the wide spectrum of one thousand and three hundred manufacturing firms to establish a framework of procurement flexibility dimensions, a mail survey was considered the most appropriate.

Some surveys in the manufacturing area have used monetary incentives (Koste & Malhotra 1999) to increase response; a technique encouraged by others (Armstrong & Yokum 1994). There were two aspects why monetary incentives were not used in the present survey. Firstly, there is no Australian evidence that monetary incentives

encourage responses and the limited research budget of the present research study did not allow for monetary incentives or gifts to be included with the questionnaire. The budget was sufficient for the cost of printing the questionnaires, both envelopes, postage for sending out and self addressed, self stamped envelopes and cost of data entry. The balance of the budget was reserved to cover the cost of follow-up telephone calls.

3.11 INCREASING RESPONSE RATE

The importance of mail surveys and problems facing researchers in maximising response rates have been extensively published. Frohlich (2002) pointed out that one in three managers now refuses to participate in any surveys. Frohlich (2002) and Pressley (1980) also pointed out the problems of increasing response while reducing costs. Jobber & O'Reilly's (1998) comparison of industrial and non-industrial populations indicate that industrial respondents respond differently and require specific approaches.

A literature review was conducted on publications proposing survey methodology on improving business and industrial mail. Most literature promulgated the use of incentives to increase industrial mail responses. They included monetary incentives, follow-up mailings, pre-notification, close ended questions, survey sponsor and promised anonymity (Faria & Dickinson 1992; Jobber *et al.* 2002; London & Dommeyer 1990; Pressley 1980). At the same time, Faria & Dickinson (1992) also reported that other commercial studies indicated that no response rate improvements were achieved using monetary incentives, personalised letters, coloured paper questionnaire, offer of survey results, deadlines, promise of anonymity or promise of gift.

Since there were mixed results from the different techniques used to increase mail surveys, the present researcher decided to use the best of both worlds within the budget constraints. To increase the response rate of the present mail survey, the following were included:

- an individualised covering letter explained the nature of the study and its usefulness,
- the persons occupying the relevant positions were identified,
- emphasis was on the importance of the respondents' reply to the success of the survey,
- a summary report of the survey was promised as soon it came available,
- all returned questionnaires would be treated confidentially,
- self addressed envelopes,
- stamped return envelopes,
- sand coloured questionnaire,
- folded A3 size questionnaire – 4 pages of A4 size,
- closed ended questionnaires,
- telephone follow-up after two weeks of mailing the questionnaire,

To overcome the excuse of time constraints of senior management, the cover letter also suggested that the questionnaire could be passed on to someone in the organisation who might be more familiar with the procurement activities.

3.12 RESPONSE RATES

Response rates are very important in every research study because they indicate a significant reflection of the general population, especially mail surveys. An extensive literature review was conducted of response rates of research in similar research domains of manufacturing firms as the present research study. Similar studies were identified in SCM, manufacturing and supplier-buyer studies. Below in Table 3.5 is a taxonomy of literature review response rates in similar areas of research..

In the 37 surveys below, the response rates range from 6.7% to 41%. The average response rate of the 37 surveys is calculated to be 23.7%. It must also be noted that most of the studies listed in Table 3.5 with responses higher than 30% were contacted prior to the survey for pre-notification of intention and agreement to take part in the survey. Also, some surveys were confined to specific industry sectors.

Table 3.5 Taxonomy of previous research and response rates

Authors/year	Type of study	Area of study	Response rates %
Anderson & Buvik 2001	Buyer-supplier relationships	Interfirm co-ordination	32
Barclay & Smith 1997	Partner relationships	Trust	31
Buvik & Gronhaug 2000	Buyer-supplier relationship	Inter-firm dependence, environmental uncertainty,	26
Carr & Smeltzer 2000	Purchasing relationships	Strategy, financial performance and supplier responsiveness	22
Carter & Carter 1998	Environmental purchasing	Inter-organisational determinants	40
Das & Narasimhan 2000	Purchasing relationships	Competence and manufacturing performance	19
Eggert & Helm 2002	Business relationships transparency	Customer value, repurchase, satisfaction	31
Gonzalez-Benito *et al.* 2002	Purchasing management system	TQM. Supplier quality, internal processes,	38
Groves & Valsamakis 1998	Supplier customer relationships	Company performance	15
Handfield & Bechtel 2002	Purchasing managers	Trust, relationship improving SC responsiveness	20
Higginson & Alam 1997	Supply chain management	Techniques for success of SCM	18
Janda, Murray & Burton 2002	Manufacturer supplier relationships	Buyer outcomes – quality, acquisitions costs possession costs	13
Jayaram & Vickery 1998	Procurement relationships	Lead-time performance, performance	39
Johnson & Sohi 2001	Inter-firm relationship	Strategic intent and relational proclivity	23
Krause *et al.* 1998	Supplier development	Reactive and strategic efforts	40
Langerak 2001	Market orientation	Behaviour – salespersons, purchaser, channels and manufacturers	18
Madu *et al.* 1995	Manufacturing firms	Quality practices	20
Maltz & Ellram 1999	Purchasing	Outsourcing supply management	29
McGinnis & Vallopra 1999	New products	Purchasing and supplier involvement	24
Monczka *et al.* 1998	Supplier alliances	Strategic success factors	37
Muhlemann *et al.* 2000	Manufacturing firms	Operations and strategic flexibility	20
Shin *et al.* 2000	Supply management	Supplier buyer performance	22
Small & Yasin 1997	Manufacturing firms	Advanced manufacturing technology policy / performance	20
Somers & Nelson 2003	Manufacturing firms	Strategy and integration mechanisms on enterprise systems	23
Tan *et al.* 1999	Supply chain management	Impact on performance	21
Tracey 1998	Logistics	Efficiency, customer service and firm performance	15

Tracey *et al.* 1999	Manufacturing firms	Technology, strategy formulation, competitiveness and performance	14.5
Turner *et al.* 2000	Buyer supplier relationships	Interdependence and co-operation	17
Vickery *et al.* 1997	Manufacturing firms	Business performance	20
Vonderembse & Tracey 1999	Manufacturing performance	Supplier selection and involvement	13.4
Walter *et al.*2002	Supplier relationships	Relationship quality	41
Wisner & Tan 2000	Supply chain management	Impact on purchasing	6.7
Zaheer *et al.* 1998	Buyer supplier relationships	Strategic value	15

3.13 MAIL OUT FOLLOWUP

Follow-up telephone calls were an alternative to be used instead of follow-up letters. The present researcher felt that since all published literature on mail survey methodology and techniques to increase response rates were of non-Australian perspectives, the telephone would provide a more accurate, first hand understanding of Australian industrial thinking and perspectives and the possibility of exploring deeper as to the non-willingness of targeted respondents. Details of the telephone follow-ups undertaken are discussed in Chapter 4.

Since this is an empirical research, it was decided to follow-up the mail out with telephone calls so as to gauge a qualitative approach to non-response participants. After two and a half weeks from initial posting of the survey instrument, 184 telephone calls were made to randomly selected manufacturing firms throughout Australia over a period of three days.

All responses after the telephone follow-up were considered as late responses. The qualitative reasons for non-response among the 184 target respondents are discussed in Chapter 4.

3.14 ASSUMPTIONS, PROBLEMS AND LIMITATIONS

It was assumed that most Australian manufacturing firms have appropriate knowledge of their procurement activities. If they have no such knowledge then they might not respond to the survey. To reduce the non-response level, the initial list of prospective respondents were carefully analysed so as to select only larger firms likely to be able to provide a response.

It was assumed also that, since this research study only focuses on five dimensions of SMPF and three elements of flexibility, there may be other dimensions that are equally important; it was accepted that there may be other determinants of flexibility within a procurement environment.

The present researcher also recognised that the 57 items in the survey instrument did not cover the five identified dimensions completely. The limitation to the 57 items was to meet the restrictions of the four page survey instrument. The four page instrument was reported to provide a higher response rate than five pages (Greer *et al.* 2000). The present researcher decided to sacrifice a part of the research for a higher response rate for an exploratory research design to allow for definition of a generalisable framework. The response rate is more critical for a refection of the general population than an extensive questionnaire which could have included a more comprehensive list of items.

CHAPTER 4

RESULTS AND ANALYSIS

4.1 INTRODUCTION

Chapter 4 first sets out the data analysis framework of the research items, constructs and dimensions (see Figure 4.1 below). Figure 4.1 is a scaled down version of the operationalised model of Figure 2.3 on page 86. This framework is the basis for defining the independent and dependent variables as they were built into an operationalised model of procurement flexibility (Figure 2.3). In Chapter 4 are presented the response analysis, descriptive statistics and then the results of the information collected in the postal survey, the testing of the proposed model, and the implications and conclusions that arise from the analysis are discussed. The model construct items also are presented.

The chapter contains four principal sections of descriptive analysis of the independent variables; statistical correlation analysis, multiple regression, principal component analysis, and discussion of the research objectives and questions. It also provides discussion of the importance of supplier relationship dimensions and environmental uncertainties, and tests the proposed hypothesised conceptual model as shown in Figure 2.2.

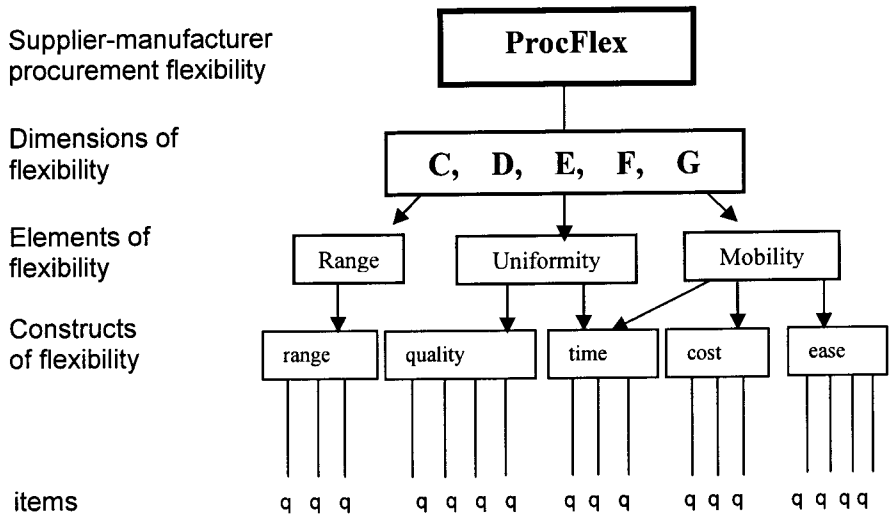
4.2 DATA ANALYSIS FRAMEWORK

The research items are the variables as set out in the survey instrument. The classification of these variables as independent and/or dependent variables varies according to the purpose of the analysis. Referring to Figure 4.1, when any of the elements of flexibility such as Range, Uniformity or Mobility are analysed, they

operate as the dependent variable and the constructs of range, quality, time, cost and ease become the independent variables.

Similarly, where the analysis is on any of the Dimensions of flexibility like C-Information Exchange or D-Supplier Integration they become the dependent variable and the elements of Range, Uniformity and Mobility become the independent variables. Therefore, to analyse the Total Supplier-Manufacturer Procurement Flexibility (ProcFlex) which is the dependent variable then, the independent variables are the Range, Uniformity and Mobility of all the five Dimensions or all the 57 items become the independent variables.

Figure 4.1 Research framework hierarchy for data analysis



Before providing the descriptive statistics, the responses and reliability were tested as reported in the next section.

4.3 RESPONSES

The first responses started arriving within the first week of mailing out. In the first two weeks two hundred and eleven responses were received, of which four were deemed unusable, because some of the items were not answered. After two and a half weeks, one hundred and eighty four telephone follow-up calls were made to non-

respondents. The non-respondents telephoned were randomly selected from the total number of non-respondents.

The date of the follow-up telephone calls was deemed as the cut-off date for early and late responses. Forty-eight responses were received up to the fifth week of which three responses were unusable. The final cut-off date for the survey was the end of the fifth week from initial mail out. Thirteen responses were received after the fifth week, which were not used in the present survey. There were five emails from persons that informed the researcher that they were unable to respond to the survey for various reasons – target respondent not working in the firm any longer, never participate in surveys, not manufacturing in Australia any longer. Ninety-nine instruments were returned to sender as undelivered. Reason for non-delivery was – named respondent no longer with firm, PO Box does not exist, do not participate in surveys, wrong address and unknown address. The final tally was that two hundred and fifty two responses were included in the data analysis. These are summarised in Table 4.1 below. The effective response rate after deducting undeliverable surveys was 21.1%.

Table 4.1 Profile of usable and unusable responses

	Numbers	Percentage %
Mail out	1300	100
Return to sender	104	7.99
Unusable - incomplete	4	0.30
Unusable – after cut-off date	13	1.0
Usable – final tally	252	21.1

4.3.1 Early and Late responses

Early and late responses were evaluated to observe whether there were any discrepancies or deviations from the mean. Two types of analysis were conducted. The first was non-bias response and secondly Chi-square test.

4.3.1.1 Non-bias analysis

The first step in minimising non-response bias was by applying available resources to maximise response rates using recommended methods by experienced researchers as discussed in Chapter 3. The second step was to measure the possibility of non-response bias, since follow-up mailings, or telephone calls as in this study, had the added benefit of enabling non-response bias by comparing the first wave and second wave responses (Larson & Chow 2003).

Non-response bias may be analysed by comparing early and late responses (Armstrong & Overton 1977). All the 69 survey items excluding the demographic data were compared between the 207 early responses received before the telephone follow-up with the remaining 45 responses.

An independent sample 't' test for equality of means using Levene's Test for equality of variances was conducted for the 69 items (Table 4.2 and Appendix 4) excluding the demographics. No significant differences (Sig. 2 tailed) were found between early and late responses except for five items. These five items were BQ7 – 'our suppliers frequently change their prices'; DQ6 – 'we can change to different suppliers in a short time'; EQ8 – 'suppliers can modify their product mix with same quality'; EQ9 – 'suppliers can implement product design changes easily'; and FQ6 – 'choice of handling routes does not affect transport costs'.

Table 4.2 't' Test of 69 items for Early and Late Responses

Item	t	Sig. (2 tailed)	Mean Differ
BQ7 – our suppliers frequently change their prices	-2.39	0.017	-0.62
DQ6 - we can change to different suppliers in a short time	2.03	0.043	0.26
EQ8 - suppliers can modify their product mix with same quality	-2.52	0.012	-0.54
EQ9 - suppliers can implement product design changes easily	-2.22	0.027	-0.48
FQ6 - choice of handling routes does not affect transport costs	2.08	0.038	0.56

The two-tailed Sig. values of the five items were below 0.05. The mean difference for these five items did not show much difference either. However, given that there

were a total of 69 items, this small number of five items was ignored and it was accepted that there were no significant differences between early and late responses in the exploratory study. The present researcher believes that this significance also is not large enough to affect the empirical nature of the research study.

4.3.1.2 Chi-square Test

A Chi-square test between early/late responses of the seven demographic items was conducted to observe if any of the demographic criteria contributed to early or late responses. Table 4.3 below shows the Pearson Chi-square values; there were a few cells with count less than 5, and these were ignored.

Except for HQ5 – manufacture for retail sales, the probability of no relationship for time of response could be that the question was ambiguous somewhat and respondents were instructed to answer to 'the best of their knowledge'. The wording of the question 'we manufacture products for retail sales' with a yes or no answer may be confusing as some manufacturers may be manufacturing components and parts for retails sales, wholesale, export or for other manufacturers. More specific questions would need to be asked to verify this and although the present researcher realises this as a potential shortcoming in the survey instrument, it was concluded that there was no non-response bias between early and late responses.

Table 4.3 Pearson Chi-square values for demographic data

Items		Asymp. Sig (2 sided)
HQ1	Position title - grouping	0.924
HQ1	Position title - individual	0.848
HQ2	Purchase volume	0.630
HQ3	SIC codes	0.600
HQ4	Supply components and parts	0.596
HQ5	Products for retail sales	0.375
HQ6	Number of employees	0.604
HQ7	Number of years in operation	0.589

4.4 TELEPHONE FOLLOW-UP ANALYSIS

The qualitative analysis of the 184 telephone follow-ups revealed several aspects related to non-responses. The later were similar to the reasons for 'return to sender' and email responses. The script for the telephone follow-up is provided in Appendix 5. The most common reason was that 'the named respondent was no longer with the firm', the second most common reason was 'when I find time I shall respond', the third most common reason was the named person was not contactable and a message was left requesting and suggesting the urgency of participation. Some named respondents argued that they had responded, however it is not known how many of the follow-up telephone recipients actually responded. All responses after the telephone follow-ups were considered as late responses.

Also, it was interesting to note that some of the feedback from the follow-up revealed that some companies had relocated their manufacturing base overseas, especially in China. This aspect provided an alternative suggestion for future research to enquire as to how procurement in China affects the overall SC.

4.5 RELIABILITY TESTING

Reliability tests the extent to which the measured items are consistent with what they were intended to measure (Hair *et al.* 1998). Firstly, internal consistency was tested on early and late responses which were discussed in Section 4.3. Secondly, reliability tests were conducted on the five flexibility dimensions. Reliability tests also were administered on the 57 flexibility measurement items of the survey instrument.

4.5.1 Internal consistency

Internal consistency was tested for all the 57 items. The Cronbach Alpha for all 57 items was more than 0.9313 (see Appendix 6) and thus highly reliable, especially as the generally accepted lower limit for Cronbach Alpha is 0.7; in exploratory research 0.6 is acceptable (Hair *et al.* 1998; Narasimhan & Jayaram 1998).

4.5.2 Item to Total Correlation

Item to total correlation (Appendix 6) was also conducted on the 57 flexibility items. The majority of the items had a correlation of more than 0.4. Those scales with less than 0.4 were removed and tested again, the correlation value did not improve significantly enough to notice reliability coefficient difference. All items were accepted as reliable.

4.6 DESCRIPTIVE STATISTICS

This section discusses the demographic data of the survey instrument (items HQ1-HQ7). Basic univariate analysis was used to establish respondent demographic profile like respondent's position, title, annual purchase volume, type of manufacturing business, SIC code and number of employees, as well as the survey items. The full descriptive statistics of the 57 items is provided in Appendix 7 with the descriptive statistics of the demographics in Appendix 8. The details of these demographics statistics are discussed in more detail below.

4.6.1 Respondent position profiles

One of the criteria for selecting and targeting respondents was their ability and knowledge of procurement activities in the organisation. Named respondents were sent a personalised cover letter with the instrument attached. The respondents were requested to indicate their position title in their responses in section H of the survey instrument. A total of 38 position titles were indicated in the responses (see Appendix 9). These positions ranged from the number one position to the hands on operational position plus a few positions that did not correspond to procurement operations; they were CEO, Director, General Manager, Vice President, Logistics Manager, Purchasing Director, Production Manager, Systems Manager, Company Secretary, Finance Manager and Marketing Manager.

Since there were a number of position titles which had less than 5 respondents, some statistical analyses needed careful assessment due to lack of sample numbers.

Therefore, to facilitate statistical analysis, the respondent titles of these 38 position titles were consolidated into 4 groups – Senior Managers (29.3%), Procurement Managers (48.8%), Operation Managers (17.8%) and Peripheral Managers (3.9%). Peripheral managers were those deemed to be not directly involved in procurement activities. Table 4.4 below provides the grouping of respondents into these four categories. The descriptive statistics of the title grouping is provided in Appendix 10.

Table 4.4 Consolidation of Position Titles

Senior Management	
Administration Manager	2
CEO	6
Director	11
General Manager	25
Group Service Manager	1
Managing director	24
Manager	4
SNR Vice President	1
Total	74
29.3%	

Procurement Management	
Logistics Admin	1
Logistics Manager	11
Materials Controller	1
Materials Manager	6
Purchasing Director	1
Purchasing Officer	8
Purchasing Manager	51
Purchasing Supervisor/Co-coordinator	2
Procurement Director	1
Procurement Officer	2
Procurement Manager	13
Supply Chain Controller	1
Supply Chain Manager	6
Supply Chain Director	2
Supply Co-ordinator	1
Stock Controller	1
Supply Director	1
Supply Manager	14
48.8% Total	123

Production Management	
Prod Development Manager	1
Production Manager	10
Manufacturing Manager	13
Operations Director	1
Operations Manager	14
Systems Manager	1
Technical Manager	1
Total	45
17.9%	

Peripheral Management	
Company Secretary	1
Commercial Manager	2
Finance Manager	1
Marketing Manager	5
Maintenance Supervisor	1
Total	10
3.9%	

From the responses it was not clear whether the fourth group, Peripheral Managers were involved in procurement activities and were knowledgeable about their procurement activities. Therefore, an F test using one way ANOVA with the five dimensions was conducted and compared with the four title groupings as shown in Table 4.5 below.

Table 4.5 ANOVA - F test between position title grouping with the 5 dimensions

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
SUPPLOG supplier logistics	Between Groups	1.621	3	.540	.625	.599
	Within Groups	214.396	248	.865		
	Total	216.017	251			
DELFLEX supplier product & delivery flexibility	Between Groups	6.739	3	2.246	2.711	.046
	Within Groups	205.495	248	.829		
	Total	212.234	251			
INFOEX information exchange	Between Groups	1.038	3	.346	.518	.670
	Within Groups	165.612	248	.668		
	Total	166.649	251			
SUPPINT supplier integration	Between Groups	2.182	3	.727	.758	.519
	Within Groups	238.033	248	.960		
	Total	240.215	251			
ORGSTRAT organisational strategy	Between Groups	2.906	3	.969	1.913	.128
	Within Groups	125.612	248	.507		
	Total	128.518	251			

The analysis indicated that there were no significant differences between the four groups except for DELFEX where the significance was 0.46. It was then decided to conduct a post-hoc analysis using Tukey Honestly Significant Different Test on the respondent position groupings. The test indicated similar trends. Therefore the Levene Test of Homogeneity of variances was conducted (see Table 4.6 below). The Levene test showed that all the Sig values were above 0.05. Although the Sig value in the Levene test for Organisational Strategy (ORGSTRAT) was low, it was accepted that all 252 respondents were knowledgeable about their firm's procurement activities. Nevertheless, it was possible that all the respondents may not be aware of the organisational strategic implications with procurement activities in their firm.

Table 4.6 Levene Test of Homogeneity of Variances

Test of Homogeneity of Variances

	Levene Statistic	df1	df2	Sig.
SUPPLOG supplier logistics	.461	3	248	.710
DELFLEX supplier product & delivery flexibility	.431	3	248	.731
INFOEX information exchange	.073	3	248	.975
SUPPINT supplier integration	1.117	3	248	.343
ORGSTRAT organisational strategy	2.626	3	248	.051

To further confirm this, it would have been ideal to have multiple respondents from the same responding firm, but it was not feasible due to resource constraints and identification of respondents. Even if the respondents in the fourth group were not fully knowledgeable of their procurement activities, the survey instrument was likely to have increased their awareness of and possibly led to a greater focus on, procurement flexibility.

4.6.2 Purchase volume in past financial year

Almost half of the respondent's (45.2%) purchases in the past financial year were between 10 and 50 million dollars. Table 4.7 below provides the purchase volume in the past financial year.

Table 4.7 Purchase volume in past financial year

Purchase value	Frequency	Percentage
Less than $10 million	61	24.2
$10-50 million	114	45.2
$51-100 million	50	19.6
more than $100 million	23	9.1

4.6.3 Standard Industry Classification Code

An analysis of the respondents SIC codes was conducted. Fifty-five respondents (21.8%) belonged to the Fabricated Metal and fifty (19.9%) to Food and Kindred Products industries. Table 4.8 below provides a breakdown of the various industries and their SIC codes. Many respondents indicated multiple SIC codes, hence the 111.1% total. The present researcher noted that for data analysis only the main SIC code was used for statistical analysis. The present researcher also accepted that the results of this exception might provide results that needed careful analysis. Consequently, the present researcher has taken great care in interpreting the results.

Pharmaceutical products and Textile manufacturers were originally not selected as a respondent categories because of the small population in the database. However, when responses were received it was found that there were three pharmaceutical and one textile manufacturer represented. Therefore, these 4 manufacturers are classified

under SIC codes 39 and 40 respectively. It is assumed that the Dun & Bradstreet database is not highly accurate or that the manufacturing companies have diversified into new ventures and the records have not been updated. The present researcher included these 4 manufacturers as part of the overall manufacturing population and has taken extra care to observe whether they caused any outliers or errors.

Also, it was noted that some of the categories did not have a sufficient number of cases for some types of statistical analysis where a minimum of 20 observations was recommended (Tabachnick 1989, Hair *et al.* 1998). Therefore, where possible statistical analysis was conducted as a group of 252 observations except for the leaders and laggers analysis to observe which industry is more flexible. Where more detailed analysis of industry classification was required, categories with less than 10 observations were deleted. Leaders and Laggers analysis is described in section 4.18 below.

Table 4.8 Respondent SIC profile

SIC code	Industry	Cases	Percentage
34	Fabricated metal products	55	21.8
20	Food and kindred products	50	19.8
28	Chemicals and allied products	27	10.7
35	Industrial and commercial machinery	21	8.3
36	Electronic and electrical equipment	21	8.3
30	Rubber and misc. plastics	18	7.1
32	Stone, clay, glass and concrete products	12	4.8
33	Primary metal industries	12	4.8
24	Lumber and wood products	12	4.8
37	Transport equipment	11	4.4
25	Furniture and fixtures	10	4.0
26	Paper and allied products	10	4.0
27	Printing, publishing industry	10	4.0
31	Leather and leather products	4	1.6
38	Measuring analysing and controlling equipment	3	1.2
39	Pharmaceutical products	3	1.2
40	Textile products	1	0.04
	Total	**252**	**111.1%**

4.6.4 Supply components and parts to other manufacturers

In order to explore how many of the respondents were first and/or second tier suppliers/manufacturers, respondents were asked to indicate whether they supplied components and parts to other manufacturers (see Table 4.9). There was almost an even balance - 46.8% of respondents indicated that they supplied to other manufacturers, while 53.2% of manufacturers did not supply to other manufacturers; so an assumption may be made that 53.2% supplied wholesalers and retailers and the remaining 46.8% were original equipment manufacturers (OEM).

Table 4.9 Supply components and parts to other suppliers

H4	Frequency	Percentage
Yes	117	46.8
No	133	53.2
Missing	2	100

4.6.5 Manufacture products for retail sales

Respondents were also asked to indicate whether they manufactured products for retail sales (see Table 4.10). Two thirds (67.7%) of the respondents indicated that they did, while 32.3% did not manufacture for retail sales. Four respondents did not answer this question. The assumption is that if the respondents did not manufacture for retail sales, then they concentrated sales on wholesale, or to other manufacturers, or for export.

Table 4.10 Profile of retail and wholesale manufacturers

H5	Frequency	Percentage
Yes	168	67.7
No	80	32.3
Missing	4	100

4.6.6 Supplier Tier

A cross-tabulation of questions HQ4 and HQ5 (see Table 4.11) was conducted to analyse how many of the respondents were first tier or second tier manufacturers. Those respondents who indicated that they did not manufacture for retail sales (HQ5 - No) must be supplying to other manufacturers or wholesales only. If this group of respondents also did supply to other manufacturers (HQ4 - Yes), then they may well be considered as second tier suppliers. From Table 4.11 it can be derived that 17.1% of the respondents were second tier manufacturers.

Table 4.11 Cross-tabulation of part supplier and retails sales

HQ4 supply components and parts to other manufacturers * HQ5 manufacture products for retail sales Crosstabulation

			HQ5 manufacture products for retail sales		
			yes	no	Total
HQ4 supply components and parts to other manufacturers	yes	Count	73	42	115
		% within HQ4 supply components and parts to other manufacturers	63.5%	36.5%	100%
		% within HQ5 manufacture products for retail sales	44.0%	52.5%	46.7%
		% of Total	29.7%	17.1%	46.7%
	no	Count	93	38	131
		% within HQ4 supply components and parts to other manufacturers	71.0%	29.0%	100%
		% within HQ5 manufacture products for retail sales	56.0%	47.5%	53.3%
		% of Total	37.8%	15.4%	53.3%
Total		Count	166	80	246
		% within HQ4 supply components and parts to other manufacturers	67.5%	32.5%	100%
		% within HQ5 manufacture products for retail sales	100.0%	100%	100%
		% of Total	67.5%	32.5%	100%

4.6.7 Years of operation

Operational duration of respondent's organisation ranged from 1 to 153 years. Half the respondents' organisations had been in operation for up to 40 years. Almost half (42.1%) of them had been in operation for up to 30 years. Another 31.74% had been in operation for more than 50 years. However, there was one respondent who

indicated that his/her organisation had been operating for 750 years. Since this outlier caused errors in calculating and computing, it was decided to delete this datum.

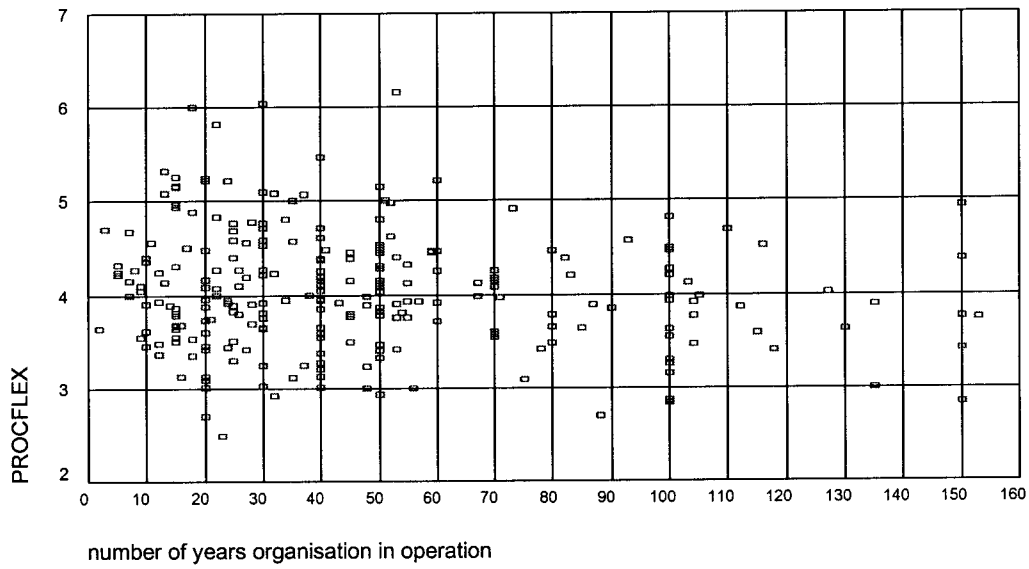
On closer scrutiny of the survey instrument, it was found that the question might have been ambiguous in the sense that it did not state the answer needed to be the number of years of operation 'in Australia' as was intended.

To investigate whether the longer a firm was in operation related to the more flexible it was, a correlation of HQ7 with Procurement Flexibility was undertaken. These correlations are discussed in more detail next.

4.6.7.1 Comparison of age of operations with level of flexibility

A new data variable, **ProcFlex** (see Chart 4.1 and section 3.2.3.1) was created using the Sum of Means of all the 57 flexibility measurement items; this, then, became a single measurement factor for Procurement Flexibility. A scatter plot (Chart 4.1) was plotted using ProcFlex and Years of operation (HQ7).

Chart 4.1 Scatterplot of ProcFlex * Years of Operations



It is commonly perceived that the longer a manufacturing firm has been in operations, it would have embraced and implemented modern manufacturing practices such as improvements in its manufacturing and production efficiency and

productivity processes. On the contrary, it can be seen from Chart 4.1 that the longer a firm was in operation, did not mean it was more flexible in procurement activities. The present researcher defines extreme procurement flexibility as having a means score above 6. It can be seen from Chart 4.1 that only 2 respondents are above 6. In fact a hand count was conducted, indicating that only 20 firms were above level 5 and had 60 years or less in operation. Ten of these firms were in operation less than 25 years. ProcFlex was also used to derive the most flexible manufacturing industry (Section 4.18). No relationships or correlations were found between operational years and procurement flexibility/capability.

4.6.7.2 Levels of Procurement Flexibility

The present researcher classified 4 levels of Procurement Flexibility as shown in Table 4.12 below. A detailed discussion of this Procurement Flexibility Rating scale is discussed in Section 4.11 below. A frequency count was conducted for the number of Australian firms at various procurement flexibility ratings. The count revealed that 20 (7.9%) firms were extremely flexible, 101 (40%) had moderate flexibility, 123 (48.8%) had low flexibility, while 8 (3.2%) were ranked as having no flexibility.

Table 4.12 Procurement Flexibility Rating Scale

ProcFlex Means Value	Flexibility Rating	No of Firms	% of Firms
More than 5	Extreme flexibility	20	7.9
4 to 4.99	Moderate flexibility	101	40
3 to 3.99	Low flexibility	123	48.8
Less than 3	Nil flexibility	8	3.2

4.6.8 Employee numbers

In response to the question of the number of employees in the organisation, almost half the respondents (49.8%) employed more than 150 staff (Table 4.13); one fifth (22.3%) employed between 101 and 150 staff, while 27.9% employed less than 100 staff. One criterion for selection of the sample from the Dun & Bradstreet on-line database was that there be more than 70 employees. Yet 10.4% of manufacturers indicated that they had less than 70 employees. It was assumed that employee numbers had been reduced for various reasons.

Table 4.13 Employee number

Category	Staff Number	Frequency	Percentage
1	Less than 70	26	10.4
2	71-100	43	17.5
3	101-150	56	22.3
4	More than 150	122	49.8
		247	100

4.6.9 Organisational size

In the present research, organisational size was determined by combining staff numbers and purchase volume. Purchasing volume ranged from 10 million AUD to more than 100 million. A large number of respondents (45.7%) indicated purchase volume of 10-50 million AUD. Due to unavailability of procurement published data on the scoping parameters for classification of staff number and purchase volume the present researcher decided to use arbitrary values.

A cross tabulation of the employee numbers with purchase volumes (Table 4.14) was administered. The analysis revealed that, in terms of the present research attributes of staff numbers and procurement volume, the largest organisations are those with a purchase volume between 10 and 50 million AUD and staff number of more than 150. Even so, there were also other factors that contributed to organisational size; e.g., turn over of items, sales volume and profit. These were not considered in the present research as the focus was on procurement flexibility. Mean scores were used for further analysis.

Table 4.14 Cross-tabulation of Number of people * Purchase volume

HQ2 purchase volume in past financial year * HQ6 number of people employed in company Crosstabulation

Count

		HQ6 number of people employed in company				
		1 less than 70	2 71-100	3 101-150	4 more than 150	Total
HQ2 purchase volume in past financial year	1 less than 10 million	15	27	14	5	61
	2 10-50 million	11	16	37	49	113
	3 51-100 million			5	45	50
	4 more than 100 million				23	23
Total		26	43	56	122	247

4.7 RESPONDENT AWARENESS AND UNCERTAINTY CRITICALNESS

Survey instrument sections A and B data results are analysed, evaluated and discussed in this section. The present researcher wanted to assess the mind-set of Australian manufacturers as to their perceptions and thinking of the current environmental uncertainties and the importance of the dimensions of the proposed flexibility model. Therefore, respondents were requested to respond to twelve direct questions regarding these two issues. These twelve questions were part of the survey instrument (Sections A and B) but were not part of the constructs or elements of procurement flexibility. Uncertainty is discussed in more detail in Section 2.7 and 3.4.

4.7.1 Importance of supplier relationship

In Section A of the survey instrument, five items, one for each of the proposed flexibility dimensions, were stated and respondents were requested to indicate the importance of each dimension on a Likert scale of 1 = no importance to 7 = very important. The means scores are shown in Table 4.16 below. The graphical representation of supplier importance is provided in Appendix 11.

The five flexibility dimensions (survey instrument sections C, D, E, F and G) were consolidated to provide the sum of means score for each dimension as shown in Table 4.15. These means scores were then compared with the responses for Section A – importance of the 5 dimensions (Table 4.16) of the survey instrument to observe if the responses matched the perceived importance of the five dimensions to the actual flexibility. The comparisons are discussed in the sections below. Graphical representations of environmental uncertainties pertaining to individual respondents is provided in Appendix 12.

Table 4.15 Sum of Means of the 5 Flexibility Dimensions

Table 4.15 Sum of Means of THE 5 Flexibility Dimensions - Sections C, D, E, F, G

	N	Mean	Std. Deviation
SUPPLOG supplier logistics	252	4.07	.93
DELFLEX supplier product & delivery flexibility	252	3.88	.92
INFOEX information exchange	252	4.14	.81
SUPPINT supplier integration	252	3.99	.98
ORGSTRAT organisational strategy	252	4.00	.72
Valid N (listwise)	252		

Table 4.16 Descriptive Statistics - Perception of Relationships Dimensions

Table 4.16 Descriptive Statistics - Survey Instrument Section A (Questions AQ1 to AQ5)

	N	Mean	Std. Deviation
AQ1 supplier logistics	252	5.75	1.14
AQ2 materials / components and delivery	252	6.30	.80
AQ3 information exchange	252	5.78	1.04
AQ4 supplier integration	252	4.73	1.33
AQ5 organisational strategy	252	4.76	1.39
Valid N (listwise)	252		

4.7.1.1 Supplier Logistics

On the importance of 'Supplier Logistics Dimension' (AQ1), most respondents (36.9%) indicated a scale of 6 and 27.8% indicated a scale of 7 with another 25.4% indicating a scale of 5. The mean was 5.75. This showed that the respondents considered supplier logistics capabilities to be an important relationship dimension with their suppliers. But when the sum of means for survey instrument Section F (supplier logistics) is derived (see Table 4.15), it portrays a different picture. The sum of means of all items in Section F is 4.07. So this meant that the suppliers were not meeting the expectations of the manufacturers or were not managing the manufacturers' perceptions.

The contradiction observed was that the mindset of the respondents was that 'Supplier Logistics relationship dimension' was important to the manufacturers but to the suppliers it was not. There was a potential mismatch between what the suppliers were actually providing and what the manufacturers wanted or needed.

4.7.1.2 Material & Components Delivery

Similarly with the dimension of 'Supplier Product & Delivery' (Section E) the sum of means of all the items is 3.88 (Table 4.15), whereas the mean for item AQ2 is 6.3 (Table 4.16). The respondents' mindset was that supplier product and delivery flexibility is critical but the suppliers are not flexible. In fact, the mean (3.88) was below the middle score of 4.0. It also means that suppliers had no flexibility in delivering new components/material easily, in a short-time at a low price or at the

same quality. Suppliers were also not flexible in modifying their product mix or implementing changes to the design.

4.7.1.3 Information Exchange

The mean for AQ3 was 5.78 (Table 4.16) and the sum of means for dimension 'Information Exchange' Section C in the survey instrument was 4.14 (Table 4.15); this means that the respondents think that information exchange is very important in procurement activities but in practice it is moderately flexible.

4.7.1.4 Supplier Integration

The mean for AQ4 was 4.73 (Table 4.16) and the sum of means for dimension 'Supplier Integration' Section D in the survey instrument was 3.99 (Table 4.15). This showed that in the respondents' (manufacturers') minds, supplier integration was seen as of average importance and the same results are reflected in their practices.

4.7.1.5 Organisational Strategy

The sum of means of the items in Section G in the survey instrument was 4.00 (Table 4.15), whereas the mean of item AQ5 was 4.76 (Table 4.16); this showed that the (manufacturers') respondents' perceptions were that organisational strategy was of average importance as is the flexibility to implement such strategies.

4.7.2 Effect of environmental uncertainty

Similar analysis was conducted for survey instrument Section B - the effect of environmental uncertainties on the respondents' manufacturing plant. Respondents were requested to respond to seven items pertaining to fluctuating customer demand; imported substitute products; changing government regulations; environmental concerns of recycling; product obsolescence rate; competitors' actions; and supplier price changes. The descriptive statistics for these seven items are reported in Table 4.17 below and a graphical plot is provided in Appendix 12.

Table 4.17 Environmental Uncertainty Descriptive Statistics

Descriptive Statistics - Section B Environmental Uncertainty

	N	Minimu	Maximu	Mean	Std.	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
BQ1	252	1	7	5.21	1.51	-.743	.153	-.121	.306
BQ2	252	1	7	4.10	1.93	.009	.153	-1.207	.306
BQ3	252	1	7	3.83	1.73	.150	.153	-.840	.306
BQ4	251	1	7	3.52	1.62	.147	.154	-1.151	.306
BQ5	252	1	7	4.67	1.55	-.351	.153	-.664	.306
BQ6	252	1	7	4.24	1.33	-.035	.153	-.386	.306
BQ7	252	1	7	3.49	1.60	.307	.153	-.781	.306
Valid N (listwise)	251								

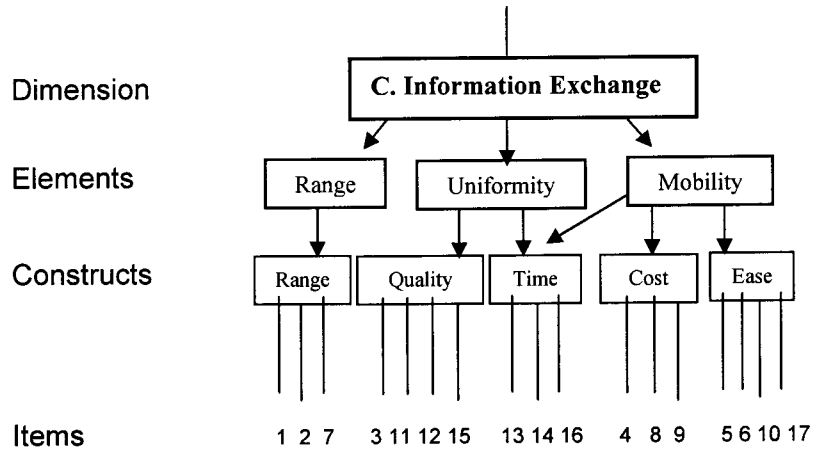
From Table 4.17 it can be seen that either the manufacturers' perception is that the environmental uncertainties are average and none is critical or important or that the respondents are not aware of any major uncertainties. It was because of this that the present researcher decided to conduct an additional qualitative survey by email to find out more information regarding this critical issue of uncertainty. The results of the qualitative survey are discussed in detail in Section 4.20.

The data analysis output of the items in Section B are not reflective of the current thinking or the public statements made by the CEO of the Australia Industry Group (The Australian, 12 January 2004) that manufacturers are rethinking their strategies of relocating manufacturing bases overseas. One of the reasons cited by the CEO was the current strong Australian dollar and foreign currency exchange rate which was making it difficult to export manufactured products. The present researcher also notes that questions on currency exchange rates and other economic conditions were not part of this survey.

4.8 MEAN SCORES

There are five flexibility dimensions in this survey. Each of these dimensions has three elements of range, uniformity and mobility. These three elements have 4 to 5 constructs of range, quality, time, cost and ease. These constructs were used to define the three elements of range, uniformity and mobility as discussed in Chapter 2. Each of these constructs has a number of items to measure its flexibility (Figure 2.3). An example of the flexibility dimension of Information Exchange is shown in Figure 4.2 below. Means scores are used to combine these construct items to create the mean response for a given element (Siguaw, Simpson & Baker 1998). Figure 4.2 below shows the operationalised model for the Dimension of Information Exchange only.

Figure 4.2 Operationalised Model of Information Exchange Flexibility



The mean scores for each of the three elements of Range, Mobility and Uniformity within the five flexibility dimensions were tested and are shown in Table 4.18 below. Table 4.18 contains the mean score distribution characteristics for each of the fifteen elements (5x3). The mean scores represent the level or magnitude achieved by an organisation for each flexibility element included in the study.

Table 4.18 Mean Scores Distribution Characteristics of the 15 Flexibility Elements

Flexibility Dimension	Element	Sample Size	Mean	Standard Deviation	Minimum	Maximum
Information Exchange	Range	252	3.98	0.90	1.67	6.67
	Uniformity	252	4.23	0.88	2.36	6.78
	Mobility	252	4.19	1.00	1.58	7.00
Product Components	Range	252	4.36	1.43	1.00	7.00
	Uniformity	252	3.90	0.93	1.00	6.42
	Mobility	252	3.64	1.06	1.17	6.63
Organisational Strategy	Range	252	4.40	1.02	1.00	7.00
	Uniformity	252	3.89	0.66	2.33	6.50
	Mobility	252	3.70	1.03	1.33	6.67
Supplier Logistics	Range	252	4.25	0.96	1.33	6.33
	Uniformity	252	3.91	1.08	1.00	6.75
	Mobility	252	4.21	1.35	1.00	7.00
Supplier Integration	Range	252	4.48	1.39	1.00	7.00
	Uniformity	252	4.10	1.02	1.50	7.00
	Mobility	252	3.74	1.13	1.25	7.00

The higher the mean score, the greater the degree of flexibility achieved. From Table 4.18 it can be seen that none of the mean scores exceeded the value of 5 although a few respondents indicated a value of 7 for all three elements in supplier integration, information exchange mobility, product components range, organisational strategy range and logistics mobility. Similarly in the same elements there are respondents who indicated a value of 1. This means that the Australian manufacturing industry has a wide spectrum of procurement flexibility ranging from no flexibility to extreme flexibility at the element level. Overall the mean scores indicate that the procurement flexibility at the element level is moderate.

All the flexibility dimensions have a similar range of standard deviation. Standard deviation ranges from 0.66 to 1.43. The range for Product Components has the highest standard deviation of 1.43 and Organisational Strategy has the lowest standard deviation of 0.66. It is possible that some respondents have a wider range of procuring 'products and raw materials' within the same SIC code, therefore higher Range and/or flexibility.

Table 4.19 Mean Scores Distribution Characteristics of the 23 Constructs

Flexibility Dimension	Constructs	Sample Size	Mean	Standard Deviation	Mini mum	Maxi mum
Information Exchange	Range	252	3.98	0.91	1.67	6.67
	Quality	252	4.85	0.83	2.25	7.00
	Cost	252	3.34	1.26	1.00	7.00
	Ease	252	3.88	1.04	1.00	7.00
	Time	252	4.49	1.19	1.67	7.00
Supplier Integration	Range	252	4.48	1.39	1.00	7.00
	Quality	252	4.81	1.25	1.00	7.00
	Cost	252	3.67	1.69	1.00	7.00
	Ease	252	3.65	1.23	1.00	7.00
	Time	252	3.82	1.17	1.00	7.00
Materials & Components	Range	252	4.36	1.43	1.00	7.00
	Quality	252	4.53	1.14	1.00	7.00
	Cost	252	3.62	1.04	1.00	6.00
	East	252	3.7	1.09	1.00	7.00
	Time	252	3.55	1.11	1.00	6.25
Supplier Logistics	Range	252	4.25	0.96	1.33	6.33
	Cost	252	3.67	1.19	1.00	7.00
	Ease	252	4.26	1.41	1.00	7.00
	Time	252	4.15	1.44	1.00	7.00
Organisational Structure	Range	252	4.41	1.02	1.00	7.00
	Cost	252	4.17	0.61	2.00	6.33
	Ease	252	3.80	1.05	1.00	6.67
	Time	252	3.60	1.12	1.33	6.67

Similarly a means score was also conducted for the 23 constructs as shown in Table 4.19 above. The scores show the level of flexibility for each of the constructs. Comparing with Table 4.18, there are more maximum scores indicated for the constructs. This meant that at a lower hierarchical level of flexibility there was more flexibility capability, but when the constructs are combined into the three elements, this flexibility was lost. This could mean that there are trade-offs when several constructs of flexibility are combined to form a single flexibility measure. Trade-offs are discussed later in Section 4.19. This could also lead to the fact that the present survey instrument needs further modification and possibly more focus into the various constructs. Each of the constructs possibly could need more items to measure a more detailed perspective of each of the constructs before being combined into its relevant flexibility element.

Mean scores were consolidated and calculated for overall Procurement Element Flexibility by combining all the fifteen elements of Range, Uniformity and Mobility (RUMs) as a single group of RANGE, UNIFORMITY and MOBILITY as shown in

Table 4.20 below. This showed the overall flexibility in terms of range, uniformity and mobility of the procurement relationship. The mean scores indicated that flexibility at the overall element level was not encouraging. The scores are averaged at around 4. It was also observed that the maximum score now had dropped to 6 and the minimum score had increased to 2 when compared to mean scores at the construct level (Table 4.19) and element level (Table 4.18).

This also meant that the respondents' firm had different flexibility performance or flexibility states or ease of flexibility at various activities of procurement and the combination of these constructs and elements provided a single overall procurement flexibility measurement scale. Before making any conclusions, the present researcher decided to conduct more statistical analysis to verify and check the collected data. Correlation analysis is conducted next.

Table 4.20 Mean Scores Distribution Characteristics of Total Flexibility Elements

Procurement Relationship Flexibility Element	Sample Size	Mean	Standard Deviation	Minimum	Maximum
RANGE	252	4.25	0.65	2	6
UNIFORMITY	252	4.02	0.62	2	6
MOBILITY	252	3.85	0.77	2	6

Table 4.21 Correlation between all 15 elements

Correlations - 15 Elements

		INFO_R	INFO_U	INFO_M	SUPP_R	SUPP_U	SUPP_M	MAT_R	MAT_U	MAT_M	LOG_R	LOG_U	LOG_M	ORG_R	ORG_U	ORG_M
INFO_R	Pearson Correlation	1.000	.581**	.605**	.185**	.225**	.305**	.209**	.256**	.269**	.172**	.215**	.194**	.370**	.291**	.365**
	Sig. (2-tailed)	.	.000	.000	.003	.000	.000	.001	.000	.000	.006	.001	.002	.000	.000	.000
	N	252	252	252	252	252	252	252	252	252	252	252	252	252	252	252
INFO_U	Pearson Correlation	.581**	1.000	.871**	.269**	.279**	.329**	.232**	.327**	.309**	.270**	.258**	.254**	.291**	.330**	.379**
	Sig. (2-tailed)	.000	.	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
	N	252	252	252	252	252	252	252	252	252	252	252	252	252	252	252
INFO_M	Pearson Correlation	.605**	.871**	1.000	.171**	.232**	.268**	.183**	.256**	.259**	.259**	.218**	.234**	.320**	.344**	.380**
	Sig. (2-tailed)	.000	.000	.	.006	.000	.000	.003	.000	.000	.000	.000	.000	.000	.000	.000
	N	252	252	252	252	252	252	252	252	252	252	252	252	252	252	252
SUPP_R	Pearson Correlation	.185**	.269**	.171**	1.000	.344**	.399**	.224**	.205**	.267**	.191**	.212**	.204**	.212**	.118	.167**
	Sig. (2-tailed)	.003	.000	.006	.	.000	.000	.000	.001	.000	.002	.001	.001	.001	.062	.008
	N	252	252	252	252	252	252	252	252	252	252	252	252	252	252	252
SUPP_U	Pearson Correlation	.225**	.279**	.232**	.344**	1.000	.805**	.243**	.500**	.513**	.288**	.270**	.225**	.209**	.332**	.417**
	Sig. (2-tailed)	.000	.000	.000	.000	.	.000	.000	.000	.000	.000	.000	.000	.001	.000	.000
	N	252	252	252	252	252	252	252	252	252	252	252	252	252	252	252
SUPP_M	Pearson Correlation	.305**	.329**	.268**	.399**	.805**	1.000	.277**	.498**	.624**	.305**	.347**	.303**	.254**	.350**	.441**
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.	.000	.000	.000	.000	.000	.000	.000	.000	.000
	N	252	252	252	252	252	252	252	252	252	252	252	252	252	252	252
MAT_R	Pearson Correlation	.209**	.232**	.183**	.224**	.243**	.277**	1.000	.414**	.378**	.277**	.192**	.286**	.119	.216**	.217**
	Sig. (2-tailed)	.001	.000	.003	.000	.000	.000	.	.000	.000	.000	.002	.000	.059	.001	.001
	N	252	252	252	252	252	252	252	252	252	252	252	252	252	252	252
MAT_U	Pearson Correlation	.256**	.327**	.256**	.205**	.500**	.498**	.414**	1.000	.856**	.286**	.292**	.325**	.332**	.389**	.413**
	Sig. (2-tailed)	.000	.000	.000	.001	.000	.000	.000	.	.000	.000	.000	.000	.000	.000	.000
	N	252	252	252	252	252	252	252	252	252	252	252	252	252	252	252
MAT_M	Pearson Correlation	.269**	.309**	.259**	.267**	.513**	.624**	.378**	.856**	1.000	.304**	.368**	.352**	.284**	.396**	.445**
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000	.000	.000	.	.000	.000	.000	.000	.000	.000
	N	252	252	252	252	252	252	252	252	252	252	252	252	252	252	252
LOG_R	Pearson Correlation	.172**	.270**	.259**	.191**	.288**	.305**	.277**	.286**	.304**	1.000	.614**	.641**	.162*	.261**	.336**
	Sig. (2-tailed)	.006	.000	.000	.002	.000	.000	.000	.000	.000	.	.000	.000	.010	.000	.000
	N	252	252	252	252	252	252	252	252	252	252	252	252	252	252	252
LOG_U	Pearson Correlation	.215**	.258**	.218**	.212**	.270**	.347**	.192**	.292**	.368**	.614**	1.000	.833**	.069	.387**	.386**
	Sig. (2-tailed)	.001	.000	.000	.001	.000	.000	.002	.000	.000	.000	.	.000	.273	.000	.000
	N	252	252	252	252	252	252	252	252	252	252	252	252	252	252	252
LOG_M	Pearson Correlation	.194**	.254**	.234**	.204**	.225**	.303**	.286**	.325**	.352**	.641**	.833**	1.000	.139*	.374**	.351**
	Sig. (2-tailed)	.002	.000	.000	.001	.000	.000	.000	.000	.000	.000	.000	.	.027	.000	.000
	N	252	252	252	252	252	252	252	252	252	252	252	252	252	252	252
ORG_R	Pearson Correlation	.370**	.291**	.320**	.212**	.209**	.254**	.119	.332**	.284**	.162*	.069	.139*	1.000	.390**	.499**
	Sig. (2-tailed)	.000	.000	.000	.001	.001	.000	.059	.000	.000	.010	.273	.027	.	.000	.000
	N	252	252	252	252	252	252	252	252	252	252	252	252	252	252	252
ORG_U	Pearson Correlation	.291**	.330**	.344**	.118	.332**	.350**	.216**	.389**	.396**	.261**	.387**	.374**	.390**	1.000	.851**
	Sig. (2-tailed)	.000	.000	.000	.062	.000	.000	.001	.000	.000	.000	.000	.000	.000	.	.000
	N	252	252	252	252	252	252	252	252	252	252	252	252	252	252	252
ORG_M	Pearson Correlation	.365**	.379**	.380**	.167**	.417**	.441**	.217**	.413**	.445**	.336**	.386**	.351**	.499**	.851**	1.000
	Sig. (2-tailed)	.000	.000	.000	.008	.000	.000	.001	.000	.000	.000	.000	.000	.000	.000	.
	N	252	252	252	252	252	252	252	252	252	252	252	252	252	252	252

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

4.9 CORRELATION OF THE ELEMENTS WITHIN ITS DIMENSION

The purpose of correlation analysis was to test the strength of the relationships between variables. The present researcher assumed that each of the five dimensions and its three elements were independent of the other dimensions and elements. It was possible that aggregation may conceal any relationships that may exist among the flexibility elements and dimensions in different manufacturing industries. Therefore, it was necessary to discuss the relationships between the dimensions and elements.

The elements of range and mobility may likely be correlated. A high level of range may be associated with a high level of mobility, while a low level of range may exist with a low level of mobility. Similarly, it can be argued that some respondents may relate or emphasise higher levels of range with higher levels of mobility and conclude that uniformity is constant across every level of range or mobility. Alternatively, it may be argued that different levels of range options or mobility do not necessarily provide similar levels of uniformity. Also there may be possible trade-offs (Koste & Malhotra 2000; Levi *et al.* 2000; Mason-Jones & Towill 1998; Spina & Zotteri 2000) between the elements within each of the five dimensions. Trade-offs are discussed in more detail in Section 4.20 later in the chapter. In the present research the elements of flexibility are correlated for statistical testing purposes and later in the chapter the correlations are also examined by the use of Principal Component Analysis to determine the underlying factor structure of the elements and dimensions themselves.

The mean scores were used to examine the correlations among the three elements for each of the five dimensions of flexibility. It was not expected that there would be correlations for all elements and dimensions to exist. The correlations within each flexibility dimension are discussed next. Table 2.10 is reproduced here to facilitate understanding of the correlation analysis.

Table 2.10 (reproduced) Construct Components of the Elements

Element	Constructs
Range	Range
Uniformity	Quality and time
Mobility	Ease, cost and time

4.9.1 Correlation among the elements of Information Exchange

From Table 4.21, it can be seen that there was a very high positive correlation (0.871) between Mobility (Info_M) and Uniformity (Info_U) and high positive correlation between the other elements, indicating that Information flexibility between suppliers and manufacturers was very high. The correlations also indicated that the accuracy, quality and range of information exchanged was high; time taken to exchange information both-ways was quick and in real time; it was easy to exchange information with the supplier and the cost of information exchange was low.

4.9.2 Correlation among the elements of Supplier Integration

There was a very high positive correlation (0.805) between Mobility (Supp_M) and Uniformity (Supp_U). This meant that the suppliers can easily adjust to changes in demand schedules while maintaining high quality standards at all demand levels. Moderate positive correlation between the other elements meant that suppliers carried a moderate inventory level. It also indicated that it was moderately easy for manufacturers to change to different suppliers. The lower correlation could also mean there are trade-offs among the items.

4.9.3 Correlation among the elements of Supplier Product & Components

The correlation between Uniformity (Mat_U) and Mobility (Mat_M) was 0.856, which is very high. The correlations between Range and Uniformity; Range and Mobility is quite high , viz., 0.414 and 0.378 respectively. This indicated that the suppliers' flexibility to supply different range, quality of components and materials in a short time at a low cost easily was high. There could be trade-offs among the lower correlated items of delivering a wider range of component parts.

4.9.4 Correlation among the elements of Supplier Logistics

There was a very high positive correlation (0.833) between Mobility (Log_M) and Uniformity (Log_U) and high positive correlation between the other elements (0.614 and 0.641). This meant that there were less trade-offs between the constructs. This also indicated that Logistics flexibility between suppliers and manufacturers was very high. These correlations also indicated that the range, time taken and ease of logistics flexibility was very highly correlated, that suppliers had various alternate routes for

delivery and were able to modify these routes easily in a short time at low cost while performing at the same level. The suppliers also had the high level of flexibility to handle materials of different shapes and sizes.

4.9.5 Correlation among the elements of Organisational Strategy

In the assessment of organisational flexibility, quality was not included under the element of uniformity. The reason being that quality of organisational strategy in procurement activities was beyond the scope of the present research. However, the correlation between Uniformity (Org_U) and Mobility (Org_M) was very high (0.851). Therefore, it was easy and cost effective for manufacturers to implement organisational strategies.

The correlation between Range and Uniformity; Range and Mobility was quite high; 0.390 and 0.499 respectively. This indicated that the manufacturers had a moderate level of flexibility to adjust their organisational strategy to counter environmental uncertainties in their procurement activities.

4.10 SUMMARY OF CORRELATION ANALYSIS OF THE ELEMENTS

Table 4.21 showed all the 15 elements correlated in a single table across the five dimensions. The correlations between the 15 elements were examined. There were a total of 225 correlations (15x15). Twenty-four of these correlations were considered large with Pearson's *r* values more than 0.5. Seventy-four had medium correlation with values between 0.3 and 0.49. The remaining ones were small correlations. In terms of significance, only 3 correlations were not statistically significant with Sig. values above 0.05. They were:

- Org_U & Supp_R Sig. (2-tailed) value of 0.62
- Org_R & Mat_R Sig. (2-tailed) value of 0.59
- Org_R & Log_U Sig. (2-tailed) value of 0.273

Because of the exploratory nature of the research, the present researcher decided to conduct further analysis before concluding.

Since all three non-significant elements were pertaining to organisational strategy, it was possible that not many manufacturing firms have a flexible organisational strategy or they may have no organisational flexibility with regards to procurement activities or managing external uncertainty. For now the present researcher considers these three elements are not significant and further research in the area could be conducted.

Since there were a number of medium and high correlations among the 15 elements of flexibility, further statistical analysis was warranted. Since the above correlation was at a higher level (Element), the present researcher decided to take a step backwards and conduct a correlation analysis at a lower level (Items) among the 57 measures of flexibility to observe if there were other revelations of flexibility.

4.10.1 Correlation of all flexibility items

A two tailed Pearson *r* correlation was conducted on all the 57 flexibility survey items (Appendix 13). The first check on the analysis output related to the number of cases. The majority of responses had 252 cases, while a few had 251 cases; thus the missing cases were ignored as insignificantly affecting the data analysis.

Next, the direction of relationships in terms of positive and negative correlations was conducted. There were 3 variables that had many negative correlations. They were:

- FQ4 - it is too costly for supplier to modify these routes
- GQ3 - these strategies are very costly to implement
- GQ6 - this flexibility is too costly to implement
- GQ12 – this responsive action is too costly to implement

The present researcher recognises that FQ4, GQ6 and GQ12 were reverse questions; and although all questions were pertaining to cost factors, GQ3 related to 'strategies' which were costly to implement.

Next, the strength of correlations was evaluated. The present researcher considered that correlation coefficient values below 0.3 had small strength, 0.3 to 05 as medium strength and more than 0.7 had very large correlation strength. A breakdown of correlation strength is provided in Table 4.22 below. A hand count of the correlations of the 57 variables (Appendix 13) was made and 83% of the correlations were small at

below 0.3 level; 13.3% with medium correlation strength between 0.3 and 0.49; a small percentage of 2.8% had a large correlation strength between 0.5 and 0.7; and 0.8% had a very large correlation strength of more than 0.7.

Table 4.22 Summary of correlation strength among the 57 variables of flexibility

Strength	*r* value	No. of cases	Percentage
Small	Less than 0.3	1328	83
Medium	0.3 - 0.49	210	13.3
Large	0.5 - 0.7	45	2.8
Very large	More than 0.7	13	0.8
	Total correlations	1596	100

The hand count also revealed that 59.4% of the cases had a significance at 0.01 level with 18.4% significant at 0.05 level. The correlation analysis also revealed that only 3.6% had *r* values above 0.5. Therefore, the present researcher concluded that there were no significant relationships between the 57 flexibility items.

4.11 CORRELATION AMONG THE 5 FLEXIBILITY DIMENSIONS

Conducting and analysing correlation analysis on 57 variables was quite daunting, as there were numerous (1596) values to inspect, and no significant correlations were found. Therefore, the present researcher decided to check if there were any relationships at the Dimensional level.

This was done by conducting correlations analysis between the five flexibility dimensions at the Dimensional level as shown in Table 4.23 to compare with the previous correlation between the 15 elements. From Table 4.23 it was found that only one correlation was very strong (0.559); viz., between 'Supplier Logistics' and 'Supplier Product & Delivery'. This suggests that these two dimensions are very closely related and perceived as such by the respondents. All the other dimensions also had significant correlations between each other. This suggests that all the dimensions are closely related to each and could mean that each dimension influence the other dimensions. This is suggested as an objective for future research.

A coefficient of determination on the Pearson's r values was calculated to find the amount of variance shared by two dimensions. This was done by using the formulae: (r x r) x 100 %. The shared variance ranged from 7.3% for 'supplier logistics' to 31.2% 'supplier product & delivery'. The present researcher felt that an explanation of 31.2% of the variance was insufficient to claim a correlation among any of the 5 variables.

Table 4.23 Dimensions Correlation

Correlations

		supplier logistics	supplier product & delivery flexibility	information exchange	supplier integration	organisational strategy
supplier logistics	Pearson Correlation	1.000	.339**	.272**	.360**	.347**
	Sig. (2-tailed)	.	.000	.000	.000	.000
	N	252	252	252	252	252
supplier product & delivery flexibility	Pearson Correlation	.339**	1.000	.347**	.559**	.453**
	Sig. (2-tailed)	.000	.	.000	.000	.000
	N	252	252	252	252	252
information exchange	Pearson Correlation	.272**	.347**	1.000	.348**	.445**
	Sig. (2-tailed)	.000	.000	.	.000	.000
	N	252	252	252	252	252
supplier integration	Pearson Correlation	.360**	.559**	.348**	1.000	.399**
	Sig. (2-tailed)	.000	.000	.000	.	.000
	N	252	252	252	252	252
organisational strategy	Pearson Correlation	.347**	.453**	.445**	.399**	1.000
	Sig. (2-tailed)	.000	.000	.000	.000	.
	N	252	252	252	252	252

**. Correlation is significant at the 0.01 level (2-tailed).

Since there were a few statistically strong correlations among the dimensions, it suggests that ProcFlex can only be achieved by the combined flexibility of all the dimensions. Next, the present researcher turned to multiple regression statistical analysis to further explore the relationship among the variables.

4.12 MULTIVARIATE ANALYSIS

Multivariate analysis was used extensively to extrapolate research findings, establish causality and determine descriptions of the operationalisation of procurement flexibility concepts. Due to the exploratory nature of this research multiple regression analysis was used first. Factor Analysis including Principal Component Analysis (PCA) was later used to analyse the interrelationships among the large number of variables and explain these variables in terms of their common underlying dimensions. This enabled the reduction of the original number of variables into a smaller number of factors without losing vital information. It provided a grouping of the original variables into a number of factors to check whether the proposed dimensions of flexibility of procurement were similar among the respondents.

Multiple regression was also used to predict the differences in responses to selected dependent and independent variables and predict the magnitude of constructs and responses of the different manufacturers.

Multiple discriminant analysis was used to observe whether there was a distinct grouping on non-metric dependent variables to provide the basis for separating or distinguishing the respondents into 'leaders or laggers' in the adoption of Procurement Flexibility into their corporate strategies. Also, it provided a greater understanding as to whether there were any other groupings of adopters of procurement strategies.

Scatterplot analysis was used to provide some basic knowledge on the respondents' characteristics; e.g. on how many manufacturing companies had their information systems extended to their suppliers, how many respondents had organisational integration strategies and how many respondents had supplier integration strategies. It enabled the separation of respondents into exclusive groups for further analysis, which also produced the 'Leaders and Laggers' comparison (Chart 4.11) according to manufacturing SIC codes to determine the leader in using procurement strategies and procurement flexibility capabilities.

Construct validity was supported by determining question responses to separate criteria. The questions used a seven point Likert scale of 1 = 'strongly disagree' to 7 =

'strongly agree'. Reliability tests used a test-retest stability and the amount of error was determined by the Cronbach Alpha coefficient. Principal component analysis was used to examine the underlying groupings.

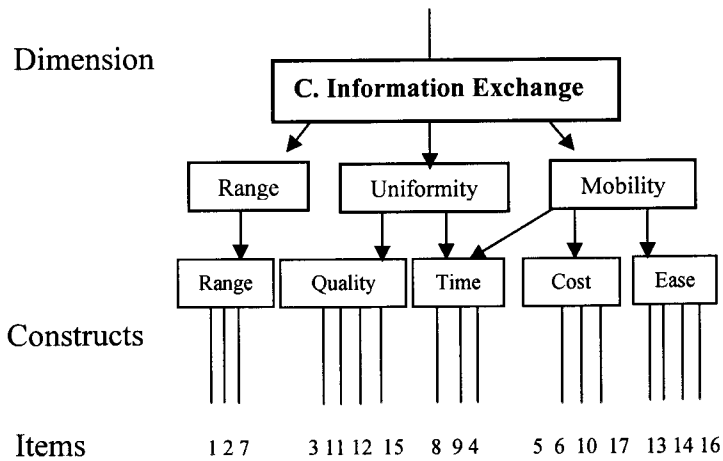
Multiple regression analysis involved a single dependent and several independent variables, whereas canonical correlation used the development of a linear combination of both independent and dependent variables; one group of dependent variables was correlated with the group of independent variables.

4.13 MULTIPLE REGRESSION

Taking the process of correlation one step further involved calculating a regression coefficient which described the slope of the best straight line through the scatter diagram. Multiple regression was employed to observe the influence of the items on the constructs and dimensions.

Since the purpose of this empirical research was to explore the dimensions of flexibility in procurement relationships, multiple regression was used to predict the changes in the dependent variables in response to changes in the independent variables. Multiple regression was also used to predict the magnitude of the independent variables for each of the five dimensions. An example of the hierarchy of one dimension, that of Information Exchange was shown in Figure 4.2 on page 112. This same hierarchical diagram is reproduced below for multiple regression analyses.

Figure 4.3 Hierarchy diagram of Information Exchange Dimension and Construct



Standard multiple regression was conducted at the items level for all the 5 flexibility dimensions. The items level was used to identify where the individual variables contributed to each of the dimensions. Standard multiple regression was conducted. Multicollinearity, outliers, normality, homoscedacity and independence of residuals were checked for all 5 dimensions. Normal P-P plots were checked for normality. Where there were discrepancies, offending variables were removed and P-P plots were plotted again.

Multicollinearity exists when there is a strong correlation between two or more predictors in a regression model. According to Bryman & Cramer (1997), some variables might be too highly correlated to each other so that there is no point in treating them as two separate entities. Therefore, the strength of relationship was checked using Pearson's *r* value (Appendix 13) so as not to exceed 0.7 as suggested by Tabachnick and Fidell (1989). Any offending variables above 0.7 were eliminated one by one and regression conducted again. Below, the results are explained, by each dimension, in detail.

4.13.1 Information Exchange Flexibility Dimension C - Items level

4.13.1.1 Multicollinearity

Following Hair *et al.*'s (1998) four step suggestion of testing for multicollinearity, the first step was to identify all condition index (CI) above the threshold value of 30 (Table 4.24). One dimension was found with values of 35.5. Step two was for those items with CI more than 30 to identify those also with variance proportions more than 90 percent. There was only one variable (CQ15) with 0.91 indicating that it did not have dependency with any other variable, therefore no collinearity.

Steps three and four were to check variance inflation factor (VIF) and tolerance values. None exceeded VIF value of 10 (Stevens 1992) and there were no tolerance values below 0.3 (Table 4.25). The maximum VIF value was 3.61 and the minimum tolerance value was 0.305 Therefore, it indicated that there was no violation of collinearity, yet the P-P plot was not normal. To further check multicollinearity, principal component analysis was used. This is discussed later in this chapter. These

four steps are duplicated for the remaining four dimensions of procurement flexibility. The above tests indicate that the variables did not violate the assumption of multicollinearity. CQ12 – 'information received from our suppliers is reliable' was removed.

Table 4.24 Collinearity Diagnostics for Information Exchange Dimension

Collinearity Diagnostics - Multiple Regression for Information[a] Exchange Dimension

Model	Items	Eigenvalue	Condition Index	Variance Proportions															
				CQ 1	CQ 2	CQ 3	CQ 4	CQ 5	CQ 6	CQ 7	CQ 8	CQ 9	CQ 10	CQ 11	CQ 13	CQ 14	CQ 15	CQ 16	CQ 17
1	1	15.6	1.000	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
	2	.450	5.886	.00	.00	.00	.00	.02	.03	.02	.04	.05	.00	.00	.00	.00	.00	.00	.00
	3	.241	8.047	.00	.00	.00	.00	.02	.06	.04	.17	.16	.00	.00	.00	.00	.00	.00	.00
	4	.118	11.507	.03	.01	.08	.03	.00	.01	.00	.03	.01	.00	.00	.06	.01	.00	.09	.02
	5	.098	12.643	.00	.01	.01	.28	.02	.01	.01	.34	.33	.00	.01	.00	.01	.00	.00	.00
	6	.087	13.361	.00	.00	.00	.34	.03	.04	.01	.38	.34	.00	.00	.00	.01	.00	.00	.00
	7	.075	14.423	.02	.05	.03	.00	.03	.01	.01	.00	.02	.01	.06	.27	.00	.01	.00	.04
	8	.067	15.219	.04	.02	.03	.08	.13	.54	.16	.00	.02	.00	.01	.00	.01	.00	.00	.00
	9	.053	17.204	.25	.03	.28	.02	.18	.01	.07	.00	.01	.03	.00	.00	.03	.01	.00	.01
	10	.043	18.943	.13	.10	.00	.02	.09	.15	.36	.00	.01	.12	.06	.05	.00	.00	.03	.03
	11	.041	19.468	.08	.05	.11	.05	.36	.01	.17	.00	.00	.03	.08	.00	.03	.00	.14	.04
	12	.036	20.866	.00	.00	.24	.15	.01	.09	.11	.00	.00	.20	.01	.00	.23	.02	.02	.05
	13	.029	23.235	.24	.23	.18	.01	.04	.02	.01	.00	.01	.02	.14	.07	.20	.01	.01	.05
	14	.022	26.401	.01	.02	.00	.00	.01	.00	.00	.02	.00	.51	.11	.04	.18	.01	.03	.39
	15	.021	27.482	.15	.21	.02	.00	.05	.02	.01	.00	.00	.03	.07	.29	.05	.02	.46	.33
	16	.018	29.164	.00	.19	.02	.02	.00	.00	.00	.00	.00	.02	.42	.15	.01	.00	.05	.00
	17	.012	35.521	.04	.09	.00	.00	.00	.01	.01	.00	.02	.01	.02	.05	.24	.91	.16	.02

a. Dependent Variable: INFOEX

Table 4.25 Regression Coefficient of Information Exchange Dimension

Coefficients [a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	.021	.037		.560	.576		
	CQ1	.077	.005	.117	14.011	.000	.659	1.516
	CQ2	.049	.006	.069	8.244	.000	.648	1.544
	CQ3	.064	.005	.097	12.675	.000	.784	1.276
	CQ4	.061	.004	.123	15.370	.000	.718	1.393
	CQ5	.084	.006	.155	14.083	.000	.379	2.637
	CQ6	.080	.006	.137	13.830	.000	.465	2.149
	CQ8	.060	.004	.126	13.333	.000	.516	1.940
	CQ9	.067	.005	.135	14.067	.000	.502	1.993
	CQ10	.060	.006	.097	10.377	.000	.531	1.885
	CQ11	.127	.006	.182	21.564	.000	.648	1.542
	CQ14	.068	.006	.101	10.591	.000	.508	1.969
	CQ15	.046	.008	.058	5.770	.000	.456	2.194
	CQ16	.093	.005	.178	17.898	.000	.463	2.161
	CQ17	.055	.006	.095	9.190	.000	.427	2.344

a. Dependent Variable: INFOEX

Evaluation of each of the independent variables in the coefficient table was made to investigate which variable contributed most to explaining the dependent variable, it was found that CQ11 had a Beta value of 0.182 (see Table 4.25). On further checking the Sig. values, all had zero value which was less than 0.05, indicating that all the independent variables were also making a significant and unique contribution to the dependent variable.

4.13.1.2 Outliers, Normality, Linearity, Homoscedasticity, Residuals

Hair *et al.* (1998) considered that residuals are instrumental in detecting violations or model assumptions and identifying outliers. These were checked by inspecting the residuals scatterplot and the normal Probability Plot of the regression standardised residuals. As can be seen from Chart 4.3A the first P-P plot is not normal. The correlation table (Appendix 13) was inspected to check which variables had correlations above 0.7. They were:

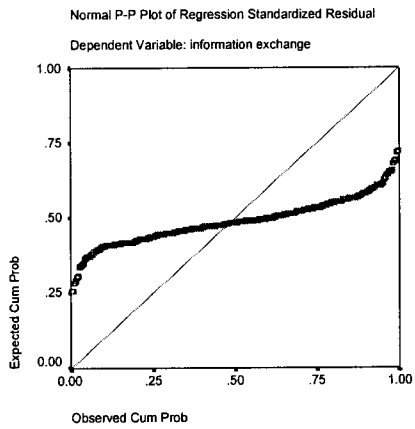
CQ5 - CQ6 = 0.710
CQ5 - CQ7 = 0.769
CQ6 - CQ7 = 0.748
CQ11 - CQ12 = 0.833.

CQ5 – our information system is well integrated with our prominent supplier's IS
CQ6 – our data structure is the same as our prominent suppliers
CQ7 –there is high connectivity of the IS with our suppliers
CQ11 – information received from our suppliers is accurate
CQ12 – information received from our suppliers is reliable

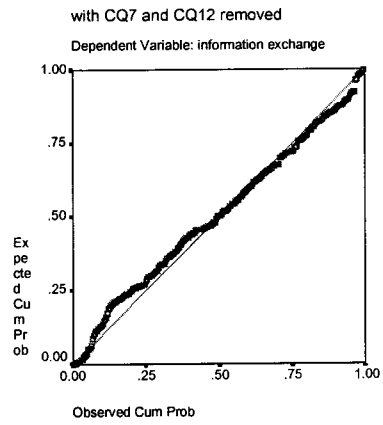
It was decided to remove CQ12 first and execute P-P plot again. The resultant plot was better; thereby demonstrating that CQ12 – 'information received from our suppliers is reliable' did cause a problem. Next CQ7 was removed and PP plotted again. The resultant plot was almost a diagonal line. Therefore, CQ7 and CQ12 were causing problems. The resultant plot is shown in Chart 4.3B below. Since also CQ5 and CQ6 had correlation greater than 0.7 removing them would have provided an even better PP plot, but the present researcher decided that this was acceptable for standard regression analysis and explored further in PCA analysis.

Chart 4.2 Normal Probability Plot Before and after removing offending variables

A.

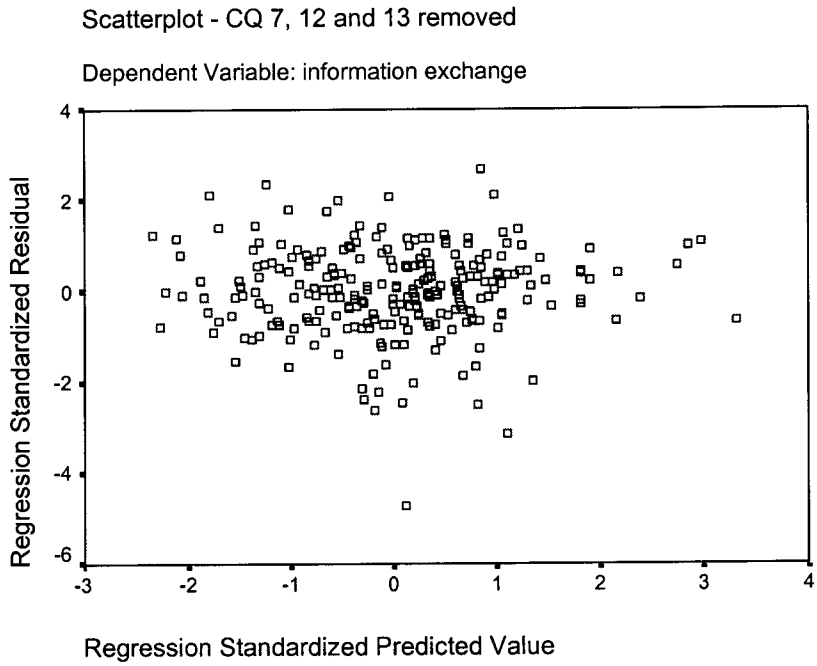


B.



To identify the outliers, the scatterplot (Chart 4.4) of the variables was used. Most of the scores concentrated along the zero line in an almost oval shape and no major outliers were found.

Chart 4.3 Scatterplot of Information Exchange Dimension



There were no curvilinear shapes or patterns to the residual plots in the scatterplot. There were only 2 cases with standard residual values more than -3.0 (see Table 4.26

below). These were case numbers 6 and 19. Removing these two outlier cases did not significantly affect the residual plot, so they were left intact.

Table 4.26 Casewise diagnostics for Information Exchange Dimension - outliers

Casewise Diagnostics[a]

Case Number	Std. Residual	INFOEX
6	-4.722	4
19	-3.133	5

a. Dependent Variable: INFOEX

The presence of outliers was also checked using the residual statistics output as shown in Table 4.27 below. The mean value of Mahalanobis distance was checked and found that it was 16.86 which did not cause a concern because of the large number of cases. Next it was checked if there were any cases that exerted undue influence over the parameters of the model. This was checked using Cook's distance not to be greater than 1. Table 4.27 showed that the maximum Cook's distance was only 0.007, therefore there was no cause for concern of any single case on the model.

Table 4.27 Residual Statistics of Multiple Regression for InfoExch Dimension

Residuals Statistics - Multiple Regression Information Exchange[a]

	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	2.24	6.77	4.14	.82	249
Std. Predicted Value	-2.338	3.223	-.004	1.004	249
Standard Error of Predicted Value	2.49E-03	8.56E-03	.00	1.19E-03	249
Adjusted Predicted Value	2.24	6.77	4.14	.82	249
Residual	-1.16E-02	1.03E-02	.00	3.49E-03	249
Std. Residual	-.659	.582	-.034	.199	249
Stud. Residual	-.728	.619	-.036	.210	249
Deleted Residual	-1.42E-02	1.17E-02	.00	3.91E-03	249
Stud. Deleted Residual	-.727	.619	-.036	.209	249
Mahal. Distance	4.002	57.923	16.86	9.742	249
Cook's Distance	.000	.007	.000	.001	249
Centered Leverage Value	.016	.233	.068	.039	249

a. Dependent Variable: INFOEX

The model summary data output (Table 4.28) were used to evaluate the model. Both the R-Square and Adjusted R-Square values were 0.989 indicating that 98.9% of the variance in the dependent variable was explained by the model. The ANOVA table

revealed a Sig. value of 0.000 for $p<0.0005$ demonstrating that the model was statistically significant.

Table 4.28 Model summary data for Information Exchange Dimension.

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.995[a]	.989	.989	8.72E-02	.989	1537.809	14	235	.000

a. Predictors: (Constant), CQ17, CQ3, CQ9, CQ2, CQ4, CQ11, CQ6, CQ1, CQ14, CQ CQ16, CQ15, CQ5

b. Dependent Variable: INFOEX

4.13.1.3 Model evaluation

In the above standard multiple regression analysis, the set of variables predicted the flexibility of the dimension of Information Exchange very well and explained 98.9% of the variance. All the included variables made statistically significant contributions.

4.13.2 Supplier Integration Dimension D - Items level

4.13.2.1 Multicollinearity

Initially it was not possible to obtain a PP plot for the following reason:

Warnings

For the final model with dependent variable SUPPINT, the variance- covariance matrix is singular. Influence statistics cannot be computed.

Premature end of pattern reached - probably illegal character: ':' (pattern is: "The chart: ^1 is not produced because it is empty.")

Therefore, multicollinearity was checked using Pearson's *r* which was not to exceed the accepted value of 0.7. There was one correlation that exceeded 0.7; DQ5 and DQ6 which was 0.821. Therefore, it was decided to remove DQ6 and conduct regression analysis again. The resultant plot an almost diagonal line as shown in Chart 4.4. Regression was conducted again by removing DQ5 only, but the PP plot was worst

than removing DQ6 only. Therefore this confirmed that DQ6 was causing a greater problem than DQ5.

DQ5 – we can change over to different suppliers easily
DQ6 – we can change over to different suppliers in a short time

Similar to the above Section (4.13.1) of regression analysis on the first dimension of Information Exchange, Hair *et al.*'s (1998) four step suggestion of testing multicollinearity was followed again. The maximum condition index was 15.68 (Table 4.29) and no regression coefficient variance was above 0.8. The SPSS analysis of collinearity (Table 4.30) under 'Tolerance' was checked; none was below 0.2 and no VIF value exceeded 3. All these tests for collinearity were negative, therefore these variables did not violate the assumption of collinearity.

Table 4.29 Collinearity Diagnostics for Supplier Integration Dimension

Collinearity Diagnostics [a]

Model	Section C Items	Eigen value	Condition Index	Variance Proportions						
				(Constant)	DQ 1	DQ 2	DQ 3	DQ 4	DQ 5	DQ 7
1	1	6.527	1.000	.00	.00	.00	.00	.00	.00	.00
	2	.216	5.502	.00	.02	.01	.01	.01	.28	.17
	3	.092	8.404	.01	.00	.02	.00	.00	.64	.72
	4	.059	10.502	.29	.01	.27	.10	.04	.03	.08
	5	.050	11.480	.01	.70	.00	.10	.22	.00	.00
	6	.030	14.752	.02	.05	.36	.36	.69	.01	.00
	7	.027	15.682	.67	.21	.35	.43	.02	.04	.02

a. Dependent Variable: SUPPINT

Table 4.30 Regression Coefficient for Supplier Integration Dimension

Coefficients[a]

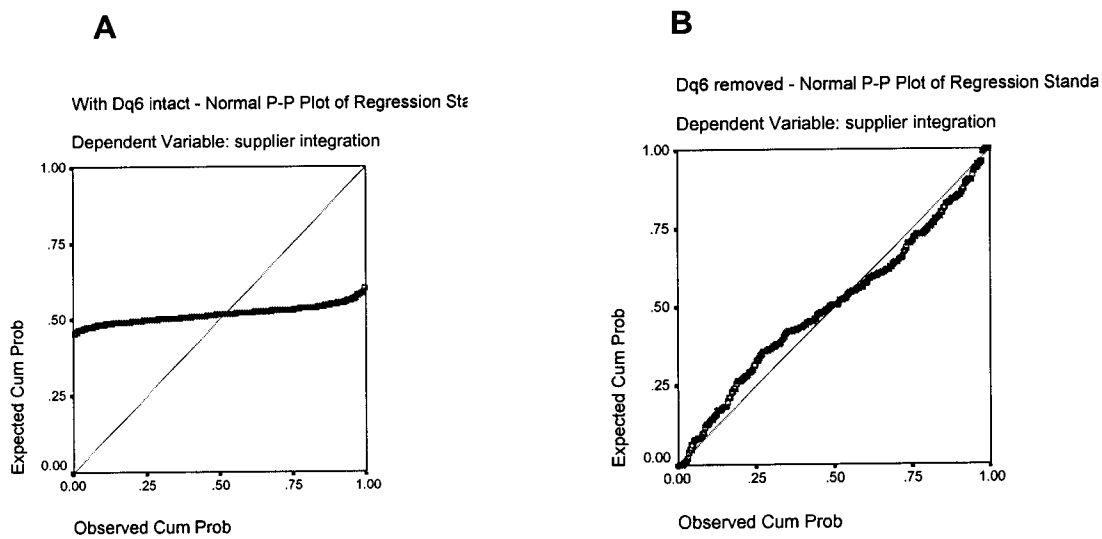
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	.044	.035		1.244	.215		
	DQ1	.136	.007	.194	20.609	.000	.635	1.574
	DQ2	.140	.008	.202	17.679	.000	.430	2.325
	DQ3	.131	.007	.168	18.241	.000	.666	1.502
	DQ4	.168	.008	.235	22.142	.000	.500	1.998
	DQ5	.242	.005	.410	45.351	.000	.690	1.450
	DQ7	.169	.005	.293	33.080	.000	.717	1.394

a. Dependent Variable: SUPPINT

4.13.2.2 Outliers, Normality, Linearity, Homoscedasticity, Residuals

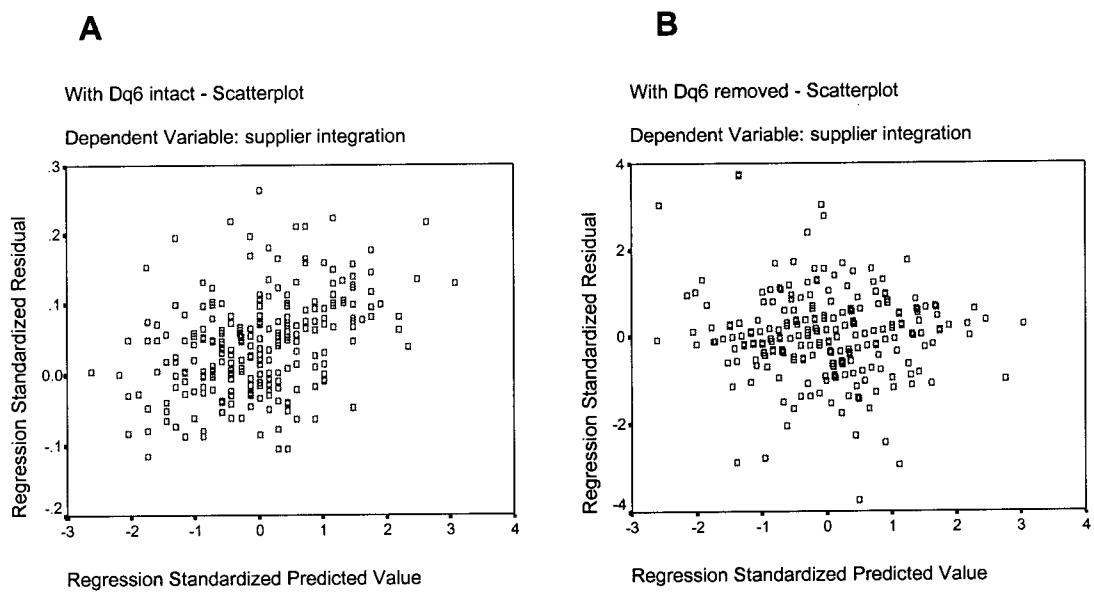
These characteristics were checked by inspecting the scatterplot of residuals and the normal probability plot of the regression standardised residuals. Chart 4.5 shows the P-P plots before and after removing DQ6 from the analysis. DQ6 was removed because it had too high a correlation with DQ5. As can be seen from Chart 4.5B (after removing DQ6), the points were almost close to the normal straight diagonal line. So it is not perfectly normal compared to the chart before removing DQ6 which was not normal. This allowed the present researcher to exactly identify where, in the distribution of residuals, the deviations from normality were greatest by using other multivariate techniques as discussed later in this chapter.

Chart 4.4 Supplier Integration Dimension - Items level



For outliers, the scatterplot of the variables was used. Most of the scores concentrated along the zero line (Chart 4.6) in an almost rectangular shape and no major outliers were found. There was no curvilinear or pattern to the residual plots in the scatterplot, therefore there was no homoscedasticity. By removing DQ6 the residual plots became much wider (Chart 4.6B), between plus and minus 4, whereas with DQ6 intact the residual plot was between plus and minus 0.3. It is interesting to note that the Normality P-P plot was better but the scatter plot was more oval in shape but more widely dispersed. The present researcher decided to conduct further multivariate analysis using PCA to explore this finding.

Chart 4.5 Scatterplot of Dimension of Supplier Integration - Items level



The model summary data output (Table 4.31) was used to evaluate the model. The R-Square value was 0.993 which means that 99.3% of the variance in the dependent variable was explained by the model. The ANOVA statistics revealed a Sig. value of 0.000 for $p<0.0005$ which meant that the model was statistically significant.

Table 4.31 Model Summary Output

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.993[a]	.986	.986	.12	.986	2922.361	6	244	.000

a. Predictors: (Constant), DQ7, DQ1, DQ3, DQ5, DQ4, DQ2

b. Dependent Variable: SUPPINT

Evaluation of each of the independent variables in the coefficient table (Table 4.30) was undertaken to investigate which variable contributed most to explaining the dependent variable. It was found that the variables had a Beta value between 0.168 and 0.410. On further checking the Sig. values all had zero value which was less than 0.05, thus indicating that all the independent variables were making a significantly unique contribution to the dependent variable. The VIF values were checked and none was greater than 10. Therefore, the model is statistically significant.

The presence of outliers and undue influence by any single case was checked using residuals statistics (Table 4.32). The maximum Mahalanobis distance was 27.125 and did not cause any concern. Cook's distance did not exceed 1, therefore, there was no undue influence by any single case on the model

Table 4.32 Residuals Statistics

Residuals Statistics [a]

	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	1.47	6.95	4.00	.97	251
Std. Predicted Value	-2.597	3.041	.005	.998	251
Standard Error of Predicted Value	8.86E-03	3.89E-02	1.86E-02	5.49E-03	251
Adjusted Predicted Value	1.47	6.94	4.00	.97	251
Residual	-.47	.45	8.36E-04	.12	251
Std. Residual	-4.045	3.878	.007	1.050	251
Stud. Residual	-4.106	4.073	.008	1.069	251
Deleted Residual	-.48	.50	9.75E-04	.13	251
Stud. Deleted Residual	-4.247	4.210	.008	1.081	251
Mahal. Distance	.467	27.125	5.968	4.352	251
Cook's Distance	.000	.244	.006	.019	251
Centered Leverage Value	.002	.108	.024	.017	251

a. Dependent Variable: SUPPINT

4.13.2.3 Model Evaluation

The above regression tests indicated that the variables in the second dimension of supplier integration explained the model very well and made statistically significant contributions to the model.

4.13.3 Supplier Product Delivery Dimension E - Items level

4.13.3.1 Multicollinearity

Multicollinearity was checked against Pearson's *r* correlation and a decision was made not to accept any correlations which exceeded 0.7 (Appendix 13). There were 3 correlations above 0.7 (EQ1-EQ2 = 0.79; EQ6-EQ5 = 0.798; and EQ12-EQ8 = 0.721). There was also one correlation above 0.8 (EQ9-EQ10 = 0.848). Without removing any variables, regression was conducted. The PP plots were normal with a diagonal line (Chart 4.7A). Therefore no variables were removed and analysis was continued.

EQ1 – our suppliers can deliver new components/materials easily
EQ2 – our suppliers can deliver new components/materials in a short time
EQ5 – our suppliers can modify their product mix easily
EQ6 – our suppliers can modify their product mix in a short time
EQ8 - our suppliers can modify their product mix with the same quality
EQ9 – our suppliers can implement product design changes easily
EQ10 – our suppliers can implement product design changes in a short time
EQ12 - our suppliers can implement product design changes with the same quality

Firstly, the condition indexes were inspected. None of the condition indexes were above the value of 30 (Table 4.33), the maximum VIF value was 4.682 (Table 4.34) and the minimum tolerance value was 0.214; therefore, there was no violation of collinearity among the variables.

Evaluation of each of the independent variables in the coefficient table (Table 4.34) assisted in investigating which variable contributed the highest to explaining the dependent variable. It was found that all the variables had a Beta value between 0.078 and 0.168. On further checking the Sig. values, all had zero value which was less than 0.05 which meant that all the independent variables were also making a significant unique contribution to the dependent variable.

Table 4.33 Collinearity Diagnostics

Collinearity Diagnostics[a]

Model	Items	Eigen value	Condition Index	Variance Proportions													
				(Constant)	EQ 1	EQ 2	EQ 3	EQ 4	EQ 5	EQ 6	EQ 7	EQ 8	EQ 9	EQ 10	EQ 11	EQ 12	EQ 13
1	1	13.278	1.000	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
	2	.155	9.241	.02	.01	.02	.00	.02	.00	.00	.01	.03	.02	.03	.00	.03	.00
	3	.122	10.420	.01	.09	.06	.01	.00	.00	.01	.02	.00	.01	.02	.03	.00	.02
	4	.097	11.700	.00	.00	.00	.02	.01	.09	.09	.02	.00	.03	.03	.04	.00	.01
	5	.086	12.452	.00	.00	.00	.22	.00	.01	.00	.06	.03	.03	.02	.03	.03	.02
	6	.055	15.566	.00	.01	.01	.02	.00	.02	.01	.04	.00	.01	.00	.01	.01	.85
	7	.045	17.173	.67	.02	.08	.02	.02	.01	.00	.01	.04	.01	.00	.00	.03	.00
	8	.037	18.965	.00	.03	.06	.25	.04	.02	.00	.01	.01	.09	.01	.40	.07	.01
	9	.029	21.370	.07	.00	.02	.06	.00	.43	.06	.31	.01	.00	.09	.17	.02	.00
	10	.028	21.943	.11	.35	.09	.06	.00	.00	.20	.26	.01	.10	.05	.01	.00	.06
	11	.018	26.912	.01	.01	.00	.21	.61	.00	.00	.00	.01	.04	.00	.17	.57	.00
	12	.018	27.086	.02	.01	.02	.01	.27	.01	.01	.04	.86	.00	.01	.07	.22	.01
	13	.016	28.481	.07	.46	.64	.12	.01	.11	.21	.17	.02	.16	.10	.02	.02	.01
	14	.016	28.897	.02	.00	.00	.00	.01	.30	.40	.05	.00	.50	.63	.05	.00	.00

a. Dependent Variable: DELFLEX

Table 4.34 Regression Coefficient

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	.123	.027		4.548	.000		
	EQ1	.078	.007	.115	10.660	.000	.341	2.930
	EQ2	.066	.008	.101	8.188	.000	.262	3.813
	EQ3	.072	.007	.099	10.563	.000	.455	2.198
	EQ4	.075	.007	.103	10.107	.000	.383	2.611
	EQ5	.084	.008	.120	10.522	.000	.306	3.272
	EQ6	.076	.008	.110	8.908	.000	.259	3.864
	EQ7	.071	.008	.095	9.092	.000	.359	2.782
	EQ8	.087	.008	.123	11.396	.000	.339	2.950
	EQ9	.064	.009	.092	7.325	.000	.248	4.024
	EQ10	.071	.009	.107	7.836	.000	.214	4.682
	EQ11	.068	.008	.089	8.560	.000	.365	2.737
	EQ12	.074	.007	.105	10.280	.000	.378	2.647
	EQ13	.091	.006	.128	14.444	.000	.503	1.987

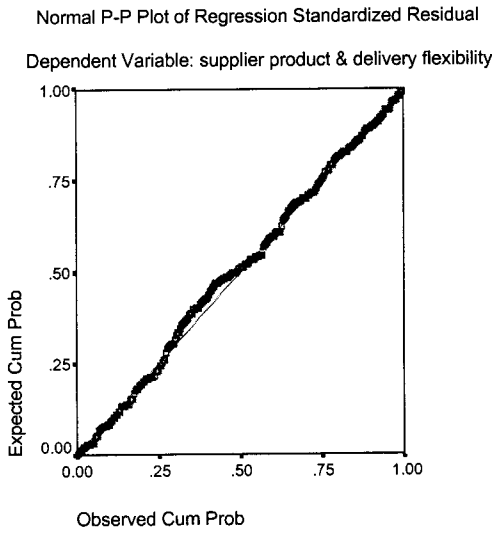
a. Dependent Variable: DELFLEX

4.13.3.2 Outliers, Normality, Linearity, Homoscedasticity, Residuals

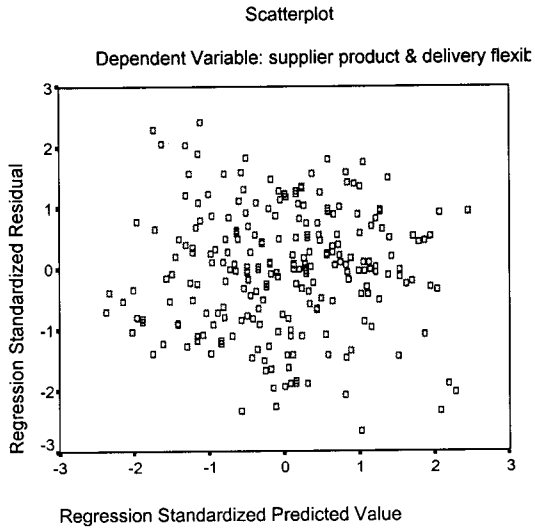
Checks were undertaken by inspecting the residuals scatterplot and the normal Probability plot of the regression standardised residuals. As can be seen from Chart 4.7A the points were almost close to the normal straight diagonal line. For outliers, the scatterplot (Chart 4.7B) of the variables was used. Most of the scores concentrated along the zero line in an almost rectangular shape and no outliers were found. There was no curvilinear or pattern to the residual plots in the scatterplot and the scatterplot was also spread between 3 and minus 3, indicating normality without outliers.

Chart 4.6 P-P plot and Scatterplot of Supplier Product Delivery Dimension

A



B



The model summary data output (Table 4.35) was used to evaluate the model. Both the R-Square and Adjusted R-Square values were 0.99 which meant that 99% of the variance in the dependent variables was explained by the model. The ANOVA table (Table 4.36) revealed a Sig. value of 0.000 for $p<0.0005$ which meant that the model was statistically significant.

Table 4.35 Model Summary

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.995[a]	.991	.990	9.09E-02	.991	1926.147	13	234	.000

a. Predictors: (Constant), EQ13, EQ12, EQ1, EQ3, EQ9, EQ7, EQ5, EQ4, EQ11, EQ8, EQ2, EQ6, EQ10

b. Dependent Variable: DELFLEX

Table 4.36 ANOVA Statistics

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	206.918	13	15.917	1926.147	.000[a]
	Residual	1.934	234	8.264E-03		
	Total	208.852	247			

a. Predictors: (Constant), EQ13, EQ12, EQ1, EQ3, EQ9, EQ7, EQ5, EQ4, EQ11, EQ8, EQ2, EQ6, EQ10

b. Dependent Variable: DELFLEX

4.13.4 Supplier Logistics Dimension F- Items level

4.13.4.1 Multicollinearity

Multicollinearity was checked to determine that Pearson's *r* did not exceed 0.7. There were two correlations exceeding 0.7. They were between: FQ1 & FQ2 (0.753) and FQ2 & FQ3 (0.811).

FQ1 – our suppliers can deliver materials and components along various routes
FQ2 – our suppliers can modify these routes easily
FQ3 - our suppliers can modify these routes in a short time

Condition index was checked and although the highest value was 22.851 (Table 4.38) there was a variance proportion of 0.92 for FQ2. The value of tolerance was also checked under collinearity statistics (Table 4.39) and the lowest value was 0.226. Both these tests for collinearity were negative; therefore, the tested variables did not violate the assumption of collinearity. This was confirmed by collinearity diagnostics (Table

4.38), where there were no dimensions with high values of variance proportions to indicate dependency among variables. Also no CI was above 16. No VIF values were above the value of 5.

Table 4.37 Coefficients

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	.000	.000		.000	1.000		
	FQ1	.143	.000	.214	1.E+08	.000	.426	2.35
	FQ2	.143	.000	.216	1.E+08	.000	.226	4.42
	FQ3	.143	.000	.223	1.E+08	.000	.327	3.06
	FQ5	.143	.000	.208	2.E+08	.000	.807	1.24
	FQ6	.143	.000	.251	2.E+08	.000	.716	1.40
	FQ7	.143	.000	.210	2.E+08	.000	.697	1.44
	REVFQ4	.143	.000	.228	2.E+08	.000	.828	1.21

a. Dependent Variable: SUPPLOG

Table 4.38 Collinearity Diagnostics

Collinearity Diagnostics[a]

Model	Items	Eigen value	Condition Index	Variance Proportions							
				(Constant)	FQ 1	FQ 2	FQ 3	FQ 5	FQ 6	FQ 7	REVF Q4
1	1	7.472	1.000	.00	.00	.00	.00	.00	.00	.00	.00
	2	.190	6.268	.00	.01	.01	.02	.03	.48	.00	.01
	3	.099	8.673	.01	.02	.01	.01	.00	.00	.07	.69
	4	.091	9.084	.04	.00	.01	.02	.57	.33	.00	.03
	5	.063	10.893	.06	.01	.03	.03	.16	.09	.63	.01
	6	.043	13.213	.25	.27	.00	.14	.14	.07	.16	.05
	7	.028	16.470	.54	.25	.02	.35	.06	.02	.13	.16
	8	.014	22.851	.11	.44	.92	.41	.04	.01	.00	.04

a. Dependent Variable: SUPPLOG

Since FQ2 was common in both correlations, it was removed first and regression conducted again. The P-P plot was almost normal. Therefore, it was variable FQ2 that was causing problems. The resultant diagnostic values were much improved.

There were no correlations above 0.7. CI was 15.554, no VIF were above 2, tolerance was 0.858, maximum Mahalanobis distance was 31.511 and the maximum Cook's distance was 0.388. These indicated that there was no collinearity or outliers. Although the Mahalanobis distance was a bit high for the low number of variables, the

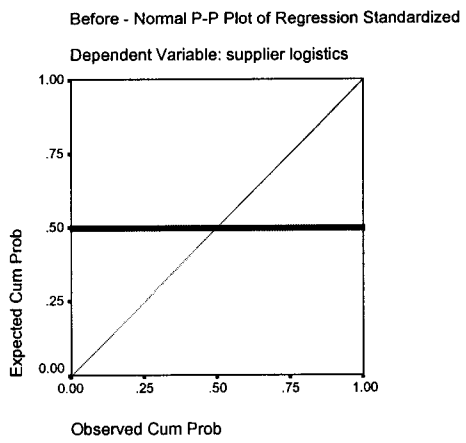
present researcher decided to ignore this and use further analysis in PCA since this was an exploratory research.

4.13.4.2 Outliers, Normality, Linearity, Homoscedasticity, Residuals

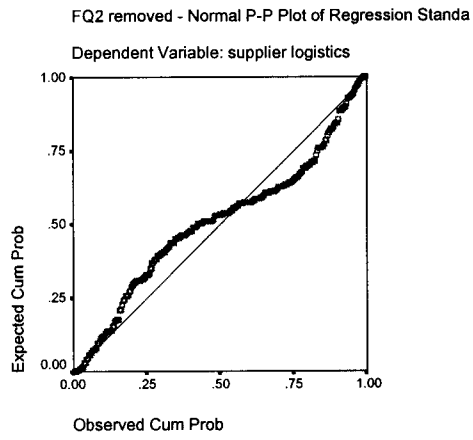
These were checked by inspecting the scatterplot of residuals and the normal Probability plot of the regression standardised residuals. Chart 4.8 shows the P-P plots before and after removing FQ2, which was not normal, from the analysis. As can be seen from Chart 4.8B (after removing FQ2), the points were almost close to the normal straight diagonal line. This allowed the researcher to exactly identify where the distribution of residuals deviations from normality were greatest.

Chart 4.7 P-P plot of Supplier Logistics

A

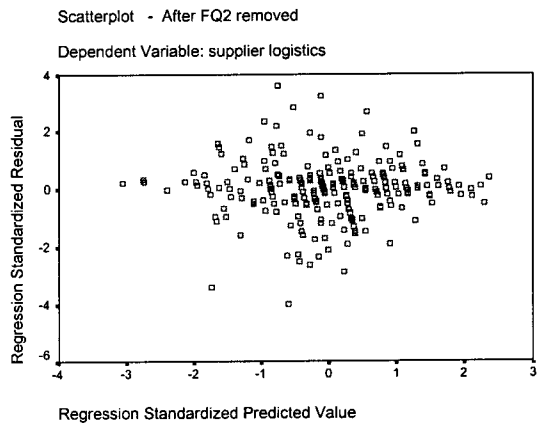


B



For outliers, the scatterplot of the variables (Chart 4.9) was used. Most of the scores concentrate along the zero line in an almost oval shape and no outliers were found. There was no curvilinear or pattern to the residual plots.

Chart 4.8 Scatterplot of Supplier Logistics



The model summary data output was used to evaluate the model. Both the R-Square and Adjusted R-Square values were 0.98 which meant that 98% of the variance in the dependent variable was explained by the model. The ANOVA table revealed a Sig. value of 0.000 for $p<0.0005$ which meant that the model was statistically significant.
In the evaluation of each of the independent variables in the coefficient table to investigate which variable contributed most to explaining the dependent variable, it was found that all the variables had a Beta value between 0.217 and 0.334. On further checking the Sig. values, all had zero value which was less than 0.05, which meant that all the independent variables were also making a significant unique contribution to the dependent variable Supplier Logistics. The VIF values were also checked; none exceeded the value of 2.

The supplier logistics dimension model was robust enough and the variables made statistically significant contributions.

4.13.5 Organisational Strategy Dimension G - Items level

It was not possible to conduct multiple regressions because of the following warning:

Warnings

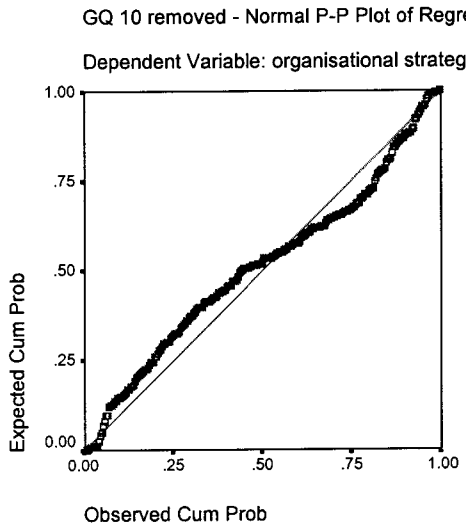
For the final model with dependent variable ORGSTRAT, the variance- covariance matrix is singular. Influence statistics cannot be computed.
Premature end of pattern reached - probably illegal character: ':' (pattern is: "The chart: ^1 is not produced because it is empty.")

Therefore the correlation matrix was checked for any correlations exceeding 0.7. There were two correlations exceeding 0.7. They were between GQ7 & GQ8 (0.771) and GQ10 & GQ11 (0.808). Also, GQ3 was the only variable which was negatively correlated with all the other variables, which meant that cost had no relationship in implementing organisational strategies.

GQ3 - these strategies are very costly to implement
GQ7 – this flexibility is easy to implement
GQ8 – this strategy is quick to implement
GQ10 – this responsive action is easy to implement'
GQ11 – this responsive action can be implemented in a short time'

Both GQ10 and GQ11 were removed one by one and regression analysis conducted again. It was found that removing GQ10 provided a slightly better PP plot (Chart 4.10) although not a straight diagonal line. The present researcher decided to continue without GQ10 and conduct PCA to observe any differences in results of different statistical techniques.

Chart 4.9 P-P plot of Organisational Strategy



4.13.5.1 Multicollinearity

Analysis of collinearity under 'Tolerance' was checked (Table 4.39) and the lowest value was 0.303. Maximum condition index was 31.3 for GQ3 (Table 4.40), therefore variance proportion was decided to be checked for the lowest eigenvalue which revealed that GQ3 had 0.55. This meant that there was some collinearity. Next the VIF was checked, none were above 4. Therefore the results are confusing that it could not be ascertained that there was actual collinearity among the predictors. Since the PP plot was almost normal, PCA shall be used for further analysis.

Table 4.39 Coefficient Analysis of Organisational Strategy

Coefficients [a]

Model		Unstandardized Coefficients		Standardized Coefficients			Collinearity Statistics	
		B	Std. Error	Beta	t	Sig.	Tolerance	VIF
1	(Constant)	.006	.032		.183	.855		
	GQ1	.083	.003	.173	24.524	.000	.545	1.834
	GQ2	.088	.004	.170	22.170	.000	.457	2.187
	GQ3	.085	.003	.158	25.602	.000	.708	1.412
	GQ4	.080	.004	.158	22.550	.000	.547	1.827
	GQ5	.083	.003	.153	25.156	.000	.731	1.368
	GQ7	.087	.005	.162	18.509	.000	.352	2.837
	GQ8	.090	.005	.170	17.986	.000	.303	3.305
	GQ9	.097	.003	.182	31.482	.000	.813	1.231
	GQ11	.140	.004	.253	35.325	.000	.526	1.899
	REVGQ6	.087	.003	.157	24.828	.000	.673	1.487
	REVGQ12	.078	.003	.134	22.745	.000	.773	1.294

a. Dependent Variable: ORGSTRAT

Table 4.40 Collinearity Diagnostics of Organisational Strategy

Collinearity Diagnostics[a]

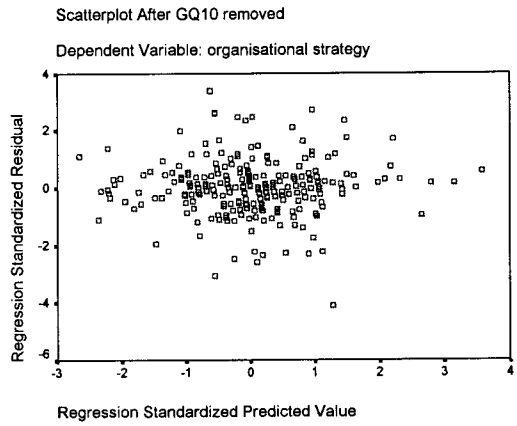
Model	Items	Eigen value	Condition Index	Variance Proportions										
				GQ 1	GQ 2	GQ 3	GQ 4	GQ 5	GQ 7	G Q8	GQ 9	GQ 11	REV GQ6	REVG Q12
1	1	11.144	1.000	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
	2	.211	7.271	.00	.01	.20	.04	.00	.01	.02	.01	.01	.00	.00
	3	.145	8.768	.00	.00	.13	.01	.00	.01	.04	.00	.01	.11	.08
	4	.133	9.147	.19	.09	.00	.01	.00	.02	.04	.01	.01	.03	.02
	5	.089	11.182	.00	.02	.06	.22	.00	.01	.01	.38	.02	.00	.07
	6	.069	12.683	.10	.02	.00	.26	.01	.10	.02	.19	.13	.04	.02
	7	.056	14.153	.00	.17	.00	.38	.04	.00	.00	.07	.31	.05	.09
	8	.045	15.709	.11	.01	.02	.01	.76	.00	.00	.00	.01	.18	.03
	9	.039	16.870	.05	.03	.02	.00	.11	.08	.01	.08	.18	.33	.48
	10	.036	17.521	.53	.62	.00	.00	.06	.01	.00	.16	.21	.03	.00
	11	.021	23.108	.01	.02	.02	.05	.01	.76	.86	.00	.11	.00	.03
	12	.011	31.314	.00	.00	.55	.00	.00	.00	.01	.08	.01	.24	.18

a. Dependent Variable: ORGSTRAT

4.13.5.2 Outliers, Normality, Linearity, Homoscedasticity, Residuals

These were checked by inspecting the residuals scatterplot and the normal Probability plot of the regression standardised residuals. Chart 4.11 shows the P-P plots after removing GQ10 from the analysis, the plot was almost close to the normal straight diagonal line.

Chart 4.10 Scatterplot of Organisational Strategy



For outliers, the scatterplot of the variables (Chart 4.11) was used. Most of the scores concentrated along the zero line in an almost rectangular shape. The casewise diagnostics (Table 4.41) indicated that there were 3 cases of minor outliers. On further

inspection, these three outliers were not too far from the zero value and since there were 252 cases, the present researcher decided to ignore these three cases. There was no curvilinear or pattern to the residual plots in the scatterplot shown above. However, by removing GQ10 the residual plots became much wider, between plus 4 and minus 6, whereas with GQ10 intact the residual plot was between plus and minus 3. It is interesting to note that the Normality P-P plot was better but the scatterplot was worse. Further PCA analysis was conducted to explore the reason why this was so.

Table 4.41 Casewise Diagnostics for Organisational Strategy

Casewise Diagnostics[a]

Case Number	Std. Residual	ORGSTRAT	Predicted Value	Residual
74	-4.107	5	4.91	-.24
127	3.411	4	3.55	.20
193	-3.084	3	3.60	-.18

a. Dependent Variable: ORGSTRAT

The model summary data output was used to evaluate the model. Both the R-Square and Adjusted R-Square values were 0.99 which means that 99% of the variance in the dependent variable is explained by the model. The ANOVA table revealed a Sig. value of 0.000 for $p<0.0005$ which means that the model is statistically significant.

Each of the independent variables in the coefficient table was evaluated to investigate which variable contributed the highest to explaining the dependent variable; it was found that the variables had a Beta value between 0.134 and 0.253 with GQ11 as the highest. On further checking the Sig. values, all had zero value which was less than 0.05, which meant that all the independent variables were also making a significantly unique contribution to the dependent variable. All the variables, except GQ10, were statistically significant to the Organisational Strategy Dimension model.

4.13.6 Summary of Multiple Regression

Section 4.13 looked very thoroughly at the standard multiple regression of the five dimensions and its related variables. Tests were carried out to the assumptions of the conceptual model. The model appears, in most instances, to be both accurate and generalisable to the population. The slight glitches of non-normal P-P plots could be a concern over the attractiveness of the test results. These glitches were overcome by removing the offending variables from the analysis. Although the tests did not fully explain all the results, more tests were required to verify whether the proposed conceptual model was robust enough; those tests are discussed in the next section on Principal Component Analysis.

4.14 PRINCIPAL COMPONENT ANALYSIS

Initially, from the literature review the present researcher developed three hundred and four items which could be used for measuring procurement flexibility. This list was reduced to 94 and then, by the use of Q-Sort technique, further reduced the number of items to 57. This is an exploratory research, and as shown in the correlation analysis and multiple regression analyses there were correlations and variances among the variables; and because the present researcher intended to predict and confirm a more up to date conceptual model of procurement flexibility, Principal Component Analysis (PCA) was warranted. Multiple regression analysis had also shown that some variables did not fully explain the identified variances and produced some discrepancies in the P-P plots and scatterplots. Thus, the researcher used PCA to transform the derived 57 items (variables) into a new set of linear combinations that were the principal components.

PCA also maximised the variances (Rencher 1995) identified in other types of statistical analysis. As was seen in the earlier analysis, there were 1596 correlations which made it difficult to comprehend the data. Therefore, PCA provided a means of data reduction to identify a structure within that data (Dillon & Goldstein 1984), while retaining the original information as much as possible. Since the present researcher

had proposed a conceptual model of the dimensions of procurement flexibility, PCA allowed the statistical testing of that proposed model and its dimensions.

The use of the terms FA (Factor Analysis) and Principal Component Analysis (PCA) are used interchangeably by many authors (Tabachnick & Fidell 1989; Field 2000; Pallant 2001), while others have separated the terms into different chapters like Mardia *et al.* (1979), Dillon & Goldstein (1984), Rencher (1995), Press (1972), and other authors have chosen not to use the term FA (Stevens 1992). Also some authors (Hair *et al.* 1998) do not use the term PCA.

The present researcher took the approach of deriving factors using PCA to analyse the hypothesised conceptual model for any underlying structures and then using FA to analyse the derived components as a means of developing a modified model.

4.14.1 Factor Extraction Framework

Since this was exploratory research on Australian manufacturing procurement flexibility dimensions and practices, a PCA was conducted without any restrictive specification of the underlying structure. The PCA examined the 57 items for each of the five flexibility dimensions.

This research also investigated the relationships between the five flexibility dimensions in procurement activities. Since there were 57 independent variables involved, there was a need for increased knowledge of the flexibility structure and inter-relationships of these variables.

In view of the major research objective of forming a generalisable framework for procurement dimensions and procurement activities in the Australian manufacturing sector, PCA can help in identifying the empirical structure of relationships among the variables and help towards flexibility model building and future analysis.

However, before using PCA it was necessary to clarify the suitability of the dataset for PCA. One clarification is by use of correlation analysis. A number of correlations were conducted and their results showed a mixture of low, medium, high and negative relationships. It was found that 75% had coefficients more than 0.3 (see Section 4.10);

therefore, PCA was a suitable technique to use. Another clarification was sample size. Although the desired sample size various from author to author, most agreed that a sample above 200 was sufficient for exploratory research.

Another mode of determining the appropriateness of PCA was by examining the entire correlation matrix for evidence of coefficients above 0.3, using the Bartlett test of sphericity. The Bartlett test of sphericity checks statistically for the presence of correlations among the variables. It provides the statistical probability that the correlation matrix has significant correlations among at least some of the variables (Hair *et al.* 1998). The Bartlett test of sphericity needed to be significant for PCA to be considered; i.e., with a Sig value smaller than 0.05. Another test is the Kaiser-Meyer-Olkin (KMO) test. The minimum value for KMO index is 0.6 for good factor extraction. The current KMO value was 0.836, which exceeded the minimum requirement of 0.6 and the Sig value was zero, thereby satisfying both tests of sphericity and KMO (see Table 4.42).

Table 4.42 Test of Sphericity

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.836
Bartlett's Test of Sphericity	Approx. Chi-Square	8715.174
	df	1596
	Sig.	.000

Next to determine the number of factors to extract, Kaiser's criterion with an eigenvalue of more than 1.0 was used. The extraction using PCA revealed 15 components which explained 71.3% of the variance. Since 15 components (Appendix 14) were too much and there were too few variables for some of the components, it was decided to look at the screeplot. The screeplot revealed three clear kinks at the 5th, 8th and 15th components (see Figure 4.4).

Figure 4.4 Screeplot of all 57 variables without forcing number of extraction

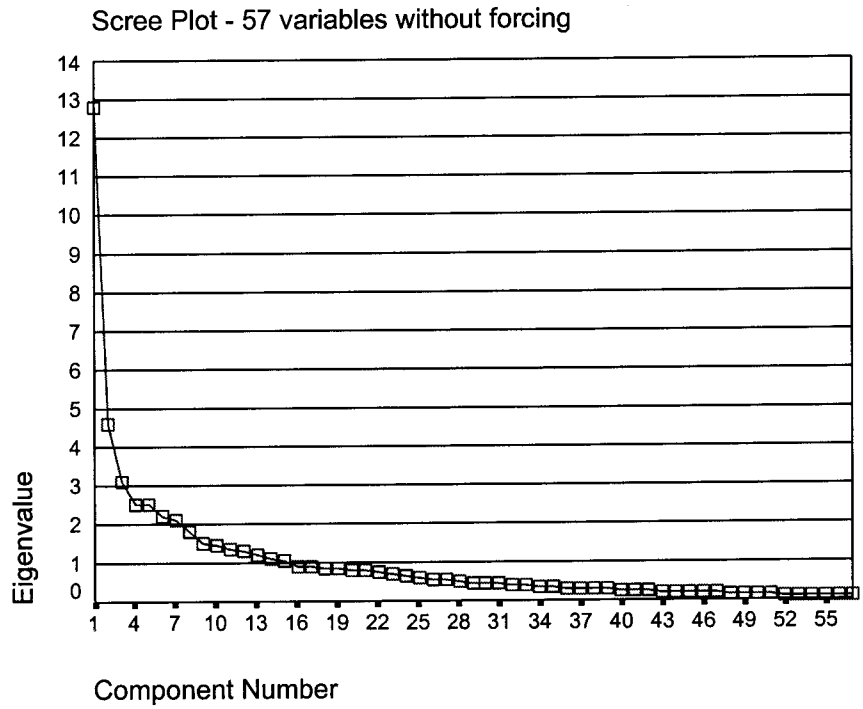


Table 4.43 Total Variance - Factor extraction without forcing at eigenvalue above 1

Total Variance Explained - All 57 variable no forcing

Component	Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %
1	12.801	22.459	22.459
2	4.596	8.063	30.522
3	3.107	5.451	35.973
4	2.519	4.419	40.392
5	2.495	4.376	44.768
6	2.214	3.885	48.653
7	2.106	3.695	52.348
8	1.802	3.162	55.509
9	1.523	2.672	58.181
10	1.452	2.547	60.729
11	1.336	2.345	63.073
12	1.310	2.299	65.372
13	1.217	2.136	67.508
14	1.112	1.952	69.459
15	1.054	1.850	71.309

Extraction Method: Principal Component Analysis.

Looking at the first kink (Figure 4.4), the first 3 components captured 35.900% of the variance. It would be recommended to use only the first three components, but the screeplot revealed that it was still more than eigenvalue of 3. Therefore, it was

decided to look at the second kink after the 8th factor which had eigenvalue of 1.8. The first 8 factors explained 55.500% of the variance, but still above the eigenvalue of 1. To obtain full factor extraction above eigenvalue of 1 revealed 15 factors (see Appendix 14) but still only explained 71.309% (Table 4.43) of the variance.

One of the reasons for the extraction of 15 factors could be that not enough items and groupings were revealed in the Q-sort techniques, and/or maybe there was insufficient relevant published literature to identify all the dimensions of procurement flexibility and/or that the Australian manufacturing sector might have some of its own critical elements of procurement. There was also no published literature available to enable comparisons of procurement characteristics between the Australian manufacturing sector with other countries.

The present researcher then decided to compare the factors derived from various extractions of the different number of components. This is discussed later in Section 4.17. It was also noted that many of the factors loaded on more than one component, possibly indicating that a particular factor has tradeoffs between two components. Trade-off is discussed in more detail in Section 4.20.

Nevertheless, the full factor extraction above eigenvalue of 1 extracted 15 factors and only explained 71.309% of the total variance. In the present researcher's mind it seemed there were too many components compared to the initial hypothesised model of 5 dimensions derived from extant literature and Q-sort survey. Therefore, the present researcher decided to investigate the PCA at the dimensional level for more information about the number of dimensions.

4.15 FACTOR EXTRACTION AT DIMENSIONAL LEVEL

Since the PCA of all the 57 flexibility items without forcing at above eigenvalue of 1 only explained 71.309% of the variance, the present researcher decided to explore PCA within each of the 5 dimensions separately. PCA would provide the constructs for each dimension. The first being the dimension of Information Exchange.

4.15.1 Information Exchange PCA

The first dimension applied to PCA using varimax rotation was Information Exchange. Table 4.44 below showed that 4 components were extracted which had an eigenvalue of more than 1. The factor loadings were quite strong, most of them above 0.6 and only two below 0.6. These 4 factors explained 64% of the variance.

The first component had 6 items about time and ease of information transfer, which amounts to convenience. The second component had 5 items about the easiness of hardware and software connectivity of the buyers' and sellers' IT systems. The third component had 2 items about reliability and accuracy of information received by the manufacturers with reference about the quality of information. The last component of 4 items was about sharing of types of information.

Table 4.44 Information Exchange Component Extraction

Rotated Component Matrix [a]

	Component			
	1	2	3	4
CQ16 information sent to our suppliers is in real time	.826			
CQ17 it is easy for us to send information to our suppliers	.804			
CQ15 information sent to our suppliers is accurate	.753			
CQ14 information sent to our suppliers is timely	.696		.320	
CQ10 easy for our suppliers to send information to us	.612			.349
CQ13 information received from our suppliers is in real time	.514		.511	
CQ5 our IS is well integrated with that of prominent supplier		.852		
CQ7 high connectivity of the IS with our suppliers		.829		
CQ6 our IS data structure is same as prominent supplier		.820		
CQ9 routine transfer of ordering info done without human intervention		.690		
CQ8 routine transfer of invoicing info done without human intervention		.662		
CQ12 information received from our suppliers is reliable			.867	
CQ11 information received from our suppliers is accurate			.845	
CQ1 we receive sufficient range of information from suppliers				.716
CQ3 suppliers are willing to share critical information with us			.317	.670
CQ2 we provide sufficient range of information to suppliers	.388			.668
CQ4 data transfer with prominent supplier does not need translation		.340		.425

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 7 iterations.

Since the third component had only two items, there may possibly be a problem with content validity. This suggests that in future research more items are included to improve content validity. The present researcher accepts this as a limitation. Therefore, the new modified Constructs for the dimension of Information Exchange were able to be identified as Convenience, Connectivity, Quality and Type.

4.15.2 Supplier Integration Factor Analysis

Table 4.45 below showed that 2 components were extracted which had eigenvalues of more than 1. The factor loadings were quite strong explaining 70% of the variance.

The first component had 4 items about changes in demand and quality, which amounted to supplier capability. The second component had 3 items about changing of suppliers, which was basically about the selection of suppliers; i.e. about choosing the most appropriate suppler. This was also confirmed in the qualitative survey as to how manufacturers overcome uncertainties.

Therefore, the new modified Constructs for the dimension of Supplier Integration would be Supplier Capability and Supplier Selection.

Table 4.45 Supplier Integration Component Extraction

Rotated Component Matrix [a]

	Component	
	1	2
DQ2 suppliers can easily adjust to changes in demand schedules	.831	
DQ4 suppliers are capable of flexible delivery at short notice	.823	
DQ1 suppliers carry sufficient inventory to cater to our demands	.766	
DQ3 suppliers maintain high quality standards at all levels of demand	.758	
DQ6 we can change to different suppliers in a short time		.922
DQ5 we can change to different supplier easily		.899
DQ7 we can change to different suppliers at a low cost		.772

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
a. Rotation converged in 3 iterations.

4.15.3 Product and Delivery Flexibility Component Extraction

Table 4.46 below showed that 3 product delivery components were extracted which had eigenvalues of more than 1. The factor loadings were quite strong, most of them above 0.6. These 4 factors explained 64% of the variance.

The first component had 8 items about time, cost and ease of product design and modification, which amount to the development of products. These amounted to the capability of the suppliers to develop a range of components and materials. The second component had 4 items about the quality and range of products, which amounted to the development performance of the suppliers in relation to component products and

materials. The third component had 2 items about delivering new components easily in a short time; it was difficult to make any assumptions as to what constructs they belong to. Basically these components pointed to the capacity or ability of suppliers to design, modify and deliver components and materials. There was no actual item measuring 'range' of products and materials. On inspection of the survey instrument, it was clear that only one variable on range was identified and on further consideration, the variable (EQ14 – our suppliers have the capacity to deliver a wide range of component parts) could be moved to the quality construct (see Figure 2.6).

Therefore, the dimension of Product & Deliver Flexibility now has the 3 constructs of Product Development, Product Performance and Delivery Capacity.

Table 4.46 Product/Delivery Flexibility FA

Rotated Component Matrix [a]

	Component		
	1	2	3
EQ11 suppliers can implement product design changes at a low cost	.802		
EQ10 suppliers can implement product design changes in a short time	.764		.363
EQ9 suppliers can implement product design changes easily	.730		.348
EQ7 suppliers can modify their product mix at a low cost	.720	.399	
EQ6 suppliers can modify their product mix in a short time	.695		.317
EQ13 short time required for suppliers to switch parts mix	.683		
EQ5 suppliers can modify their product mix easily	.633	.322	.343
EQ3 suppliers can deliver new components / materials at a low price	.444		.438
EQ8 suppliers can modify their product mix with same quality		.851	
EQ12 suppliers can implement product design changes with same quality		.833	
EQ4 suppliers can deliver new components / materials with same quality		.814	
EQ14 suppliers can deliver wide range of component parts		.470	
EQ1 suppliers can deliver new components / materials easily			.899
EQ2 suppliers can deliver new components / materials in a short time	.339		.849

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 7 iterations.

The present researcher accepts possible concern for content validity in the third component, which has only 2 items. Since this is an exploratory research, it is suggested that more items be included in future research.

4.15.4 Supplier Logistics Component Extraction

Table 4.47 below showed that 2 supplier logistics components were extracted which had eigenvalues of more than 1. The factor loading were quite strong, most of them above 0.6. These 2 components explained 63% of the variance.

The first component had 4 items about alternatives in delivering routes of supplier logistics flexibility, which amounted to route selection. The second component had 3 items about the cost and range alternatives of logistics, which is about transport cost of logistics. Basically these components pointed to the flexibility of a supplier's ability to arrange the route of the delivery of components and materials.

There was no actual item measuring 'quality' of logistics service delivery. Also on inspection of the Q-sort item list, it was clear that quality of logistics was not indicated as of high importance. This was possibly because many suppliers and manufacturers could be using third party logistics service providers. Another reason may be that outsourcing logistics services was more flexible and compatible to the core operations of the suppliers and manufacturers in Australia.

Therefore, the dimension of Supplier Logistics now has 2 constructs of Route Selection and Handling Costs.

Table 4.47 Supplier Logistics Factor Analysis

Rotated Component Matrix[a]

	Component	
	1	2
FQ2 suppliers can modify these routes easily	.927	
FQ3 suppliers can modify these routes in a short time	.878	
FQ1 suppliers can deliver materials and components along various routes	.839	
REVFQ4	.462	
FQ6 choice of handling routes does not affect transport costs		.841
FQ5 all materials handling routes exhibit similar performance levels		.754
FQ7 transport facilities for materials of different sizes are flexible	.383	.604

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
a. Rotation converged in 3 iterations.

4.15.5 Organisational Strategy Component Extraction

Table 4.48 below showed that 4 components of organisational strategy were extracted which had eigenvalues of more than 1. The factor loadings were quite strong, most of them above 0.5. These 4 components explained 69% of the variance.

The first component had 4 items about ease and time of organisational strategic flexibility, which amounted to the implementation time of organisational strategy. The second component had 4 items about the ease, time and range of organisational strategy, which is about complexity of organisational strategy. The third component had 3 items related to implementation cost and the last component had only 1 item on risk management strategy. Therefore the four constructs of Organisational Strategy may be classified under 'Implementation Time', 'Structural Integrity', 'Cost Benefits' and 'Risk Management'.

Basically, these four components point to an organisation's ability to implement strategic flexibility. There was no actual item measuring the 'quality' of organisational strategy and on inspection of the Q-sort item list indicated that quality was not considered of high importance; therefore it was not included in the survey instrument.

Table 4.48 Organisational Strategy Factor Analysis

Rotated Component Matrix[a]

	Component			
	1	2	3	4
GQ8 this flexibility is quick to implement	.887			
GQ11 this responsive action can be implemented in a short time	.791			.312
GQ7 this flexibility is easy to implement	.768			
GQ10 this responsive action is easy to implement	.754			.471
GQ1 have a range of organisational strategies for supplier integration		.841		
GQ2 these strategies are easy to implement	.350	.775		
GQ5 org structure flexible to improve operational relationships with suppliers		.594		
GQ4 these strategies can be implemented in a short time	.527	.565		
REVGQ6			.800	
GQ3 these strategies are very costly no implement			-.781	
REVGQ12			.708	
GQ9 strategies are designed to respond to environmental uncertainties				.872

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
a. Rotation converged in 7 iterations.

Nevertheless, quality of strategy has been shown to be important in the four derived components. One possible explanation for the results was that manufacturers and extant researchers have a different understanding of the role of strategy in an organisation; a matter for future research. Similar to previously discussed component extraction, component four has only one item, therefore there may be possible concern for content validity.

4.15.6 Summary of PCA at Dimensional Level

The above analysis of the PCA at dimensional level and the new derivation of constructs is tabulated in Table 4.49 below.

Table 4.49 New Constructs at Dimensional Level

Dimensions	Constructs
Information Exchange	Convenience, Connectivity, Quality, Type
Supplier Integration	Capability, Choice
Supplier Product Delivery	Development, Performance, Capacity
Supplier Logistics	Route Selection, Handling Costs
Organisational Strategy	Implementation Time, Structural Integrity, Cost Benefits, Risk Management

From Table 4.49 it can be seen that for each of the proposed dimensions there were different constructs from those proposed in the original hypothetical model in Chapter 2. This further confirms the need for the use of Principal Component Analysis to design an up to date Australian model from the collected research data.

4.16 FACTOR EXTRACTION AT ITEM LEVEL

Having evaluated and discussed the extraction of factor components at independent dimensional level and arriving at various new dimensions, the present researcher decided to explore factor component extraction of the 57 items together as a single group. This enabled the researcher to observe if there were any new dimensions different from those extracted at the dimensional level.

For the 57 items, PCA with varimax rotation was used to force the extraction of 4, 5, 6, 7, and 8 components. The PCA extraction of 8 components seemed the best output as recommended by Hair *et al.* (1998) that the ideal PCA extraction should have about 4 or 5 factors in each component. The present researcher found that the extraction of 8 components was the best output to follow Hair *et al.'s* recommendation. There was one component with 14 factors, one component with eleven factors, one component with nine factors, two components with five factors each, one component with seven factors, one component with four factors and one component with 3 factors. The PCA extraction of 8 components is reproduced below (Table 4.50) to extenuate the output results. Analysis of this 8 factor extraction is discussed next.

Table 4.50 PCA Extraction of 8 Components from the 57 flexibility items

	Component							
	1	2	3	4	5	6	7	8
EQ7 suppliers can modify their product mix at a low cost	.737							
EQ5 suppliers can modify their product mix easily	.732							
EQ6 suppliers can modify their product mix in a short time	.729							
EQ11 suppliers can implement product design changes at a low cost	.722							
EQ10 suppliers can implement product design changes in a short time	.711							
EQ9 suppliers can implement product design changes easily	.694						-.31	
EQ8 suppliers can modify their product mix with same quality	.681							
EQ13 short time required for suppliers to switch parts mix	.673						-.35	
EQ12 suppliers can implement product design changes with same quality	.643							
EQ4 suppliers can deliver new components / materials with same quality	.586							
EQ3 suppliers can deliver new components / materials at a low price	.557		.300		.308		.301	
EQ2 suppliers can deliver new components / materials in a short time	.460				.394			
EQ1 suppliers can deliver new components / materials easily	.415							
EQ14 suppliers can deliver wide range of component parts		.734						
CQ15 information sent to our suppliers is accurate		.728						
CQ17 it is easy for us to send information to our suppliers		.723						
CQ16 information sent to our suppliers is in real time		.709						
CQ10 easy for our suppliers to send information to us		.667						
CQ14 information sent to our suppliers is timely		.612						
CQ13 information received from our suppliers is in real time		.526						
CQ2 we provide sufficient range of information to suppliers		.511			.509			
CQ11 information received from our suppliers is accurate		.443						
CQ1 we receive sufficient range of information from suppliers		.398		.305				
CQ4 data transfer with prominent supplier does not need translation		.316						
CQ3 suppliers are willing to share critical information with us			.734					
GQ10 this responsive action is easy to implement			.690					
GQ11 this responsive action can be implemented in a short time			.690					
GQ7 this flexibility is easy to implement			.630					
GQ8 this flexibility is quick to implement			.614					
GQ2 these strategies are easy to implement			.550					
GQ4 these strategies can be implemented in a short time			.532					
GQ1 have a range of organisational strategies for supplier integration			.504					
GQ9 strategies are designed to respond to environmental uncertainties			.501					
GQ5 org structure flexible to improve operational relationships with suppliers				.811				
CQ5 our IS is well integrated with that of prominent supplier				.795				
CQ7 high connectivity of the IS with our suppliers				.791				
CQ6 our IS data structure is same as prominent supplier				.694				
CQ9 routine transfer of ordering info done without human intervention				.634				
CQ8 routine transfer of invoicing info done without human intervention					.704			
DQ1 suppliers carry sufficient inventory to cater to our demands	.368				.702			
DQ4 suppliers are capable of flexible delivery at short notice					.688			
DQ2 suppliers can easily adjust to changes in demand schedules	.316				.609			
DQ3 suppliers maintain high quality standards at all levels of demand		.456			.594			
CQ12 information received from our suppliers is reliable						.863		
FQ2 suppliers can modify these routes easily						.797		
FQ3 suppliers can modify these routes in a short time						.761		
FQ1 suppliers can deliver materials and components along various routes						.506		
FQ7 transport facilities for materials of different sizes are flexible						.462		
REVFQ4 – too costly for suppliers to modify these routes						.363		-.35
FQ5 all materials handling routes exhibit similar performance levels						.330	.318	
FQ6 choice of handling routes does not affect transport costs							.766	
DQ6 we can change to different suppliers in a short time							.726	
DQ5 we can change to different supplier easily							.642	
DQ7 we can change to different suppliers at a low cost								.702
REVGQ6 – flexibility is too costly to implement								.665
REVGQ12 – responsive action is too costly to implement								-.62
GQ3 these strategies are very costly no implement								

Extraction Method: Principal Component

4.17 COMPARISON OF MULTIVARIATE ANALYSES

4.17.1 Comparison between Multiple Regression and PCA

A comparison of the items that caused normality problems in multiple regression are discussed next. From the PCA of 8 component extraction in Table 4.50, it was noted that item CQ12 which was causing normality problems in multiple regression analysis of Information Exchange (Section 4.13.1) did not group together with the other items from the same dimension C; but it grouped with other items from the D dimension of 'supplier integration' under the fifth component. Variables CQ5, CQ6 and CQ7 which had correlations more than 0.7 grouped together with CQ8 and CQ9 to form a separate component.

In the supplier integration dimension the items that caused normality problems in multiple regression were DQ5 & DQ6; which was grouped together with DQ7 as a separate dimension in component 7.

In the Supplier Product & Delivery Flexibility dimension, although the variables which had correlation values greater than 0.7 (EQ1 & EQ2, EQ5 & EQ6, EQ8 & EQ12, EQ9 & EQ10) they grouped together as component 1. On closer inspection of the extraction of 15 components, it was seen that EQ1 and EQ2 were also represented in the same component but with different weightings. Therefore it may be deduced that PCA provided a more accurate representation of the flexibility dimensions. The other offending variables, although with correlations more than 0.7 were grouped together with the other variables from the same dimension. Therefore, it may also be assumed that the non-normality caused in multiple regression may be ignored as they performed well in PCA .

Although there were three variables with more 0.7 correlation values in the supplier logistics dimension (FQ1, FQ2 and FQ3), they still grouped together as one component. Similarly with the dimension of organisational strategy which had two correlations values of more than 0.7, they grouped together as component 3. The only variable (GQ3) that had negative correlation, grouped itself with two of the reverse worded questions as the last component.

4.17.2 Comparison between Factor extraction at Dimensional and Item Levels

Factor extraction at dimensional level was analysed and discussed in Section 4.15 with item level in Section 4.16; the PCA at the dimensional level provided new constructs and the PCA at the items level provided new dimensions.

The present researcher felt that the items in the Q-sort technique and lack of extant literature in procurement flexibility may have not provided sufficient knowledge to design an accurate survey instrument that reflected the true nature of procurement flexibility in practice. Therefore, it is considered that the constructs derived at dimensional level as shown in Table 4.49, would not be used, but the components from Table 4.50 shall be used to derive the final model.

The present researcher also felt that some of the items also may not belong to the dimensions as initially designed in the hypothetical model. Some of the items may be relevant to more than one dimension; therefore the present researcher decided to use the PCA of the 57 variables at item level to devise the new model together with the new constructs at the dimensional level. But this posed a problem of non-existence of researched constructs for the four new dimensions. This lead to further research of the new model.

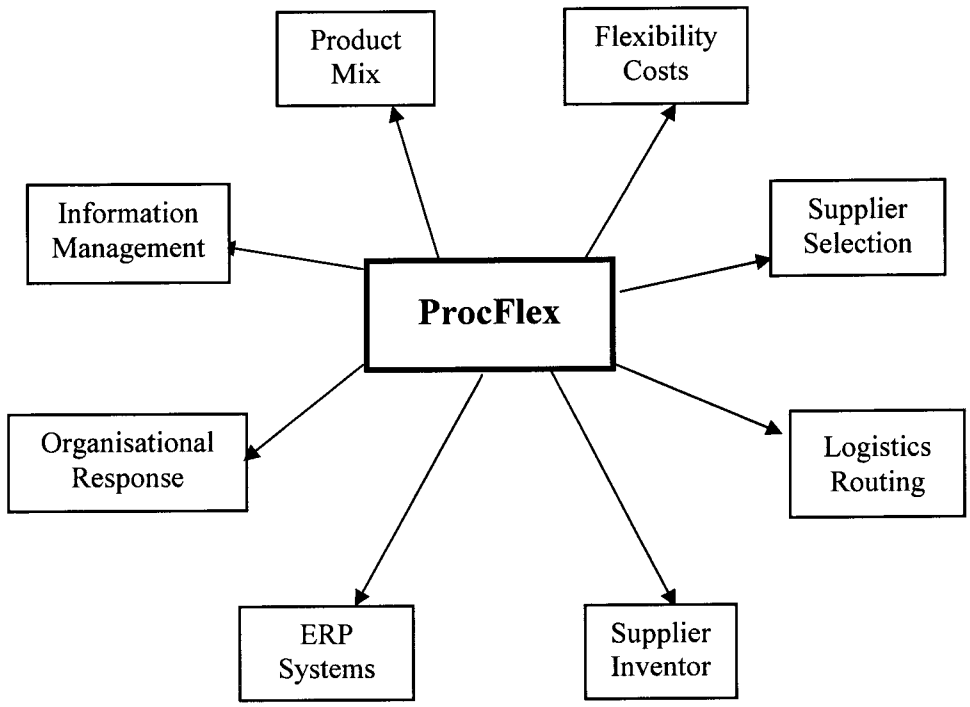
4.18 NEW MODEL

The PCA of the 57 variables at the item level produced 8 components (Table 4.50) and these were converted into 8 dimensions of ProcFlex as shown in Figure 4.5. Based on the contents of each of these 57 variables (items) the present researcher has defined the 8 dimensions as Product Mix, Information Management, Organisational Response, ERP System, Supplier Inventory, Routing, Supplier Selection, and Flexibility Costs (Table 4.51). Each of the eight derived dimensions are discussed in detail below.

Table 4.51 Attributes of Modified Model of Procurement Flexibility Dimensions

Dimension Name	Attributes
Product mix	Product design & modification
Information management	Send, receive, accuracy and reliability
Organisational response	Implementation, Integration
ERP system	Connectivity, compatibility, automation
Supplier inventory	Capability, capacity, quality
Routing	Selection, modification
Supplier selection	Time, ease, cost
Flexibility costs	Implementation & risks

Figure 4.5 Modified Model of Procurement Flexibility



4.18.1 Dimensions of New ProcFlex Model

4.18.1.1 Product Mix

The first dimension is about the suppliers' ability of product mix in terms of modifying the product components and raw materials; implementing product design changes; and delivering that product mix. Therefore this dimension has three constructs, viz. modification, implementation and delivery of the product mix. Each of these constructs can be further separated into the elements of cost, ease, time, range and quality.

The element of cost refers to modifying the product mix, implementing product design changes, and delivering new components/materials at a low cost. Therefore, from the perspective of the manufacturing organisation component/material cost is critical. The element of ease refers to modifying the product mix, implementing product design changes and delivering these component/materials easily.

The element of time is seen as modifying the product mix, implementing design changes and delivering them in a short time. The manufacturers' concern here would be that the procured components/materials are delivered on time, possibly in line with the production schedules. The element of quality is about maintaining the same quality when components and materials are modified or have design changes or when new components/materials are procured.

The element of range is about a supplier's ability to deliver a wide range of components and materials. This would indicate that manufacturers prefer the same supplier to be able to supply and deliver a wide variety of procured components and

materials. Since the qualitative email survey indicated that the majority of the manufacturers practice dual sources of supply, it could mean that the first preference would be dealing with one supplier if possible then an alternate supplier is maintained for situations of uncertainty. Other factors could be for reasons of quality and quantity which is indicated as the next element of this dimension.

The above findings of the present research is supported by published literature. The constructs refer to the shorter product life cycles together with increasing global competition is forcing manufacturers to implement new product development at a faster rate. Suppliers have the potential to generate and implement new product development (Araujo *et al.,* 1999) and others (Liker, *et al.* 1996) suggest that supplier involvement also decreases the complexity of the development process. Although the present research did not ask a specific question of supplier involvement, it does however suggest that procurement flexibility can be enhanced with the manufacturer involvement in their suppliers' new product development process.

Research also indicates that order quantities and supply lead-times are the two most common changes which occur in a SC (Das & Abdel-Malek 2003). Order quantities and supply lead-times are part of the product mix, therefore this published literature supports the present research findings.

The ability of suppliers to satisfy the various elements of time, range, cost and quality also fall under the realm of supplier selection, because suppliers are selected based on their ability and capability to satisfy these elements of the product mix dimension. This is supported by authors like Braglia and Petroni (2000).

4.18.1.2 Information Management

Organisations deem information management alignment with their business strategy as important (Chan & Huff 1993). In today's volatile business environment when the competitive factors are keenly exploited by business, the value of information has increased. This is further enhanced in organisations using JIT, lean production techniques and other business philosophies. Therefore the flexibility of managing information between the supplier and manufacturer is critical in ensuring that the production process operates without any interruptions in supplies.

This dimension is about the flexibility of the management of information exchanged both ways. It concerns the reliability, timeliness and sufficiency of information exchanged. This dimension can be further classified into the constructs of transmission, accuracy and reliability. It also concerns about the quality and willingness of information exchanged between the suppliers and manufacturers. The elements of these constructs are ease, time and range both ways. The element of ease is how easy is it to send information either direction. Time is real time consideration and the timely exchange of information. Range is the sufficiency of the information required by either entity.

From Appendix 20 it can be seen that those respondents who agreed that the willingness of and receiving sufficient information which are timely and reliable from their supplier have also indicated that their ProcFlex level is high. Also respondents who indicated the same when send information to their supplier ProcFlex level is high. This is supported by research in procurement processes (Brenner & Hamm 1996).

4.18.1.3 Organisational Response

The third dimension can be classified into the constructs such as the organisation's flexibility to respond to uncertainty. These constructs are implementation and integration of strategies. The elements are ease, time and range. Ease is how easy is it to implement and integrate the flexibility response strategies with their suppliers and within their own organisational structure. Time is how long it takes to implement these response strategies. Range is the availability of the different strategies available in the manufacturing organisation.

As shown in Table 4.50, all the variables (except GQ3, GQ6 and GQ12 which pertained to costs) extracted in component 3 were plotted using scatterplot against ProcFlex as shown in Appendix 20. The scatterplot indicated that the more strongly the respondents agreed with the statements of these variables the higher the flexibility level. This shows that those respondents who indicated that those organisations who have a wider range of strategies; easier to implement these strategies; in a shorter time; quicker responsive time; easier responsive action; easier and quicker implementation of these strategies and strategies designed to respond to environmental uncertainties have a higher ProcFlex level.

As also shown in Appendix 17, the higher the Range, Uniformity and Mobility the higher the flexibility of ProcFlex. These support the findings of Dyer and Singh's (1998) and Young *et al.* (2003) argument that flexible inter-organisational relationships enable more value creation.

Other studies found that management's ability to influence organisational outcomes also affect response strategies (Beal & Yasai-Ardekani 2000; Ramaswamy *et al.*

1994). Therefore, in the present research organisational response in implementing strategies in response to environmental uncertainty provides greater procurement flexibility.

4.18.1.4 ERP System

The fourth dimension if the flexibility of the Enterprise Resource Planning (ERP) system. This may be MRP1 or MRP2 systems or other ERP systems. The constructs defined are connectivity, compatibility and automation. The respondents have indicated that this dimension is about the connectivity and compatibility of their systems with their suppliers'. Also the importance of automation which requires no human intervention. As there is more human intervention occurs, the likelihood of efficiency and effectiveness may be compromised because in some manufacturing firms there may be a huge number of parts, components and materials handled by their MRP system.

There is insufficient number of variables (items) in this component for the present research to identify definitive elements. Therefore, the constructs explain how well the ERP systems between the suppliers and manufacturers are integrated and whether the data structures of both entities are compatible with each other. It also identifies the flexibility of the ERP systems to function automatically without human intervention.

The problems of incompatibility in integrating systems and data is highlighted by authors like McLaren *et al.* (2002). Other problems in ERP systems are trying to encourage smaller suppliers to adopt similar ERP systems like EDI or other web based order entry systems (Archer & Yuan 2000).

4.18.1.5 Supplier Inventory

Inventory is a critical dimension in JIT activities (Dong *et al.* 2001) of manufacturing organisations. Manufacturing operations determine the production schedules based on their customer demands and forecasts. Hence components and materials are procured in relation to the production schedules. Inventory on suppliers' outgoing side and manufacturers' incoming side are critical in ensuring manufacturing operations do not experience interruptions.

This dimension's constructs are flexibility of or level of suppliers' inventory; delivery flexibility to match demand; and quality of supplies. Suppliers need to have the flexibility to deliver supplies, at short notice, depending on the stochastic demand levels. Reliability of information from suppliers is also considered important as the production schedules are programmed in accordance with suppliers' promises of delivery.

The qualitative email survey also indicated that the manufacturers practice safety and buffer inventory stocks in cases on emergencies. This is supported by Dong *et al.*'s (2001) findings that buyers benefit from JIT purchasing while suppliers may need to adjust their practices.

4.18.1.6 Routing

In the current global business environment of uncertainty, it is important that there are no disruptions in the transportation of components and materials. Whether the components and materials are procured locally or overseas, it must be ensured that they arrive at the manufacturing plant on time as requested. Other threats to the transportation industry are natural disasters and labour force strikes. Suppliers need to

ensure that there are flexibility measures in place to counter such uncertainties and threats. Therefore, the flexibility of routing of components and materials is critical to ensure that the correct procured item is delivered to the right place at the right time. The constructs are selection and modification of routes. The elements of this dimension are ease, time and cost.

Most manufacturing organisations practice JIT and have limited space for warehousing incoming inventory. Research indicates that the basic logistics services have undergone change and now include value added bundled services like information technology, warehousing, incorporation into the SC of customers and clients (van Laarhoven *et al.* 2000). There is also an increased use of third party logistics (3PL) service providers.

Normally the responsibility of the delivery and transportation of components and materials is on the suppliers even when third party logistics service providers are used. The flexibility element of ease is how easily and quickly the routes can be modified and how many alternate routes are available while maintaining the same costs of transportation. The other flexibility elements are ability to handle different lot sizes at similar performance levels for all available routes.

These 3PL service providers are facing constant challenges to their relationships with their clients and their customers' processes (Andersson & Norrman 2002). They need to have very close interactions with both clients and their customers if not either party might be hurt by bad service. The traditional purchasing of logistics services used to

be at arms length but the trend now is towards partnerships, contracting and vendor certification (Sink & Langley 1997).

Therefore services of these 3PL service providers need to be flexible to handle the requirements of both the client and their customers, therefore 3PL service provider selection and their routing capabilities need to risk assessed by both the suppliers and manufacturers. For example Efficient Customer Response (ECR) is gaining importance in the retailing business practice and creating an impact on the overall SCM (Alvarado & Kotzab 2001).

4.18.1.7 Supplier Selection

Procurement flexibility also means the ability to switch suppliers (Marquez & Blanchar 2004). For various reasons, it might be necessary to switch suppliers and this ability is critical in the manufacturing process. Therefore, the elements of supplier selection are time, ease and cost. How easily the suppliers can be changed over during times of uncertainty and supply disruptions determines the smoothness of the production operations. The cost of switching suppliers can also be costly depending on various factors like contractual arrangements, geographical distance, validating quality of supplies, system implementation and integration. The opportunity costs of switching suppliers is discussed further in Section 4.18.1.8.

Since the qualitative email survey indicated that the majority of the respondents have dual sources of supply and assess supplier risks together with alternate products and components, there is sufficient flexibility in switching suppliers. Therefore supplier selection is important that they understand the requirements of the buyer

(manufacturer). This not only promotes the relationships but also the down streamside of the supply chain (Butterworth 1996).

This email survey supports the postal survey where the respondents were requested to indicate their agreement with changing to different suppliers at a low cost, easily and in a short time. Those who could do so had high levels of ProcFlex. The cost of switching suppliers is discussed further in Section 4.18.1.8.

Supplier selection is not an easy process (Ellram 1991; Marquez & Blanchar, 2004). They suggested that procurement risk management must be conducted in terms of price and demand. They suggest that it must also incorporate flexibility for different strategic options like quantity and pricing based on demand forecasts. Others have suggested that dual sourcing techniques saves costs during times of uncertainty (Ramasesh 1991; Virolainen 1998).

4.18.1.8 Flexibility Costs

The constructs of the last dimension are the high cost of flexibility implementation; cost of responsive actions; and high costs of implementing strategies. This indicates that access to flexibility measures is not cheap. It is costly to formulate, design and implement procurement flexibility strategies.

Literature review has revealed that competitive benefits include cost reductions and increased return of assets and increased reliability and responsiveness to market needs (McLaren *et al.* 2002). Although there are benefits such as reduced inventory levels, service levels, faster product to market cycle and market intelligence, the authors have

identified that costs in these collaborative ventures include partnership opportunity costs.

These opportunity costs are associated with being tied into a specific partner like systems acquisition, usage, maintenance and dealing with errors and inefficiencies. It also includes systems implementation and integration, co-ordinating and integrating processes, translating and integrating data among the systems. The switching of suppliers requires changes and modification to these system costs which increases the partnership opportunity cost as well as other system deficiencies like system inflexibilities, incompatible data transfer and translation. Therefore the present research views that this may also cause partnership instability.

4.18.2 Discussion of Procflex Dimensions

Since the present research's survey instrument was initiated with five dimensions derived from literature review, it is warranted that the measurement tool ProcFlex which is a combination of all the 57 variables (items) be discussed in relation to these five dimensions. SPSS data analysis was applied to this ProcFlex tool in relation to various demographic data, the three elements of Range, Mobility and Uniformity, uncertainty (section B), relationship dimensions (section A) and the five dimensions.

4.18.2.1 Demographic Data

ProcFlex was plotted against all the demographic data of purchase volume, supply to other manufacturers, retail sales, number of staff and years in operation using scatterplot. Firstly the scatterplot of ProcFlex against purchase volume (Appendix 15) showed that all the four categories of less than $10 million, $11-50 million, $51-100 million and more than $100 million did not have sufficient significant differences. All

four categories had a very small number of occurrences in the 'extreme flexibility' level.

For manufacturing tier (HQ4) as to whether the responding manufacturer was manufacturing for other manufacturers, there were equal number of few occurrences for 'extreme flexibility' and 'no flexibility'. In terms of manufacturing for retail sales (HQ5), similarly there were an equal number of few occurrences for 'extreme flexibility' and 'no flexibility'.

At the survey instrument design stages the present researcher decided to use the criterion of seventy employees as the cut-off number as this would justify that the target respondent organisation would be large enough to have sufficient procurement activities. The scatterplot showed that the more the number of employees (more than 150) the more number of cases in 'extreme flexibility' and also that this accounted for 49.6% of the respondents. Therefore number of employees did not influence flexibility level

It was also assumed that the more number of years an organisation has had been in operations, it would have the opportunity to adopt more modern business practices for higher productivity. The scatterplot of ProcFlex against Years in Operations contradicted this assumption. Those cases in the 'extreme flexibility' level were those in operation between 10 and 60 years with the majority in the 10 to 40 year range.

4.18.2.2 ProcFlex Vs Range, Uniformity and Mobility

A scatterplot of ProcFlex against Range, Uniformity and Mobility was applied as discussed in Section 2.5.4. All these three scatterplots indicated that the higher the value of these three elements the higher the flexibility measure. This confirms the first objective that the SMPF dimensions can be articulated by have the highest Range, Uniformity and Mobility in the procurement activities.

4.18.2.3 ProcFlex Vs Relationship Dimensions (Section A)

Scatterplots were plotted with ProcFlex against all the five variables in Section A of the questionnaire (Appendix 18). The respondents were requested to indicate the importance of the five stated dimensions. Since the variables (items) in Section A were not part of the 57 variables used to derive the measure and new model of ProcFlex, it provides a form of confirmatory analysis of the results. The three items of 'supplier logistics' (AQ1), 'components/materials delivery' (AQ2) and 'information exchange' (AQ3) indicate that the higher the importance of these three items the higher the ProcFlex flexibility level. Therefore this indicates that those respondent organisations that perceive these three dimensions as very important have a higher degree of procurement flexibility.

However the remaining two items of 'supplier integration' and 'organisational strategy' have an even distribution of 'extreme flexibility' for all levels of importance. This may also mean that 'organisational strategy' and 'supplier integration' dimensions do not influence the ability and capability of procurement flexibility.

4.18.2.4 ProcFlex Vs Environmental Uncertainty (Section B)

Scatterplots (Appendix 19) were also plotted for all the seven items in Section B of the questionnaire. The respondents were requested to indicate the agreement or

disagreement with the seven statements. The seven statements were pertaining to fluctuating customer demand; substitute products; changing government regulation; environmental concerns; product obsolescence; competitors' actions; and supplier price changes.

The seven scatterplots indicated that none of them influenced the level of ProcFlex. All the responses were evenly distributed between strongly disagree and strongly agree. This is supported by the findings of Hatten & Schendel (1978) and Strandholm *et al.* (2004) who found that different organisations competed differently within the same industry. This was based on their unique perception of the their environment and different organisations faced different environmental constraints and contingencies.

4.18.2.5 ProcFlex Vs Proposed Dimensions

Next ProcFlex was plotted using scatterplot (Appendix 20) against the proposed five dimensions of information exchange, supplier integration, supplier delivery, supplier logistics and organisational strategy as laid out in the survey instrument.

The scatterplot graph provides relationships between two variables. Here the five dimensions are the five variables. All the items in each dimension were combined to form a single variable for that dimension and plotted against ProcFlex. Example, the 17 items in the Information Exchange dimension (Section C) was aggregated into a single variable.

All the seven scatterplots indicated a high correlation between the aggregated variables and ProcFlex. This meant that the higher the agreement of the respondents with each

of the statements in the survey instrument, the higher the level of ProcFlex. The scatterplot also characterised a liner relationship.

4.19 LEADERS AND LAGGERS DERIVATION

The present researcher decided to observe whether there was a pattern associated with the leaders and laggers and their capability of procurement flexibility within the Australian Manufacturing Industry sector. The major question was to determine 'which industry' has the highest level of procurement flexibility was analysed. Therefore, a graphical representation of SIC codes against ProcFlex was plotted as shown in Chart 4.11 below. ProcFlex (see Section 4.7.8.2) was computed using the sum of the means value of all the 57 flexibility items into one means value to be a single procurement flexibility measure.

Chart 4.11 Leaders & Laggers in terms of ProcFlex

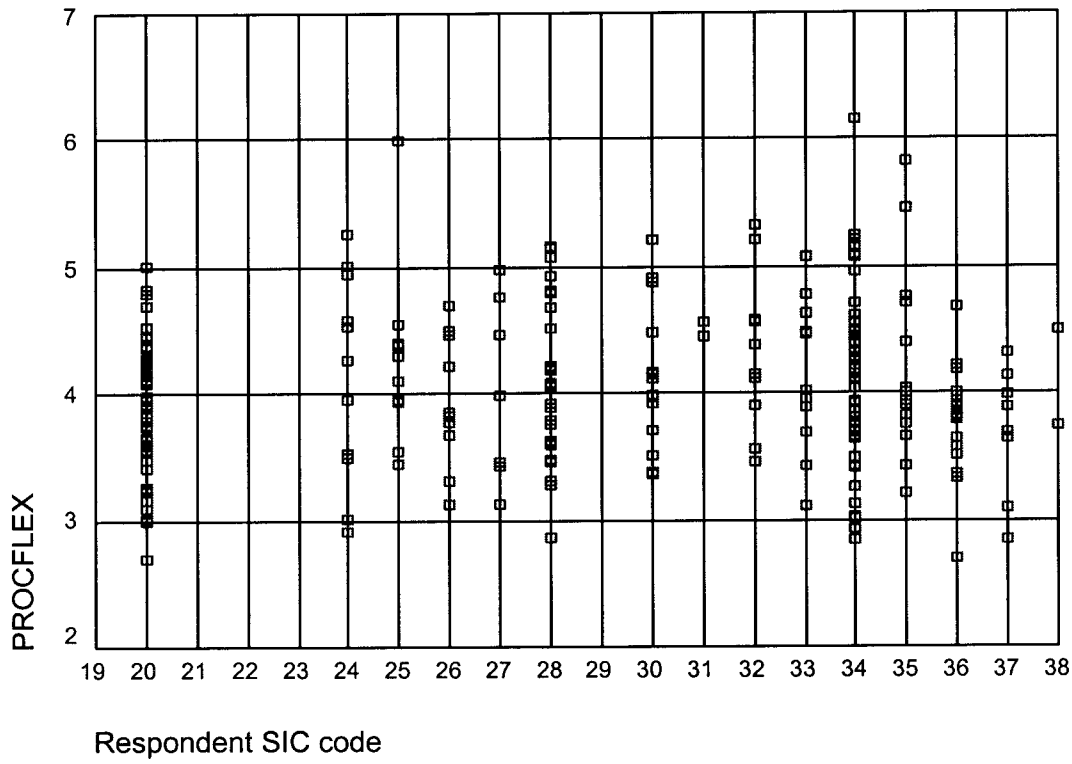


Chart 4.11 was used to derive an assessment scale of procurement flexibility as shown in Table 4.52. This assessment scale could be used to evaluate or measure procurement flexibility of an industry or even a case or respondent.

Table 4.52 Procurement Flexibility Assessment Scale

ProcFlex value	Level of flexibility
>5.00	Extremely flexible
4.00 – 4.99	Moderately flexible
3.00 – 3.99	Low flexibility
<3.00	No flexibility

Chart 4.11 included all the targeted SIC codes, but those with less than 5 cases were removed from the analysis leaving a total of 239 cases. Due to the lack of published literature, the present researcher felt that any ProcFlex value above 5.00 was considered to be extremely flexible and only twenty cases qualified. Most of them were in the fabricated metal products industry group while three were in the chemical and allied industry group and the remainder were distributed among the lumber and wood products industry group; stone, clay, glass and concrete industry group; and industrial and commercial machinery industry group.

There were ninety-five cases with Moderate ProcFlex (values between 4.00 and 4.99), mostly in the fabricated metal products and food & kindred products industries. The number of Low ProcFlex cases were one hundred and sixteen cases with most of the cases each in the fabricated metal products and food & kindred products industries as well. The remaining eight cases had virtually no procurement flexibility.

These cases with extremely high procurement flexibility (>5.00) were considered leaders and those less than 3.00 were laggers. From Chart 4.11 there did not seem to be any distinct leaders or laggers in ProcFlex although SIC code 34 had the highest number of cases above 5.0. The ProcFlex capabilities were spread out evenly among all the industries in the moderate and low flexibility scales.

To provide an accurate reflection of industry leaders and laggers, the present researcher matched the occurrences of levels of 'extreme flexibility' and 'no flexibility' in Chart 4.11 against the frequency distributions of the SIC Codes

(Appendix 15). SIC Code 20 and SIC Code 34 had about 20% of the responses. SIC Code 28 had 10.7% of the responses.

A comparison of ProcFlex leader and laggers against SIC Code data was conducted to observe if there were any trends or criterion that indicated an inclination to be a leader or a lagger. This was to ensure proportionate percentage distribution comparison was made.

The comparison indicates that SIC Code 34 had eight occurrences (Table 4.53) in the 'extreme flexibility' whereas SIC Code 20 only had one occurrence and SIC Code 28 had three occurrences. Therefore it appears that SIC Code 34 appears to be the industry leader and SIC Code 28 to be following the industry leader.

In terms of laggers, it is also interesting to note that there were three occurrences for SIC Code 34 while SIC Codes 20 and 28 only had one occurrence each. Therefore SIC Code 34 also appears to be the industry lagger. It is not logical to conclude that the same industry is the leader as well as the lagger in procurement flexibility.

The present research indicates that manufacturing organisations in the Metal Fabrication industry have both extremely high procurement flexibility as well as no flexibility. The manufacturing industries that had extreme flexibility capabilities were arranged in ascending order of number of cases below in Table 4.53.

Table 4.53 Most Flexible Manufacturing Industries

SIC Code	Name	No of cases
34	Fabricated metal products	8
28	Chemical and allied products	3
24	Lumber and wood products	2
32	Stone, clay, glass and concrete	2
35	Industrial and commercial machinery	2
25	Furniture and fixtures	1
30	Rubber and miscellaneous plastic	1
33	Primary metal industry	1
20	Food and kindred	1

It must however be noted that in the descriptive data analysis, SIC code 34 (Fabricated metal products) also had the highest number of responses. Therefore in term of

percentage comparison it would seem that it is logical that SIC code 34 has the most number of flexibility cases. Similarly SIC codes 25, 30, 33 and 20 had a few number of cases, therefore proportionately they had few cases in the extreme flexibility range.

4.20 TRADE OFFS

The concept of flexibility has been explained in terms of its constituent dimensions and elements. This raises the question of whether it is possible for organisations to achieve maximum flexibility in its operations without sacrificing one or more of its dimensions or elements. Questions have been raised as to whether trade-offs occur between the different dimensions of flexibility (Koste & Malhotra 2000). Trade-offs are defined as the additional activities or resources implemented to achieve a certain level of flexibility.

Various aspects of trade offs have been published; some in manufacturing (Albino & Garavelli 1998; Cvsa & Gilbert 2002; Koste & Malhotra 2000; Mason-Jones & Towill 1998; Prater *et al.* 2001; Spina & Zotteri 2000) and others in survey strategies (Larson & Chow 2003). Koste and Malhotra (2000) concluded that trade-offs in terms of cost, quality, benefits, productivity and other transition penalties, do occur in the automobile industry. They also illustrated that different industries make different sacrifices or trade-offs. De Meyer *et al.* (1989) suggested that many advanced manufacturers concentrated their efforts in overcoming the trade-offs between flexibility and cost efficiency. They also concluded that manufacturers needed to overcome the trade-offs between efficiency and flexibility.

In terms of flexibility it is possible to achieve a higher flexibility but it may require more resources. These resources translate to possibly more human resources and more equipment or more money to achieve that level of flexibility in a quicker time. Therefore the trade-off is costs for more resources allocated to achieve higher flexibility of mobility.

It is however not possible to deduce the trade-offs among the different SIC classifications to see if different industries have different trade-offs. This would require further research.

4.21 E-MAIL SURVEY RESULTS

The present researcher conducted a qualitative survey consisting of two questions. This questionnaire was sent by email to all the respondents who provided their business cards for a feedback of the survey results. This group of respondents was chosen because of their interest in the feedback and the present researcher expected a higher response rate. Thirty emails were sent out and 15 responded (50% response rate). All 15 responses are summarised below in Table 4.53 and Table 4.54. the results need careful consideration because of the small number of respondents indicating each item.

The qualitative survey asked the respondents to answer the following two questions:

3. How does your firm respond to environmental uncertainties affecting your procurement activities?

4. Which is the most critical uncertainty in the procurement activities of your industry?

Although it was disappointing to note that some of the respondents were not able to comprehend or understand that the questions were pertaining to procurement activities, most of them had viable and practical strategies. Some of the answers provided were related to the manufacturing plant as a whole and not focused on their procurement activities, which suggests that there may be little or no procurement strategy.

Table 4.54 Responding to uncertainties,

Response Type	No
Seeking dual sources of supply	5
Check safety stocks and buffer	3
High in-house inventory	2
Manufacture in-house	2
Assess supplier risks	1
Risk assessment of key products and suppliers	1
Review inventory levels	1
Contingency plans with suppliers	1
Reschedule production	1
Alternate products and components	1

The viable and practical strategies in managing environmental uncertainties (Table 4.53) included a pool of alternate suppliers, contingency plans, risk assessment,

frequent reviews of inventory and safety stocks and production rescheduling. Use of multiple sourcing was supported by Min and Galle (1991) as a useful technique to reduce uncertainties.

Some respondents performed risk strategies for their major suppliers and reviewed established plans as, and when, necessary. A few commented that it was not feasible to forecast or to have an ongoing contingency plan as any one of a number of uncertainties could occur, with each one requiring a different strategy to overcome the particular problem. However, one response was that it was the supplier's responsibility to find alternate means of supply.

Table 4.55 Response to the most critical uncertainty question.

Critical Uncertainty	No
Lead time	2
Supplier stock levels	2
Shipping	1
Transport strike	1
Currency fluctuations	1
Plant fire	1
Supplier performance	1

The most critical uncertainties (Table 4.54) were supplier stock levels and supplier lead time; other uncertainties included logistics constrictions like transport strikes, shipping problems, supplier stock levels and currency exchange rate fluctuations. Some of the respondents did not attempt to answer the second question.

Some of the respondents also commented about cost trade-offs in terms of reducing risks. Most of the strategies implemented incurred additional costs, especially after-the-event disaster recovery. Trade-offs varied according to the manufacturing industry and the personal preferences of manufacturers.

4.22 PROCUREMENT FLEXIBILITY AND SUPPLY CHAIN MANAGEMENT

The importance of SCM was discussed in Section 2.1. In that Section, procurement flexibility was related to the overall SCM concept. It was also established in Section 2.1 that procurement activities are duplicated all along the SC and between every

entity in the SCN. Therefore supplier-manufacturer procurement flexibility (SMPF) is a critical part of SCM. The relationships between SMPF dimensions and SCM dimensions are important for the success of the overall SCM strategy.

The flexibility of the procurement activities complements the flexibility of the SC. It is similar to the bull-whip effect (Lee *et al.* 1997), except it is in the reverse direction. The present author describes this using Australian terminology as the 'stock whip effect' which means that all the constrictions and/or bottlenecks occurring in the procurement activities in the up-stream side is transferred along the SC in the downstream direction. If a second tier supplier due to environmental uncertainties cannot meet the demand, or delays the supply of some vital material or component to a first tier supply, that delay is transferred to the first tier supplier unless the first tier supplier has an alternative means of supply. That first tier suppliers' delay is now transferred to the manufacturer who has to reschedule capacity or production run. This further delays the expected, targeted output of the factory to the customer. This is further delayed until the end consumer. Therefore SMPF is critical in making the SC more effective and efficient.

4.23 CONCLUSION

The results from the current research instrument were analysed using sundry statistical techniques. As demonstrated in this chapter, the outcomes from the Australian study of manufacturers provided many important insights to the issue, clarified the national view and suggested variations to the ideas established by overseas research.

Consequently, the hypothesised model established in Chapter 2 from extant research was revised quite substantially, resulting in a new, recommended model for examining the nature of flexibility in Australian manufacturing. The final chapter, Chapter 5, provides a discussion and conclusions from the current research and suggests avenues which require future investigation.

CHAPTER 5

DISCUSSION AND CONCLUSIONS

5.1 INTRODUCTION

Chapter 5 provides a brief, summary overview of the present research and discusses its implications for both academics and practitioners. It also presents the key findings of the present research, acknowledges evident limitations and discusses areas for future research.

5.2 RESEARCH OVERVIEW

The current business environment is undergoing extreme competition from both local and global competitors. At the time of this thesis completion the exchange rate of the Australian dollar to the United States currency was 79 cents, which is an increase of more than 30% in the previous 12 months. Thus, many firms have been forced into embracing the collaborative strategies of combining manufacturing strategies with supplier-relations management, customer relations management and other activities within a supply chain, while others have been rethinking their strategies to relocate their manufacturing plant overseas.

The present research investigated the procurement relationship aspects between manufacturers and their suppliers in order to increase the understanding of on-going procurement activities within the supply chain network.

Although there are many articles published by both practitioners and academics on these collaboration efforts, there is still a lack of empirical research in flexibility dimensions of procurement activities and how they fit into the overall supply chain strategy.

The present researcher took a step in this direction explicitly and proposed to develop an understanding of a conceptual framework of supplier-manufacturer procurement flexibility (SMPF) dimensions and to identify generalisable dimensions of flexibility within the procurement relationship.

To achieve these objectives, a literature review was undertaken and revealed that there was a lack of published articles in procurement flexibility and its understanding. The present researcher has tried to fill that gap. Based on research findings, model constructs were identified, validated and operationalised. From PCA, it was found that there were more than 5 flexibility dimensions as posited in the original model.

Churchill's (1979) paradigm was used for the development of flexibility measures for the proposed five dimensions of procurement flexibility. The initial scales underwent purification and data was collected by mail survey. The validity and reliability of these measures were established using analytical techniques.

A qualitative survey was also conducted to find out the strategies taken to combat environmental uncertainties and which uncertainties were critical in the various manufacturing sectors. The next section presents a discussion of the key findings.

5.3 DISCUSSION OF KEY FINDINGS

In this section are discussed the key findings in terms of implications for manufacturing organisations and supply chain management in the Australian manufacturing industry.

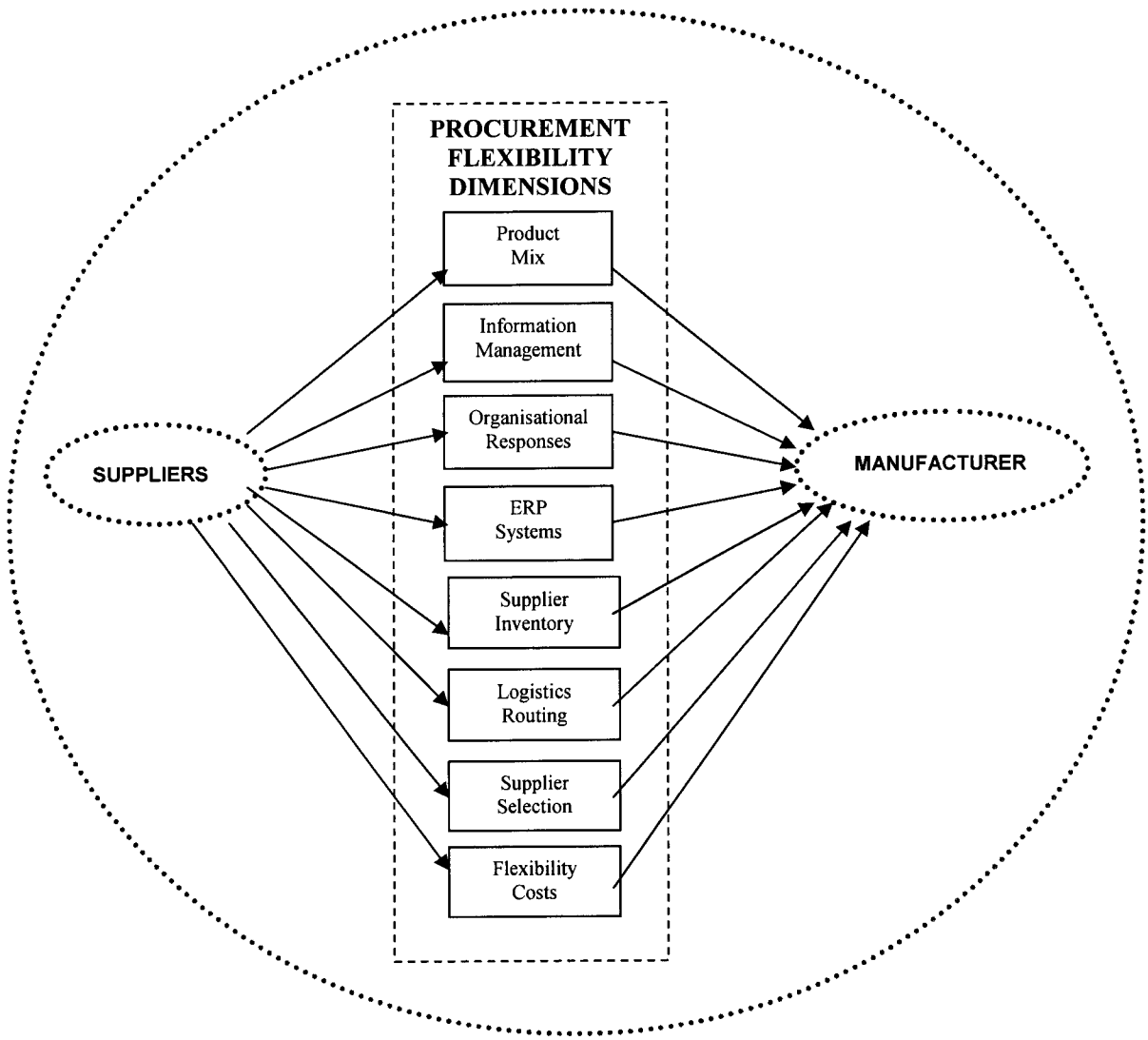
5.3.1 Understanding of Conceptual SMPF framework

In reference to the first objective of how are the definitions of SMPF are best articulated, the present researcher has developed a basis for the understanding of a conceptual SMPF model. This is explained in section 4.1, Table 4.51 and Figure 5.1. Although there is much work to be done in further development of this, the present researcher has developed a basis for the understanding of a conceptual SMPF model. Although there is much work to be done in further development of this model it provides a much needed theoretical understanding for

further development. The present researcher has also modified, based on the survey data, the initial proposed model into a new conceptual model as shown in Figure 5.1. The present researcher also realises that further research and data collection would keep improving and developing this conceptual model of ProcFlex.

The present researcher identified 8 dimensions in the conceptual model as per data collected. But from PCA there may possibly be at least 15 dimensions as the full factor extraction above eigenvalue of 1 suggests. This would need a more comprehensive list of survey items comprising all facets of procurement activity. It may well increase the size of the survey instrument while possibly sacrificing the response rates. These factors are discussed in more detail in Section 5.5.

Figure 5.1 Proposed Procurement Flexibility Conceptual Model



Above in Figure 5.1 is the new modified model derived from the results of this research. It is noteworthy that each dimension has different attributes in the new model (see Table 4.51). This is considerably more detailed than the original hypothesised model which had only three elements (see Figure 2.2).

5.3.2 Most critical dimensions.

With regards to the second objective of the criticalness of SMPF dimensions, the respondents were requested to respond directly, to five questions representing each of the original five dimensions in the questionnaire. They were asked to respond as to the importance of the supplier relationship dimensions in Section A of the survey instrument. The responses indicated in the original hypothesised model that AQ2 – 'materials and component delivery' was perceived as the most important and AQ4 – 'supplier integration' was indicated as the least important (Appendix 11).

5.3.3 Most critical uncertainties

The third objective of the criticalness of environmental uncertainties, as established in the Q-sort methodology, respondents were requested, in Section B of the survey instrument, to respond to seven items of uncertainty. Customer demand was indicated as the item most affecting manufacturing (Appendix 12). Second was product obsolescence, third competitors' action and fourth substitute imported products. Fifth was changing government regulations, sixth environmental concerns; and lastly, was the issue of suppliers changing their prices. These quantitative results contradict the subsequent qualitative survey findings in the email survey.

From the email survey (Section 4.21) the present researcher found that, in terms of capability and ability to satisfy manufacturers' demand and requirements, the suppliers' performance was the most critical. The performance was related to suppliers' inventory and stock levels, suppliers' risk management strategies, suppliers' lead-time and logistics in general.

Therefore, it can be concluded that fluctuating customer demand is the most critical uncertainty followed by supplier performance and product obsolescence. The least critical uncertainty was supplier price changes. This may possibly be due to contractual arrangements as procurement contracts were not part of this study.

The critical nature of supplier performance depends on their tier level. If it is a second or third tier supplier then the degree of seriousness is compounded. As the tier level increases, the source of the raw material or component decreases as the supply side narrows. This may best be viewed as the stock-whip effect as discussed in Section 4.22.

The qualitative email survey also revealed that the postal survey instrument items did not investigate uncertainty factor that were critical to the respondents in terms of the suppliers' capability and ability of satisfying the manufacturers' procurement flexibility. These suppliers' capabilities and abilities were not identified in the literature review neither in the Q-sort process. Therefore, the present researcher accepts these as part of the limitations of the research and suggests its inclusion in future studies.

5.3.4 Implications for manufacturing organisations

The fourth objective pertaining to the interaction between environmental uncertainty and SMPF dimensions for Australian manufacturing organisations are discussed in Section 4.19 and Section 4.21. The major current threat of uncertainty in the Australian Manufacturing sector is the current high foreign exchange rate, which has been ongoing for the past six months.

The other main threat that seems certain, reported by the Manufacturing Society of Australia (MANSA 2003), is the manufacturing shock on finding that China is aiming for 50% of the world's market. MANSA claims that 80% of the Australian manufacturing could be under threat. It also states that even mega retailers like WalMart and Carrefour with enormous buying power are pressuring manufacturers globally to reduce manufacturing costs.

An Australian newspaper (The Australian 15th Jan 2004) reported that the Federal Treasurer, Peter Costello and the Australian Industry Group Chairman both expressed fears that the current economic climate was forcing one out of every four manufacturers to rethink their strategy regarding the option to move their manufacturing plant overseas.

However, exercising the trade-offs by shifting the manufacturing base overseas will increase unemployment in Australia. The present researcher argues that, in the long term, optimising and streamlining the Australian manufacturing supply chain network would establish cost effectiveness, increase worker skills and experience, improve research and design as well as retain profits within Australia.

In order to optimise and streamline the Australian manufacturing SCN, it is necessary that all activities within this SCN is made cost effective and efficient. Procurement is an important part of this improvement process in the SCN.

De Meyer *et al.* (1989) analysed the results of the 1986 Manufacturing Futures survey by comparing the European, North American and Japanese manufacturing management techniques and priorities which demonstrated that the Japanese were far ahead of the rest of the world in responding to competitive threats due to quality issues. The Japanese had overcome manufacturing quality issues and were focusing on other competitive issues like flexibility, whereas the European and North American manufacturers were still focusing on quality issues. The present researcher found similar trends in the Australian manufacturing sector that Australian manufacturers have not yet generally embraced the concept of flexibility competitiveness like procurement strategies.

As the results of the research analysis indicate, there is still much work to be done and many opportunities for increasing the effectiveness and efficiencies of the manufacturing SCN.

5.3.5 Response to procurement flexibility and uncertainty

The fifth objective was conducted using a separate qualitative survey by the means of email to those original respondents who supplied a business card with their postal responses and indicated that they want a summary copy of the postal survey results.

Analysis of the email responses revealed that most respondents have viable and practical strategies to counter environmental uncertainties. Most of the responses however reflected strategies affecting the manufacturing organisation as whole rather than procurement activities. This suggests that there may be no procurement strategies in place to respond to environmental uncertainties.

One third of the email respondents indicated that they had in place supplier risk management strategies like dual sources of supply. Other strategies were safety stocks, high in house inventory, ability to manufacture in-house and continuous monitoring of inventory levels.

Although some of these strategies do not embrace modern business management concepts and principles like JIT and Quick Response, it must be noted that respondents are aware of environmental uncertainties in their up stream supply side. The present researcher highlights that future research could take into account these risk management strategies into SCM streamlining and optimisation strategies and also how these upstream strategies relate to downstream activities like managing customer demand.

The responses to environmental uncertainties were discussed in detail in Section 4.21. Unfortunately there is no readily available data from other countries with which the present researcher can make comparisons. However, there are some authors who state that a key determinant of co-operative exchange is the uncertainty perceived by the co-operating parties (Eriksson & Sharma 2003). They suggest that decision-making uncertainty can be improved by both parties opting for one of two strategies. Firstly, either party can alter their perception on uncertainty in their own environment or secondly, alter the perception of their counterpart's firm's environment. Therefore in the present research, it is suggested that the manufacturing firm invest resources in

improving information exchange with their suppliers to alter the uncertainties in their joint environment. This view is also supported by Blankenburg *et al.* (1999). Further to this and the availability of modern communications and network technologies, field interviews (Bantham *et al.* 2003) reveal that face to face communication is still critical to partnership success. The present research believes that procurement uncertainty can be reduced and procurement flexibility can be increased by face to face communications.

Other authors like Horowitz (1986) suggest multiple sources of supply during times of stochastic demand. During times of stochastic lead times multiple vendors can reduce inventory investment (Hayya *et al.* 1987).

The quantitative analysis revealed that Australian manufacturers, for various reasons, do not have sufficient flexibility in their procurement activities due to various reasons. Unfortunately there is no readily available data from other countries with which the present researcher can make comparisons.

5.3.6 Implications for supply chain management

Recent studies (Carr & Smeltzer 1999; Anderson & Rask 2003) indicated that many firms are restructuring their procurement department's role in line with SCM principles. Others (Cox 1996) promulgate the idea of a proactive approach to supply management, but the data from this study indicates that many Australian manufacturers do not seem to have a strategic procurement plan.

If manufacturing firms are to include procurement strategy as part of their SCM strategy, new responsibilities and procurement practices need to evolve (Anderson & Rask 2003). As the present research revealed, there are trade-offs of cross-dimensional involvement and cross co-ordination of procurement activities; procurement staff need to be multi-skilled and have cross department knowledge.

As the present researcher's telephone follow-up analysis revealed that many manufacturers have relocated their manufacturing overseas, the implications for SCM

are now more critical. The procurement strategy for a relocated manufacturing base has become more globally orientated and the SC becomes more geographically dispersed. This creates a greater or increasing need for control and co-ordination of the SC.

5.3.7 Implications for future research

As the present research set out to establish a generalisable framework for procurement flexibility measures, it is suggested that future research delve deeper into each of the identified dimensions and elements of procurement. It is also suggested that other organisational strategies and collaborative activities be linked to procurement activities. For example, critical strategic decisions may be necessary to include supplier relations management at all levels of the organisation.

Some literature described the variety of critical decisions related to the procurement of parts and materials. A case-based reasoning approach was proposed by Luu *et al.* (2003), who suggested that different procured materials have different levels of uncertainty and the need to be treated as such. Research on this concept could be built on to the findings of flexibility established by the current thesis.

Similarly, the service sectors, including financial services, consist of complex supply chains. A survey instrument based on the current research questionnaire may be implemented in the examination of service delivery supply chains and service procurement activities.

The present research conducted a mail survey which relied on the respondents identifying their most prominent suppliers. As every manufacturing firm has a multitude of suppliers of various categories, use of case studies or a multiple survey instrumentation may provide a deeper understanding of procurement flexibility together, leading to the development of a taxonomy of different categories of suppliers.

In the current qualitative survey, costs related to managing environmental uncertainties were highlighted. In the postal questionnaire, items concerning costs appeared to be

problematic once the data was examined using certain statistical techniques. Therefore, the present researcher recommends that procurement costs in the transaction activities of manufacturers needs further research. This also was confirmed in trade-off situations where lower flexibility was accepted rather than the achieving of greater flexibility but at higher costs.

One of the recent published articles (Marquez & Blanchar 2004) highlighted some limitations of flexibility within contractual portfolios. Some contracts are structured on volume discounts and higher part prices dependent on demand volume; a view supported by Quayle (1998). Different contracts have different relationship attributes; therefore, different flexibility attributes. Further focused studies appear warranted, specifically on different types of contracts and how they impact on procurement flexibility dimensions.

It is also suggested that SEM be used in future research as it is a more robust analytical method compared to regression analysis and PCA is causal relations between the various dimensions of ProcFlex are to be investigated.

Further, to the identified possibilities for additional research, it would be worth replicating the current research in the future to evaluate longitudinal data to observe whether any improvements/changes to procurement flexibility occur over time in the Australian Manufacturing sector.

5.3.8 Survey Methodology

An overview of the data analysis results indicated firstly, that the Q-Sort methodology needs to be re-structured to reflect more of the procurement activities at different levels of an organisation. As the results indicate there is not much practice of procurement strategic planning items, so it is possible that many respondents are not aware of such strategies.

Secondly, it is considered that there is value in having two survey instruments in accordance with the Q-Sort result, one instrument for hands-on operational procurement staff and the other for senior management regarding strategies.

This would also provide a dyadic response from the same organisation, so an evaluation of top-down flow of procurement and SCM strategic implementation can be undertaken. Identified differences between responses from the same manufacturer would provide another perspective on the flexibility issue.

On reflection, the final survey instrument also does not have sufficient multi-item measurement scales for some of the constructs (Figure 2.3), as recommended by Churchill (1979). Future instruments must ensure that sufficient items are included for each construct.

The email survey could have included more qualitative questions to investigate current issues and trends like: possibility of shifting operations overseas; strategic objectives to counteract the higher exchange rate of the Australian currency; and other strategic objectives in procurement and purchasing activities.

5.4 CONTRIBUTIONS

The main contribution of the current research is the development of a conceptual framework and derivation of the procurement flexibility dimensions. These establish the groundwork for future research. Trade-offs or sacrifices were identified also as important factors that influenced not only flexibility but other resources such as costs and time.

The Leaders and Laggers chart indicated that Australian manufacturers have some way to go to achieve a higher level of flexibility which positively affects their businesses. The thesis also identified critical uncertainties within the Australian manufacturing sector which influenced manufacturing and procurement trends.

Results from the research also may be used by the Australian manufacturing sector representative bodies and government agencies in deriving procurement strategies in conjunction with SCM agenda for a more globally competitive industry.

5.5 LIMITATIONS

As with all research, the present study inevitably had some limitations; however it did make several valuable contributions despite limitations in the survey design. Firstly, more items could be included in the survey instrument to encompass more details of the various constructs, although at the confirmatory research stage this may only have been achieved with a consequent drop in the survey return rate. The trade-off in increasing the number of items is that the greater length of the survey instrument may adversely affect the response rate; nevertheless, with an improved model of flexibility in manufacturing available to future researchers, the length of the survey instrument may be reduced.

Secondly, the research only assessed the manufacturers' perspective and knowledge of procurement activities, which is regarded by some practitioners as only one-half of the procurement activity. A dyadic approach would reveal more information and provide more knowledge of the interactive nature of procurement flexibility. Also flexibility attributes and capabilities are complemented, identified by and related to both parties to the procurement activity.

Thirdly, the limited nature of published literature, especially Australian, severely handicapped this study in the formulation of sufficient flexibility dimensions and Q-Sort items. Future researchers may well choose to examine other identified dimensions and constructs.

Some of the SIC codes had small samples which limited detailed analysis and generalisability of some results. Future research of a detailed case study methodology would enable the collection of further quantitative data on flexibility, and provide also some rich qualitative data on the flexibility experience of manufacturers. The qualitative research could be conducted together with quantitative research even in a postal survey so as to have a higher response rate in the qualitative research.

5.6 CONCLUSION

Supplier relations and procurement management within the context of supply chain management is becoming strategically important and critical as global procurement and global customer bases are expanding.

It is clear from the preceding chapters that considerable work remains to be done before the concept of procurement flexibility can be understood more clearly and in its entirety. The present researcher trusts that this study takes a step in that direction, thereby helping the theoretical development of this area. Similarly, that the contributions from this study provide the building blocks for future research efforts.

The present researcher has taken the initial steps in successfully identifying several additional dimensions of procurement flexibility. This expands the available knowledge and literature in procurement flexibility. The results from the previous chapter also indicate that the majority of the Australian manufacturing companies do not have a strong procurement flexibility strategy, neither do they have a complementary organisational strategy pertaining to procurement activities. This may be due to the complex nature of procurement activities or that the respondents are not aware of, or have an apathy about, the value of flexibility procurement and organisational strategy.

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APPENDICES

APPENDIX 1 - Q-SORT QUESTIONNAIRE

DEFINING MANUFACTURING PROCUREMENT DIMENSIONS

DIRECTIONS

These dimensions of manufacturing procurement are between suppliers and manufacturers. The goal of this exercise is to match the listed items with their associated dimension type in a manufacturing procurement environment.

The following pages contain randomly listed items formulated to describe 5 types of procurement dimensions. Each item is associated with a single type of procurement dimension.

Carefully read the descriptions of each dimension. Then, for each item record the associated dimension number which you feel is most closely associated with that particular item. If any item does not match the stated dimension, please mark as '0'.

To further improve the survey, you may contribute comments on the last page.
Please return the completed this exercise electronically. If you have any questions please call me on 0411 849 906

Thank you for your participation.

TYPES OF PROCUREMENT DIMENSIONS

These dimensions relate to '*procurement by manufacturer from supplier*'

1	Partnership Integration	Represents the extent of operational integration of suppliers with manufacturers. It is the collaborative and co-ordination activities to enhance the integration. It also includes sharing risks & rewards and synergy by supplier and manufacturer towards the mutual common end consumer. It also involves involvement in each other's processes.
2	Components & materials	Represents supply of materials/components/sub-components, product modification & product specifications. It also includes mixed product range.
3	Logistics	Represents supplier delivery, scheduling, inventory, warehousing and transportation to manufacturer. It includes adjustment and modification of delivery of supplies.
4	Information systems	Represents the exchange of information between supplier and manufacturer and compatibility of Information Systems.
5	Organisational	Represents the manufacturing organisation's structure, systems, processes, people and technology. It also includes organisational resources used in the procurement activities.
0	None of the above	

Examples of responses:
_3_ Suppliers can deliver additional materials quickly
_4_ Information sent to our suppliers is timely

Project Director:
Ananda Jeeva

___ Suppliers carry sufficient inventory to cater to our demands

___ Suppliers' lead-times are very short

___ Suppliers are responsive to our manufacturing requirements

___ Suppliers' deliveries are synchronised with our manufacturing schedules

___ Suppliers can adjust to changes in our demand schedules

___ Suppliers are involved in our new product design

___ Suppliers maintain high quality standards of delivery at all levels of demand

___ Suppliers are capable of flexible delivery schedules at short notice

___ For suppliers to modify their processes, our cost is low

___ It is easy for us to change over to different suppliers

___ Our procurement plans focus on achievement of best practices.

___ Our site's manufacturing operations are effectively aligned with our business mission.

___ The rate at which products and services are getting obsolete in the industry is very slow.

___ Actions of competitors are very easy to predict.

___ Liaison personnel co-ordinate the efforts of different departments

___ The input of manufacturing managers is an integral part of the strategy formation process.

___ Manufacturing managers are involved in decisions related to strategies for company growth.

___ Percentage of incoming materials conforming to our specifications.

___ Percentage of product returns to suppliers.

___ Percentage of on time delivery from suppliers.

___ Supplier total lead-time.

___ Supplier component development cycle time.

___ Number of changes in delivery schedules by suppliers per week.

___ Supplier stock levels.

___ Elimination of inspection of supplies.

___ Suppliers can produce new components

___ Suppliers can modify their product mix

___ Suppliers can modify component design changes

___ Suppliers can implement component design changes

___ Integration of information systems reduces the administration for managing suppliers.

___ Supplier delivery performance.

___ Stability of supplier production and delivery schedules.

___ Joint efforts for continuous improvement of components.

___ Supplier involvement in new product/component development.

___ Joint efforts for continuous improvement of manufacturing and logistics processes.

___ Our suppliers work closely with us in product development.

___ We work closely with our suppliers to improve each other's processes.

___ Our suppliers have an effective system for measuring the quality of their materials

___ Supplier's ability to make design changes in the product after production has started.

___ Length of cycle time from order to delivery (standard products).

___ Length of cycle time from order to delivery (special request products).

___ Cost required to introduce new products/components by suppliers.

___ Time required by supplier to increase or decrease production volume by 20%.

___ Time required by supplier to add a unit of production capacity.

___ The capacity of supplier system can be increased when needed with ease.

___ Time required by supplier to switch from one part mix to another.

___ Cost required by supplier to switch from one part mix to another.

___ Number of new parts introduced by supplier per year.

___ Our company has a quality assurance (certified) program for our supplier's specific product.

___ Our company takes advantage of supplier provided technical support and test capability.

___ Suppliers can deliver materials and components along different routes

___ Suppliers have access to our inventory systems

___ We use our suppliers' warehousing facilities

___ Our manufacturing personnel regularly visit our supplier's facility.

___ Suppliers receive changes to our specifications after we develop a new product design.

___ We share a great deal of sensitive information with our suppliers.

___ We undertake annual negotiations to establish the price for key input items from our suppliers.

___ Interaction with suppliers to set reliability, responsiveness and other standards.

___ On time delivery of purchased parts.

___ Percentage of incoming shipments acceptable.

___ Percentage of suppliers certified.

___ The concept of the supply chain management is well understood by all staff.

___ Has effective top down/bottom up communication processes.

___ Employee satisfaction is formally and regularly measured.

___ OH&S practices are excellent.

___ Employee flexibility, multiskilling and training are actively used to improve performance

___ All employees believe that quality is their responsibility.

___ The material-handling path is very different from each other.

___ The material-handling path uses a large portion of general-purpose pallets.

___ Material-handling routes can be added easily.

___ All material handling routes exhibit similar performance levels in delivery time.

___ The choice of material handling routes does not affect the material transport costs (in dollars).

___ The delivery time is not compromised by the different materials handling routes.

___ Use of IT technology with our suppliers

___ A reduction in the inventory of raw materials or components

___ We consider our suppliers to be our partners.

___ Our organisational strategies include suppliers

___ Our organisational structure is designed to improve operational supplier relationships

___ Our organisational strategies respond to environmental conditions

___ Our internal processes are co-ordinated with our suppliers

___ Our suppliers are aware of our manufacturing processes

___ Our suppliers are an integral part of our manufacturing strategy

___ Routine transfer of information on pricing is done without human intervention

___ We actively implement efficient consumer response incentives with our suppliers

___ Our supplies share critical information with us

___ We provide up to date information to our suppliers

___ Our IS are compatible with our suppliers' Information Systems

___ Our IS systems are well integrated with our suppliers' Information Systems

___ Data transfer with our suppliers does not require any translation

___ Suppliers' after sales service

___ Modifying component configuration

___ Supplier involvement in manufacturing R&D

___ Manufacturers' involvement in suppliers' R&D

___ Manufacturer influencing suppliers' safety stock levels

COMMENTS

If you have any comments regarding any part of this survey, please use the space provided below:

_____
_____
_____
_____
_____
_____

94 items

APPENDIX 2 - SURVEY INSTRUMENT

Curtin
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School of Management
CURTIN BUSINESS SCHOOL

SUPPLIER-MANUFACTURER PROCUREMENT RELATIONSHIP SURVEY

A study conducted by the School of Management, Curtin Business School, Perth, Western Australia.

Project Director and Ph.D Candidate: Ananda Jeeva

Purpose of this research:

This research explores the procurement flexibility of Australian manufacturing firms in their relationship with their suppliers.

Instructions:

1. This questionnaire relates to your most prominent suppliers.
2. Please answer ***all*** questions as accurately as possible.
3. If you are not sure of an answer to a question, please provide your ***best estimate***.
4. The questions should be answered with respect to your suppliers and your organization/firm/plant.
5. Please complete and return this questionnaire in the pre-addressed, postage paid envelope. I shall be happy to send you a summary of the results; simply include a business card with the completed survey.
6. Pre-tests indicate that the estimated time for filling in this questionnaire in 10 minutes.
7. Your response is critical in making this survey a success.

Your responses will remain ***strictly confidential***.

Thank you for your participation.

We hope that what we learn from this research will enable a better understanding of the flexibility capability of procurement relationships between suppliers and manufacturers.

Should you have any query about this survey,
please contact Ananda Jeeva on 0411 849 906 or Fax 08 - 9266 7694
or email jeevaa@cbs.curtin.edu.au

For Office use.
.....

A. Supplier Relationship Dimensions.

How would you rate the importance of the following relationship dimensions with your suppliers?

	Not important 1	2	3	4	5	6	Very important 7
1. Supplier Logistics– distribution, warehousing and inventory.	1	2	3	4	5	6	7
2. Materials/components & Delivery – range, timing and volume.	1	2	3	4	5	6	7
3. Information Exchange – both ways.	1	2	3	4	5	6	7
4. Supplier Integration – involvement in each other's processes.	1	2	3	4	5	6	7
5. Organisational Strategy - to collaborate with suppliers' organisations.	1	2	3	4	5	6	7

B. Environmental Uncertainty.

The questions below relate to environmental uncertainties that may affect your manufacturing plant. Please circle the most appropriate number for each statement.

	Strongly Disagree 1	2	3	4	5	6	7 Strongly Agree
1. Fluctuating customer demand is affecting our manufacturing strategy.	1	2	3	4	5	6	7
2. Substitute imported products are affecting our product sales.	1	2	3	4	5	6	7
3. Changing government regulations and tariffs are affecting our plant.	1	2	3	4	5	6	7
4. Environmental concerns like recycling is affecting our manufacturing strategy.	1	2	3	4	5	6	7
5. Our product obsolescence rate is very low.	1	2	3	4	5	6	7
6. It is difficult to predict competitors' actions.	1	2	3	4	5	6	7
7. Our suppliers frequently change their prices.	1	2	3	4	5	6	7

C. Information Exchange

The following questions relate to your Information Technology activities with your suppliers. Please circle the appropriate number for each statement.

	Strongly Disagree 1	2	3	4	5	6	7 Stro Agı
1. We receive sufficient range of information from our suppliers.	1	2	3	4	5	6	7
2. We provide sufficient range of information to our suppliers.	1	2	3	4	5	6	7
3. Our suppliers are willing to share critical information with us.	1	2	3	4	5	6	7
4. Data transfer with our prominent suppliers does not require translation.	1	2	3	4	5	6	7
5. Our Information System (IS) is well integrated with our prominent supplier's IS.	1	2	3	4	5	6	7
6. Our IS data structure is the same as our prominent suppliers.	1	2	3	4	5	6	7
7. There is high connectivity of the Information Systems with our suppliers.	1	2	3	4	5	6	7
8. Routine transfer of information on invoicing is done without human intervention	1	2	3	4	5	6	7
9. Routine transfer of information on ordering is done without human intervention.	1	2	3	4	5	6	7
10. It is easy for our suppliers to send information to us.	1	2	3	4	5	6	7
11. Information received from our suppliers is accurate.	1	2	3	4	5	6	7
12. Information received from our suppliers is reliable.	1	2	3	4	5	6	7
13. Information received from our suppliers is in real time.	1	2	3	4	5	6	7
14. Information sent to our suppliers is timely.	1	2	3	4	5	6	7
15. Information sent to our suppliers is accurate.	1	2	3	4	5	6	7
16. Information sent to our suppliers is in real time.	1	2	3	4	5	6	7
17. It is easy for us to send information to our suppliers.	1	2	3	4	5	6	7

D Supplier Integration.

The questions below relate to your prominent suppliers' ability to integrate into your manufacturing processes. Please circle the most appropriate number for each statement.

	Strongly Disagree 1	2	3	4	5	6	7 Strongly Agree
1. Our suppliers carry sufficient inventory to cater to our demands.	1	2	3	4	5	6	7
2. Our suppliers can easily adjust to changes in our demand schedules.	1	2	3	4	5	6	7
3. Our suppliers maintain high quality standards at all levels of demand.	1	2	3	4	5	6	7
4. Our suppliers are capable of flexible delivery schedules at short notice.	1	2	3	4	5	6	7
5. We can change over to different suppliers easily.	1	2	3	4	5	6	7
6. We can change over to different suppliers in a short time.	1	2	3	4	5	6	7
7. We can change over to different suppliers at a low cost.	1	2	3	4	5	6	7

E. Supplier Product & Delivery Flexibility.

The questions below relate to your supplier's products/component/materials.
Please circle the most appropriate number for each statement.

	Strongly Disagree 1	2	3	4	5	6	7 Stron Agree
1. Our suppliers can deliver new components/materials easily.	1	2	3	4	5	6	7
2. Our suppliers can deliver new components/materials in a short time.	1	2	3	4	5	6	7
3. Our suppliers can deliver new components/materials at a low price.	1	2	3	4	5	6	7
4. Our suppliers can deliver new components/materials with the same quality.	1	2	3	4	5	6	7
5. Our suppliers can modify their product mix easily.	1	2	3	4	5	6	7
6. Our suppliers can modify their product mix in a short time.	1	2	3	4	5	6	7
7. Our suppliers can modify the product mix at a low cost.	1	2	3	4	5	6	7
8. Our suppliers can modify the product mix with the same quality.	1	2	3	4	5	6	7
9. Our suppliers can implement product design changes easily.	1	2	3	4	5	6	7
10. Our suppliers can implement product design changes in a short time.	1	2	3	4	5	6	7
11. Our suppliers can implement the product design changes at a low cost.	1	2	3	4	5	6	7
12. Our suppliers can implement product design changes with the same quality.	1	2	3	4	5	6	7
13. Time required for our suppliers to switch from one part mix to another is short.	1	2	3	4	5	6	7
14. Our suppliers have the capacity to deliver a wide range of components parts.	1	2	3	4	5	6	7

F. Supplier Logistics

The questions below relate to your suppliers' logistics.
Please circle the most appropriate number for each statement.

	Strongly Disagree 1	2	3	4	5	6	7 Stron Agree
1. Our suppliers can deliver materials and components along various routes.	1	2	3	4	5	6	7
2. Our suppliers can modify these routes easily.	1	2	3	4	5	6	7
3. Our suppliers can modify these routes in a short time.	1	2	3	4	5	6	7
4. It is too costly for the suppliers to modify these routes.	1	2	3	4	5	6	7
5. All material handling routes exhibit similar performance levels.	1	2	3	4	5	6	7
6. The choice of material handling routes does not affect the transport costs.	1	2	3	4	5	6	7
7.Transport facilities to handle materials of different shapes and sizes are flexible	1	2	3	4	5	6	7

G. Organisational Strategy

The questions below relate to your organisational co-ordination with your suppliers.
Please circle the most appropriate number for each statement.

	Strongly Disagree 1	2	3	4	5	6	7 Strongly Agree
1. We have a range of organisational strategies for supplier integration.	1	2	3	4	5	6	7
2. These strategies are easy to implement.	1	2	3	4	5	6	7
3. These strategies are very costly to implement.	1	2	3	4	5	6	7
4. These strategies can be implemented in a short time.	1	2	3	4	5	6	7
5. Our organisational structure has the flexibility to improve operational relationships with our suppliers.	1	2	3	4	5	6	7
6. This flexibility is very costly to implement.	1	2	3	4	5	6	7
7. This flexibility is easy to implement.	1	2	3	4	5	6	7
8. This flexibility is quick to implement.	1	2	3	4	5	6	7
9. Our strategies are designed to respond to environmental uncertainties.	1	2	3	4	5	6	7
10. This responsive action is easy to implement.	1	2	3	4	5	6	7
11. This responsive action can be implemented in a short time.	1	2	3	4	5	6	7
12. This responsive action is too costly to implement.	1	2	3	4	5	6	7

H. General Information

1. Respondent Position Title: .....

2. What is the approximate purchase volume, in dollars, of your company in the past financial year?
   1☐ less than 10 million 2☐ 10 – 50 million 3☐ 51 – 100 million 4☐ more than 100 millior

3. Please circle which Standard Industry Classification (SIC) code represents your business?

   20 – Food and Kindred
   24 – Lumber and Wood Product
   25 – Furniture and Fixtures
   26 – Paper and Allied Products
   27 – Printing, Publishing Industries
   28 – Chemicals and Allied Products
   30 – Rubber and Miscellaneous Plastics
   31 – Leather and Leather Products
   33 – Primary Metal Industries
   34 – Fabricated Metal products
   35 – Industrial and Commercial Machinery
   36 – Electronic and Electrical Equipment
   37 – Transport Equipment
   38 – Measuring, Analysing, Controlling
   32 – Stone, Clay, Glass and Concrete

	Yes	No
4. We supply components & parts to other manufacturers	1☐	2☐
5. We manufacture products for retail sales	1☐	2☐

6. How many people are employed in your company?
   1☐ less than 70 2☐ 71- 100 3☐ 101-150 4☐ more than 150

7. Number of years your organisation is in operation? ____ years

Thank you for your participation

APPENDIX 3 - COVER LETTER

<Name>
<Title>
<Company><Address1> <Address2

Dear <Sal>:

Re: Australian Supplier-Manufacturer Procurement Relationship Survey

As part of my Ph.D. research at the School of Management, Curtin University of Technology is sponsoring a research project designed to explore procurement relationships of Australian manufacturing firms. Specifically, the objective of this nation-wide study is to investigate and analyse the flexibility dimensions and its elements impacted by supplier relationships. Towards this end, I am administering a questionnaire to a selected small sample of manufacturing firms in Australia.

Enclosed is a questionnaire, included with a pre-paid, self-addressed envelope, to be completed by yourself or someone in your firm familiar with your procurement activities. Based on pre-test results, it should take no more than 10 minutes to complete. If you are personally unable to complete the questionnaire, I request that you select a person that you deem knowledgeable about the objective of the study who can complete it in your place.

The sample population is small because of the nature of the business. Therefore, your response is absolutely critical to the success of this survey. Your input will also provide valuable information regarding the competitiveness of Australian manufacturing and emerging procurement, supply chain management theories and practices in Australia. Responding to this nation-wide study is entirely voluntary. In exchange for your participation, I shall be happy to send you a summary of the results after the data are analysed. Please note that you may withdraw your responses from this study at anytime, prior to data analysis. If you wish to withdraw, please contact the researcher listed below.

Please be assured that all information will be treated as *strictly confidential.* A third party will remove the identification serial numbers at the bottom of the questionnaire, after consolidating responses, to preserve confidentiality. Data entry will be aggregated by another third party prior to analysis. I shall conduct only data analysis. No information or any subsequent publication of this study will be able to be traced to any company.

On behalf of the School of Management, Curtin University of Technology, I look forward to receiving your completed questionnaire. If you have any questions regarding this study, please contact Ananda Jeeva (jeevaa@cbs.curtin.edu.au) on 0411 849 906.

Kind Regards.
Ananda Jeeva.
Project Director & Ph.D. Researcher

APPENDIX 4 - FOLLOW-UP TELEPHONE CALL SCRIPT

Re: Australian Manufacturing Procurement Survey – Follow-up Telephone Call

Hello <FIRST NAME><LAST NAME>

My name is Ananda Jeeva
I am calling from Curtin University, Perth, Western Australia.

I am following up on the procurement survey questionnaire mailed to you two weeks ago.
If you have not responded, I urgently request your response to make this survey a success.

It is extremely important that information about your company be included in the study if the results are to accurately represent the broad base of manufacturing firms operating in Australia.

The questionnaire should take no more than 10 minutes of your time to complete.

I understand your time is valuable and that this is a very busy time of year.

Is there any particular reason that you are unable to complete the survey or respond?

Thank you for your co-operation

APPENDIX 5 - T TEST FOR EARLY AND LATE RESPONSES

T-Test

Independent Samples T Test: Early and Late Responses

		Levene's Test for Equality of Variances		t-test for Equality of Means			
		F	Sig.	t	Sig. (2-tailed)	Mean Difference	Std. Error Difference
AQ1 supplier logistics	Equal variances assumed	.164	.686	-.180	.858	-3.E-02	.19
	Equal variances not assumed			-.166	.868	-3.E-02	.20
AQ2 materials / components and delivery	Equal variances assumed	.015	.902	-.293	.770	-4.E-02	.13
	Equal variances not assumed			-.294	.770	-4.E-02	.13
AQ3 information exchange	Equal variances assumed	1.187	.277	-.763	.446	-.13	.17
	Equal variances not assumed			-.812	.420	-.13	.16
AQ4 supplier integration	Equal variances assumed	.001	.978	-1.156	.249	-.25	.22
	Equal variances not assumed			-1.105	.274	-.25	.23
AQ5 organisational strategy	Equal variances assumed	.004	.947	.724	.470	.17	.23
	Equal variances not assumed			.705	.483	.17	.23
BQ1 fluctuating customer demand is affecting manufacturing strategy	Equal variances assumed	.720	.397	-.186	.853	-5.E-02	.25
	Equal variances not assumed			-.180	.858	-5.E-02	.26
BQ2 substitute imported producrs are affecting our product sales	Equal variances assumed	.128	.721	-1.498	.135	-.47	.32
	Equal variances not assumed			-1.527	.131	-.47	.31
BQ3 changing govt regulations & tariffs are affecting our plant	Equal variances assumed	2.729	.100	-1.880	.061	-.53	.28
	Equal variances not assumed			-2.044	.045	-.53	.26
BQ4 environmental concerns are affecting manufacturing strategy	Equal variances assumed	2.144	.144	-1.270	.205	-.34	.27
	Equal variances not assumed			-1.358	.179	-.34	.25
BQ5 our product obsolescence rate is very low	Equal variances assumed	.046	.830	-.318	.751	-8.E-02	.26
	Equal variances not assumed			-.312	.756	-8.E-02	.26
BQ6 difficult to predict competitors' actions	Equal variances assumed	3.104	.079	.212	.833	4.6E-02	.22
	Equal variances not assumed			.186	.853	4.6E-02	.25
BQ7 our suppliers frequently change their prices	Equal variances assumed	.068	.795	-2.397	.017	-.62	.26
	Equal variances not assumed			-2.396	.019	-.62	.26
CQ1 we receive sufficient range of information from suppliers	Equal variances assumed	1.623	.204	.659	.511	.13	.20
	Equal variances not assumed			.602	.549	.13	.22
CQ2 we provide sufficient range of information to suppliers	Equal variances assumed	.065	.799	.595	.552	.11	.19
	Equal variances not assumed			.637	.526	.11	.18
CQ3 suppliers are willing to share critical information with us	Equal variances assumed	.429	.513	.447	.655	9.1E-02	.20
	Equal variances not assumed			.414	.680	9.1E-02	.22
CQ4 data transfer with prominent supplier does not need translation	Equal variances assumed	5.049	.026	.298	.766	8.1E-02	.27
	Equal variances not assumed			.267	.791	8.1E-02	.30
CQ5 our IS is well integrated with that of prominent supplier	Equal variances assumed	.119	.730	-.433	.665	-.11	.25
	Equal variances not assumed			-.425	.672	-.11	.25
CQ6 our IS data structure is same as prominent supplier	Equal variances assumed	.079	.778	.449	.654	.10	.23
	Equal variances not assumed			.432	.667	.10	.24
CQ7 high connectivity of the IS with our suppliers	Equal variances assumed	1.603	.207	.473	.637	.11	.22
	Equal variances not assumed			.474	.637	.11	.22
CQ8 routine transfer of invoicing info done without human intervention	Equal variances assumed	.000	.990	-.206	.837	-6.E-02	.28
	Equal variances not assumed			-.195	.846	-6.E-02	.30
CQ9 routine transfer of ordering info done without human intervention	Equal variances assumed	2.502	.115	-1.333	.184	-.36	.27
	Equal variances not assumed			-1.171	.247	-.36	.31
CQ10 easy for our suppliers to send information to us	Equal variances assumed	.262	.609	-.455	.650	-1.E-01	.22
	Equal variances not assumed			-.467	.642	-1.E-01	.21
CQ11 information received from our suppliers is accurate	Equal variances assumed	3.978	.047	.547	.585	.11	.19
	Equal variances not assumed			.495	.622	.11	.21
CQ12 information received from our suppliers is reliable	Equal variances assumed	2.462	.118	-.113	.910	-2.E-02	.18
	Equal variances not assumed			-.103	.919	-2.E-02	.20
CQ13 information received from our suppliers is in real time	Equal variances assumed	.006	.937	.016	.988	3.9E-03	.25
	Equal variances not assumed			.015	.988	3.9E-03	.26
CQ14 information sent to our suppliers is timely	Equal variances assumed	5.197	.023	.645	.519	.13	.20
	Equal variances not assumed			.574	.568	.13	.22

Independent Samples T Test: Early and Late Responses

		Levene's Test for Equality of Variances		t-test for Equality of Means			
		F	Sig.	t	Sig. (2-tailed)	Mean Difference	Std. Error Difference
CQ15 information sent to our suppliers is accurate	Equal variances assumed	1.408	.237	.608	.544	.10	.17
	Equal variances not assumed			.551	.584	.10	.19
CQ16 information sent to our suppliers is in real time	Equal variances assumed	.336	.563	-.452	.651	-.12	.26
	Equal variances not assumed			-.461	.647	-.12	.25
CQ17 it is easy for us to send information to our suppliers	Equal variances assumed	.323	.570	.165	.869	3.9E-02	.23
	Equal variances not assumed			.171	.865	3.9E-02	.23
DQ1 suppliers carry sufficient inventory to cater to our demands	Equal variances assumed	.009	.924	-.122	.903	-3.E-02	.23
	Equal variances not assumed			-.117	.907	-3.E-02	.24
DQ2 suppliers can easily adjust to changes in demand schedules	Equal variances assumed	.435	.510	-.208	.836	-5.E-02	.23
	Equal variances not assumed			-.217	.829	-5.E-02	.22
DQ3 suppliers maintain high quality standards at all levels of demand	Equal variances assumed	.009	.923	-.290	.772	-6.E-02	.21
	Equal variances not assumed			-.287	.775	-6.E-02	.21
DQ4 suppliers are capable of flexible delivery at short notice	Equal variances assumed	2.957	.087	-1.120	.264	-.25	.22
	Equal variances not assumed			-1.222	.226	-.25	.21
DQ5 we can change to different supplier easily	Equal variances assumed	1.500	.222	1.188	.236	.32	.27
	Equal variances not assumed			1.217	.228	.32	.27
DQ6 we can change to different suppliers in a short time	Equal variances assumed	2.712	.101	2.038	.043	.53	.26
	Equal variances not assumed			2.151	.035	.53	.25
DQ7 we can change to different suppliers at a low cost	Equal variances assumed	.002	.969	1.492	.137	.42	.28
	Equal variances not assumed			1.483	.143	.42	.28
EQ1 suppliers can deliver new components / materials easily	Equal variances assumed	1.119	.291	.437	.663	9.8E-02	.22
	Equal variances not assumed			.484	.630	9.8E-02	.20
EQ2 suppliers can deliver new components / materials in a short time	Equal variances assumed	.924	.337	.233	.816	5.4E-02	.23
	Equal variances not assumed			.248	.805	5.4E-02	.22
EQ3 suppliers can deliver new components / materials at a low price	Equal variances assumed	.061	.805	-.923	.357	-.19	.21
	Equal variances not assumed			-.935	.353	-.19	.20
EQ4 suppliers can deliver new components / materials with same quality	Equal variances assumed	3.527	.062	-.125	.901	-3.E-02	.21
	Equal variances not assumed			-.144	.886	-3.E-02	.18
EQ5 suppliers can modify their product mix easily	Equal variances assumed	4.554	.034	-1.098	.273	-.24	.22
	Equal variances not assumed			-1.260	.211	-.24	.19
EQ6 suppliers can modify their product mix in a short time	Equal variances assumed	1.501	.222	-.801	.424	-.18	.22
	Equal variances not assumed			-.863	.391	-.18	.20
EQ7 suppliers can modify their product mix at a low cost	Equal variances assumed	.250	.618	-1.178	.240	-.24	.20
	Equal variances not assumed			-1.177	.243	-.24	.20
EQ8 suppliers can modify their product mix with same quality	Equal variances assumed	1.646	.201	-2.526	.012	-.54	.21
	Equal variances not assumed			-2.707	.009	-.54	.20
EQ9 suppliers can implement product design changes easily	Equal variances assumed	6.186	.014	-2.221	.027	-.48	.22
	Equal variances not assumed			-2.502	.015	-.48	.19
EQ10 suppliers can implement product design changes in a short time	Equal variances assumed	1.103	.295	-1.895	.059	-.43	.22
	Equal variances not assumed			-2.094	.040	-.43	.20
EQ11 suppliers can implement product design changes at a low cost	Equal variances assumed	.152	.697	-1.396	.164	-.28	.20
	Equal variances not assumed			-1.418	.161	-.28	.19
EQ12 suppliers can implement product design changes with same quality	Equal variances assumed	.068	.795	-1.007	.315	-.22	.21
	Equal variances not assumed			-1.043	.301	-.22	.21
EQ13 short time required for suppliers to switch parts mix	Equal variances assumed	.520	.472	-.780	.436	-.17	.21
	Equal variances not assumed			-.791	.432	-.17	.21
EQ14 suppliers can deliver wide range of component parts	Equal variances assumed	1.591	.208	.623	.534	.15	.24
	Equal variances not assumed			.588	.558	.15	.25
FQ1 suppliers can deliver materials and components along various routes	Equal variances assumed	.279	.598	-.312	.755	-7.E-02	.23
	Equal variances not assumed			-.302	.764	-7.E-02	.24
FQ2 suppliers can modify these routes easily	Equal variances assumed	.024	.877	-.334	.739	-8.E-02	.23
	Equal variances not assumed			-.336	.738	-8.E-02	.23
FQ3 suppliers can modify these routes in a short time	Equal variances assumed	.195	.659	-.438	.662	-.10	.24
	Equal variances not assumed			-.434	.666	-.10	.24

Independent Samples T Test: Early and Late Responses

		Levene's Test for Equality of Variances		t-test for Equality of Means			
		F	Sig.	t	Sig. (2-tailed)	Mean Difference	Std. Error Difference
FQ4 too costly for suppliers to modify these routes	Equal variances assumed	.557	.456	-.997	.320	-.24	.24
	Equal variances not assumed			-.939	.352	-.24	.26
FQ5 all materials handling routes exhibit similar performance levels	Equal variances assumed	.215	.643	1.340	.181	.30	.22
	Equal variances not assumed			1.410	.163	.30	.21
FQ6 choice of handling routes does not affect transport costs	Equal variances assumed	1.568	.212	2.087	.038	.56	.27
	Equal variances not assumed			2.270	.026	.56	.25
FQ7 transport facilities for materials of different sizes are flexible	Equal variances assumed	.425	.515	-.073	.942	-2.E-02	.22
	Equal variances not assumed			-.076	.940	-2.E-02	.22
GQ1 have a range of organisational strategies for supplier integration	Equal variances assumed	.832	.363	-1.449	.149	-.36	.25
	Equal variances not assumed			-1.372	.175	-.36	.26
GQ2 these strategies are easy to implement	Equal variances assumed	.052	.820	-.981	.328	-.22	.23
	Equal variances not assumed			-.989	.326	-.22	.23
GQ3 these strategies are very costly no implement	Equal variances assumed	.381	.537	-1.392	.165	-.30	.22
	Equal variances not assumed			-1.402	.166	-.30	.22
GQ4 these strategies can be implemented in a short time	Equal variances assumed	1.221	.270	-1.030	.304	-.24	.23
	Equal variances not assumed			-1.094	.278	-.24	.22
GQ5 org structure flexible to improve operational relationships with suppliers	Equal variances assumed	1.020	.313	-.570	.569	-.12	.22
	Equal variances not assumed			-.606	.547	-.12	.20
GQ6 this flexibility is costly to implement	Equal variances assumed	2.475	.117	.592	.555	.13	.21
	Equal variances not assumed			.662	.510	.13	.19
GQ7 this flexibility is easy to implement	Equal variances assumed	5.932	.016	-.115	.909	-3.E-02	.22
	Equal variances not assumed			-.133	.895	-3.E-02	.19
GQ8 this flexibility is quick to implement	Equal variances assumed	2.095	.149	.316	.752	7.1E-02	.22
	Equal variances not assumed			.343	.732	7.1E-02	.21
GQ9 strategies are designed to respond to environmental uncertainties	Equal variances assumed	1.213	.272	-1.122	.263	-.25	.22
	Equal variances not assumed			-1.251	.215	-.25	.20
GQ10 this responsive action is easy to implement	Equal variances assumed	.092	.762	.335	.738	7.0E-02	.21
	Equal variances not assumed			.351	.727	7.0E-02	.20
GQ11 this responsive action can be implemented in a short time	Equal variances assumed	1.491	.223	-.087	.931	-2.E-02	.21
	Equal variances not assumed			-.095	.924	-2.E-02	.19
GQ12 this responsive action is too costly to implement	Equal variances assumed	2.516	.114	.146	.884	3.0E-02	.20
	Equal variances not assumed			.162	.871	3.0E-02	.18
REVFQ4	Equal variances assumed	.557	.456	.997	.320	.24	.24
	Equal variances not assumed			.939	.352	.24	.26
REVGQ6	Equal variances assumed	2.475	.117	-.592	.555	-.13	.21
	Equal variances not assumed			-.662	.510	-.13	.19
REVGQ12	Equal variances assumed	2.516	.114	-.146	.884	-3.E-02	.20
	Equal variances not assumed			-.162	.871	-3.E-02	.18

APPENDIX 6 - RELIABILITY ANALYSIS SCALE (A L P H A)

*** Method 2 (covariance matrix) will be used for this analysis *

Item-total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Alpha if Item Deleted
CQ1	224.6266	1230.8766	.4565	.5883	.9299
CQ2	224.2324	1247.6958	.2868	.5387	.9309
CQ3	224.5975	1241.4248	.3315	.4207	.9307
CQ4	224.6058	1224.1148	.3900	.4749	.9304
CQ5	226.2822	1224.0034	.4312	.7554	.9301
CQ6	226.5809	1232.8278	.3768	.7175	.9304
CQ7	226.5934	1225.1923	.4685	.7792	.9298
CQ8	226.3320	1221.1477	.4008	.6265	.9304
CQ9	226.4481	1227.0483	.3650	.6684	.9306
CQ10	224.0124	1231.1623	.4250	.6226	.9301
CQ11	224.3485	1231.8030	.4651	.8007	.9299
CQ12	224.3361	1231.3074	.5091	.8168	.9297
CQ13	224.9917	1213.4999	.5285	.6926	.9293
CQ14	224.3651	1234.1661	.4267	.5903	.9301
CQ15	223.8589	1242.7050	.3853	.6613	.9304
CQ16	224.5602	1222.3557	.4306	.7665	.9301
CQ17	224.0705	1225.9242	.4494	.6588	.9299
DQ1	224.6473	1235.5543	.3510	.5363	.9306
DQ2	225.0871	1214.5049	.5618	.6776	.9291
DQ3	224.3527	1228.7959	.4736	.6252	.9298
DQ4	224.8133	1222.8942	.4948	.6772	.9296
DQ5	225.9129	1219.6049	.4328	.7859	.9301
DQ6	225.8299	1217.2001	.4681	.8098	.9298
DQ7	225.4772	1237.2839	.2671	.5957	.9315
EQ1	225.2199	1216.6473	.5620	.7404	.9292
EQ2	225.4855	1207.3925	.6390	.7886	.9286
EQ3	225.3983	1226.5407	.4957	.6253	.9297
EQ4	224.4025	1224.2332	.5162	.7283	.9295
EQ5	225.4066	1220.1506	.5463	.7707	.9293
EQ6	225.4647	1215.9581	.5758	.8134	.9291
EQ7	225.4855	1229.2425	.4698	.7105	.9298
EQ8	224.7137	1226.1469	.4827	.7318	.9297
EQ9	225.5602	1217.9224	.5658	.7948	.9292
EQ10	225.7718	1212.4185	.6078	.8256	.9289
EQ11	225.6598	1227.4254	.5138	.7282	.9296
EQ12	224.6929	1231.1470	.4290	.7076	.9301
EQ13	225.5892	1220.4097	.5519	.6357	.9293
EQ14	224.7967	1228.5210	.4097	.4302	.9302
FQ1	224.4813	1233.1424	.3794	.6918	.9304
FQ2	224.8797	1225.5646	.4494	.8428	.9299
FQ3	224.9876	1216.1790	.5264	.7737	.9294
FQ5	225.2656	1251.1459	.1964	.4500	.9316
FQ6	225.9461	1236.4179	.2865	.5004	.9313
FQ7	224.9668	1226.3406	.4595	.5005	.9299
GQ1	225.0622	1227.9753	.4026	.5684	.9303
GQ2	225.4232	1217.7701	.5366	.6689	.9293
GQ3	225.4481	1286.4233	-.1696	.5063	.9339
GQ4	225.6722	1216.7796	.5367	.5769	.9293
GQ5	224.2365	1233.7147	.4059	.4091	.9302
GQ7	225.2075	1224.4568	.4907	.7317	.9297
GQ8	225.5436	1216.3325	.5668	.7732	.9291
GQ9	224.8797	1250.4896	.2133	.5086	.9315
GQ10	225.3195	1225.4683	.5202	.7707	.9295
GQ11	225.3402	1220.1421	.5660	.7785	.9292
REVFQ4	224.9917	1252.1249	.1677	.4032	.9320
REVGQ6	224.7469	1262.7148	.0819	.5217	.9323
REVGQ12	224.6598	1256.0671	.1687	.4194	.9316

Reliability Coefficients 57 items

Alpha = .9313 Standardized item alpha = .9326

APPENDIX 7 - DESCRIPTIVE STATISTICS - 69 ITEMS (Sections A to G)

	N	Mean	Std. Deviation
AQ1 supplier logistics	252	5.75	1.14
AQ2 materials / components and delivery	252	6.30	.80
AQ3 information exchange	252	5.78	1.04
AQ4 supplier integration	252	4.73	1.33
AQ5 organisational strategy	252	4.76	1.39
BQ1 fluctuating customer demand is affecting manufacturing strategy	252	5.21	1.51
BQ2 substitute imported producrs are affecting our product sales	252	4.10	1.93
BQ3 changing govt regulations & tariffs are affecting our plant	252	3.83	1.73
BQ4 environmental concerns are affecting manufacturing strategy	251	3.52	1.62
BQ5 our product obsolescence rate is very low	252	4.67	1.55
BQ6 difficult to predict competitors' actions	252	4.24	1.33
BQ7 our suppliers frequently change their prices	252	3.49	1.60
CQ1 we receive sufficient range of information from suppliers	252	4.49	1.24
CQ2 we provide sufficient range of information to suppliers	252	4.89	1.15
CQ3 suppliers are willing to share critical information with us	252	4.56	1.23
CQ4 data transfer with prominent supplier does not need translation	252	4.56	1.65
CQ5 our IS is well integrated with that of prominent supplier	252	2.85	1.50
CQ6 our IS data structure is same as prominent supplier	252	2.55	1.40
CQ7 high connectivity of the IS with our suppliers	251	2.55	1.36
CQ8 routine transfer of invoicing info done without human intervention	251	2.80	1.71
CQ9 routine transfer of ordering info done without human intervention	252	2.68	1.64
CQ10 easy for our suppliers to send information to us	252	5.12	1.32
CQ11 information received from our suppliers is accurate	252	4.80	1.17
CQ12 information received from our suppliers is reliable	252	4.81	1.08
CQ13 information received from our suppliers is in real time	252	4.16	1.51
CQ14 information sent to our suppliers is timely	252	4.75	1.21
CQ15 information sent to our suppliers is accurate	251	5.26	1.04
CQ16 information sent to our suppliers is in real time	252	4.57	1.56
CQ17 it is easy for us to send information to our suppliers	252	5.03	1.42
DQ1 suppliers carry sufficient inventory to cater to our demands	252	4.49	1.40
DQ2 suppliers can easily adjust to changes in demand schedules	252	4.07	1.41
DQ3 suppliers maintain high quality standards at all levels of demand	252	4.82	1.25
DQ4 suppliers are capable of flexible delivery at short notice	252	4.35	1.36
DQ5 we can change to different supplier easily	251	3.24	1.65
DQ6 we can change to different suppliers in a short time	252	3.31	1.60
DQ7 we can change to different suppliers at a low cost	252	3.67	1.70
EQ1 suppliers can deliver new components / materials easily	252	3.92	1.36
EQ2 suppliers can deliver new components / materials in a short time	252	3.67	1.41
EQ3 suppliers can deliver new components / materials at a low price	252	3.75	1.26
EQ4 suppliers can deliver new components / materials with same quality	252	4.73	1.27
EQ5 suppliers can modify their product mix easily	252	3.74	1.32
EQ6 suppliers can modify their product mix in a short time	252	3.65	1.34
EQ7 suppliers can modify their product mix at a low cost	252	3.65	1.24
EQ8 suppliers can modify their product mix with same quality	250	4.42	1.30
EQ9 suppliers can implement product design changes easily	252	3.56	1.33
EQ10 suppliers can implement product design changes in a short time	252	3.36	1.37
EQ11 suppliers can implement product design changes at a low cost	252	3.48	1.21
EQ12 suppliers can implement product design changes with same quality	252	4.44	1.31
EQ13 short time required for suppliers to switch parts mix	250	3.55	1.30
EQ14 suppliers can deliver wide range of component parts	252	4.37	1.43
FQ1 suppliers can deliver materials and components along various routes	252	4.67	1.39
FQ2 suppliers can modify these routes easily	252	4.27	1.41
FQ3 suppliers can modify these routes in a short time	252	4.16	1.45
FQ4 too costly for suppliers to modify these routes	252	3.85	1.48
FQ5 all materials handling routes exhibit similar performance levels	252	3.89	1.35
FQ6 choice of handling routes does not affect transport costs	252	3.19	1.63
FQ7 transport facilities for materials of different sizes are flexible	252	4.19	1.36
GQ1 have a range of organisational strategies for supplier integration	252	4.06	1.49
GQ2 these strategies are easy to implement	252	3.68	1.39
GQ3 these strategies are very costly no implement	252	3.71	1.33

	N	Mean	Std. Deviation
GQ4 these strategies can be implemented in a short time	251	3.45	1.43
GQ5 org structure flexible to improve operational relationships with suppliers	251	4.88	1.31
GQ6 this flexibility is costly to implement	252	3.62	1.30
GQ7 this flexibility is easy to implement	252	3.91	1.33
GQ8 this flexibility is quick to implement	252	3.59	1.36
GQ9 strategies are designed to respond to environmental uncertainties	252	4.29	1.34
GQ10 this responsive action is easy to implement	251	3.81	1.26
GQ11 this responsive action can be implemented in a short time	251	3.78	1.29
GQ12 this responsive action is too costly to implement	251	3.56	1.23
Valid N (listwise)	240		

APPENDIX 8 - DESCRIPTIVE STATISTICS – DEMOGRAPHIC (Section H)

Descriptive Statistics

	N	Minimum	Maximum
HQ1 position title	252	1	38
HQ2 purchase volume in past financial year	248	1	4
HQ3.1	252	20	40
HQ4 supply components and parts to other manufacturers	250	1	2
HQ5 manufacture products for retail sales	248	1	2
HQ6 number of people employed in company	251	1	4
HQ7 number of years organisation in operation	252	2	750

APPENDIX 9 - DESCRIPTIVE STATISTICS - POSITION TITLES

position title

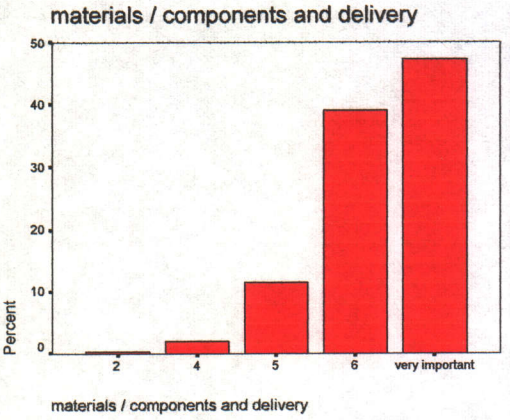
	Frequency	Percent	Valid Percent	Cumulative Percent
1 Managing Director	24	9.5	9.5	9.5
2 Purchasing Mgr	51	20.2	20.2	29.8
3 Supply Mgr	14	5.6	5.6	35.3
4 Operations Mgr	18	7.1	7.1	42.5
5 Group Services Mgr	1	.4	.4	42.9
6 General Mgr	25	9.9	9.9	52.8
7 Admin Mgr	2	.8	.8	53.6
8 CEO	6	2.4	2.4	56.0
9 Procurement Mgr	13	5.2	5.2	61.1
10 Director	11	4.4	4.4	65.5
11 Purchasing Spvr / Coord	2	.8	.8	66.3
12 Materials Controller	1	.4	.4	66.7
13 Logistics Mgr	11	4.4	4.4	71.0
14 Production Mgr	10	4.0	4.0	75.0
15 Supply Chain Mgr	6	2.4	2.4	77.4
16 Manufacturing Mgr	13	5.2	5.2	82.5
17 Materials Mgr	6	2.4	2.4	84.9
18 Commercial Mgr	2	.8	.8	85.7
19 Prod Dev Mgr	1	.4	.4	86.1
20 Manager	4	1.6	1.6	87.7
21 Supply Director	1	.4	.4	88.1
22 Procurement Officer	2	.8	.8	88.9
23 Purchasing Officer	8	3.2	3.2	92.1
24 Marketing Mgr	5	2.0	2.0	94.0
25 Logistics Admin	1	.4	.4	94.4
26 Operations Director	1	.4	.4	94.8
27 Procurement Director	1	.4	.4	95.2
28 Purchasing Director	1	.4	.4	95.6
29 Technical Mgr	1	.4	.4	96.0
30 Supply Chain Controller	1	.4	.4	96.4
31 Systems Mgr	1	.4	.4	96.8
32 Stock Controller	1	.4	.4	97.2
33 Company Secretary	1	.4	.4	97.6
34 Snr Vice President	1	.4	.4	98.0
35 Supply Coordinator	1	.4	.4	98.4
36 Supply Chain Director	2	.8	.8	99.2
37 Maintenance Spvr	1	.4	.4	99.6
38 Finance Mgr	1	.4	.4	100.0
Total	252	100.0	100.0	

APPENDIX 10 - DESCRIPTIVES STATISTICS - POSITION TITLE GROUPING

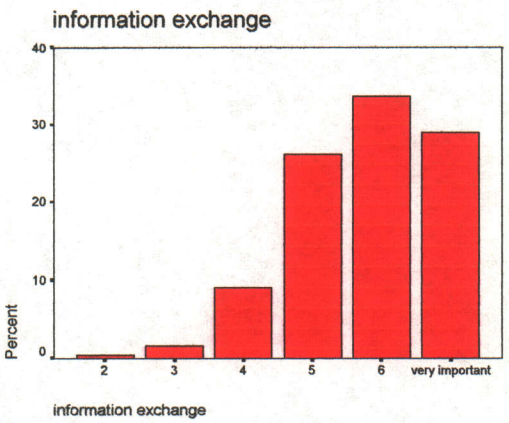
		N	Mean	Std. Deviation	Std. Error
SUPPLOG supplier logistics	1 Senior Managers	74	4.06	1.00	.12
	2 Procurement Managers	123	4.14	.92	.08
	3 Operations Managers	45	3.95	.88	.13
	4 Peripheral Managers	10	3.90	.65	.20
	Total	252	4.07	.93	.06
DELFLEX supplier product & delivery flexibility	1 Senior Managers	74	3.74	.93	.11
	2 Procurement Managers	123	4.05	.90	.08
	3 Operations Managers	45	3.70	.91	.14
	4 Peripheral Managers	10	3.68	.75	.24
	Total	252	3.88	.92	.06
INFOEX information exchange	1 Senior Managers	74	4.21	.85	.10
	2 Procurement Managers	123	4.15	.81	.07
	3 Operations Managers	45	4.02	.78	.12
	4 Peripheral Managers	10	4.08	.79	.25
	Total	252	4.14	.81	.05
SUPPINT supplier integration	1 Senior Managers	74	3.96	1.02	.12
	2 Procurement Managers	123	4.06	.98	.09
	3 Operations Managers	45	3.82	.95	.14
	4 Peripheral Managers	10	4.11	.70	.22
	Total	252	3.99	.98	.06
ORGSTRAT organisational strategy	1 Senior Managers	74	3.96	.78	.09
	2 Procurement Managers	123	4.09	.72	.06
	3 Operations Managers	45	3.87	.54	.08
	4 Peripheral Managers	10	3.68	.76	.24
	Total	252	4.00	.72	.05

APPENDIX 11 - SUPPLIER RELATIONSHIP IMPORTANCE (Section A)

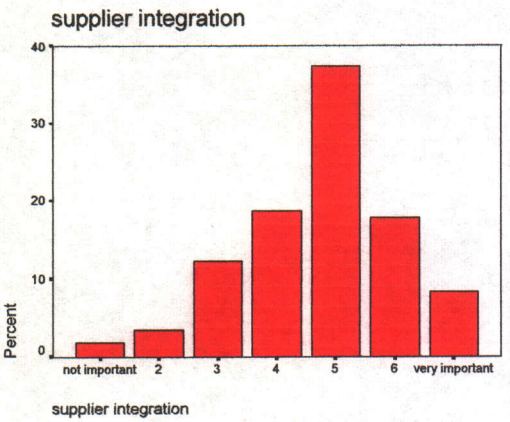
supplier logistics



materials / components and delivery



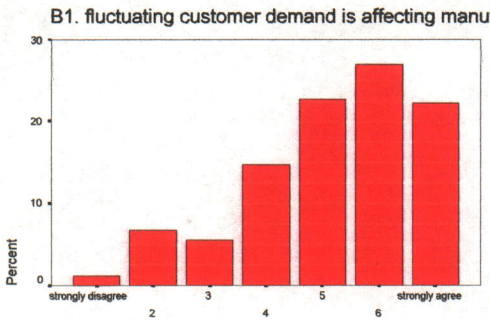
information exchange



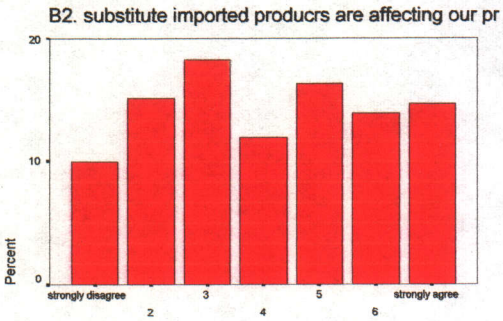
supplier integration

organisational strategy

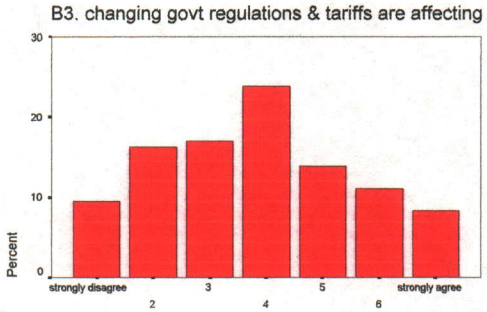
APPENDIX 12 - AFFECT OF UNCERTAINTY ON MANUFACTURING



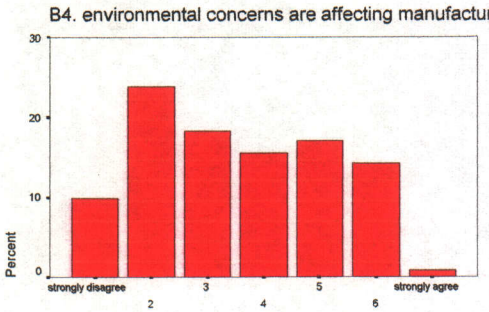
fluctuating customer demand is affecting manufacturing strategy



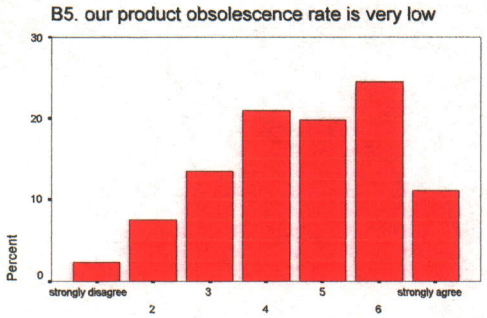
substitute imported producrs are affecting our product sales



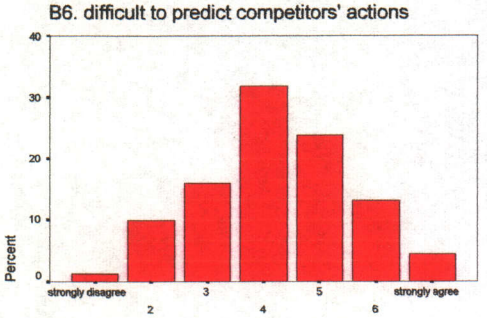
changing govt regulations & tariffs are affecting our plant



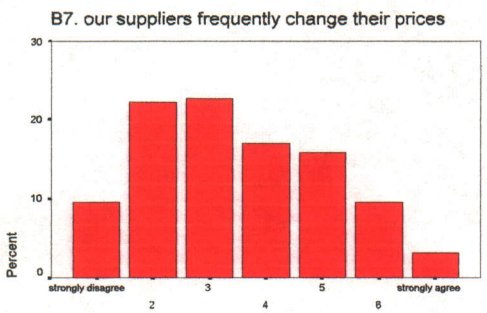
environmental concerns are affecting manufacturing strategy



our product obsolescence rate is very low



difficult to predict competitors' actions



our suppliers frequently change their prices

Correlations - 57 variables

		CQ1	CQ2	CQ3	CQ4	CQ5	CQ6	CQ7	CQ8	CQ9	CQ10	CQ11	CQ12	CQ13	CQ14	CQ15	CQ16	CQ17	DQ1	DQ2	DQ3
CQ1	Pearson Correlation	1.000	.430**	.323**	.278**	.199**	.159*	.233**	.206**	.151*	.351**	.358**	.353**	.364**	.265**	.207**	.210**	.272**	.221**	.251**	.248**
	Sig. (2-tailed)	.	.000	.000	.000	.001	.011	.000	.001	.016	.000	.000	.000	.000	.000	.001	.001	.000	.000	.000	.000
	N	252	252	252	252	252	252	251	251	252	252	252	252	252	252	251	252	252	252	252	252
CQ2	Pearson Correlation	.430**	1.000	.247**	.197**	.229**	.141*	.213**	.181**	.173**	.334**	.126*	.072	.189**	.249**	.419**	.314**	.323**	.030	.056	.003
	Sig. (2-tailed)	.000	.	.000	.002	.000	.026	.001	.004	.006	.000	.046	.252	.003	.000	.000	.000	.000	.634	.376	.963
	N	252	252	252	252	252	252	251	251	252	252	252	252	252	252	251	252	252	252	252	252
CQ3	Pearson Correlation	.323**	.247**	1.000	.251**	.187**	.110	.162**	.170**	.124*	.214**	.314**	.314**	.230**	.172**	.207**	.097	.085	.180**	.171**	.281**
	Sig. (2-tailed)	.000	.000	.	.000	.003	.081	.010	.007	.049	.001	.000	.000	.000	.006	.001	.124	.177	.004	.006	.000
	N	252	252	252	252	252	252	251	251	252	252	252	252	252	252	251	252	252	252	252	252
CQ4	Pearson Correlation	.278**	.197**	.251**	1.000	.410**	.305**	.288**	.248**	.187**	.364**	.242**	.245**	.338**	.168**	.219**	.298**	.326**	.037	.190**	.165**
	Sig. (2-tailed)	.000	.002	.000	.	.000	.000	.000	.000	.003	.000	.000	.000	.000	.008	.000	.000	.000	.554	.003	.009
	N	252	252	252	252	252	252	251	251	252	252	252	252	252	252	251	252	252	252	252	252
CQ5	Pearson Correlation	.199**	.229**	.187**	.410**	1.000	.710**	.769**	.471**	.485**	.261**	.248**	.233**	.352**	.261**	.240**	.365**	.346**	.087	.137*	.053
	Sig. (2-tailed)	.001	.000	.003	.000	.	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.166	.030	.405
	N	252	252	252	252	252	252	251	251	252	252	252	252	252	252	251	252	252	252	252	252
CQ6	Pearson Correlation	.159*	.141*	.110	.305**	.710**	1.000	.748**	.400**	.403**	.222**	.288**	.276**	.261**	.214**	.216**	.256**	.216**	.111	.162*	.028
	Sig. (2-tailed)	.011	.026	.081	.000	.000	.	.000	.000	.000	.000	.000	.000	.000	.001	.001	.000	.001	.080	.010	.656
	N	252	252	252	252	252	252	251	251	252	252	252	252	252	252	251	252	252	252	252	252
CQ7	Pearson Correlation	.233**	.213**	.162**	.288**	.769**	.748**	1.000	.410**	.427**	.255**	.289**	.294**	.332**	.225**	.194**	.324**	.273**	.152*	.187**	.098
	Sig. (2-tailed)	.000	.001	.010	.000	.000	.000	.	.000	.000	.000	.000	.000	.000	.000	.002	.000	.000	.016	.003	.121
	N	251	251	251	251	251	251	251	250	251	251	251	251	251	251	250	251	251	251	251	251
CQ8	Pearson Correlation	.206**	.181**	.170**	.248**	.471**	.400**	.410**	1.000	.660**	.233**	.255**	.248**	.332**	.257**	.197**	.256**	.209**	.219**	.233**	.117
	Sig. (2-tailed)	.001	.004	.007	.000	.000	.000	.000	.	.000	.000	.000	.000	.000	.000	.002	.000	.001	.000	.000	.065
	N	251	251	251	251	251	251	250	251	251	251	251	251	251	251	250	251	251	251	251	251
CQ9	Pearson Correlation	.151*	.173**	.124*	.187**	.485**	.403**	.427**	.660**	1.000	.161*	.257**	.274**	.335**	.245**	.128*	.260**	.194**	.226**	.231**	.047
	Sig. (2-tailed)	.016	.006	.049	.003	.000	.000	.000	.000	.	.010	.000	.000	.000	.000	.043	.000	.002	.000	.000	.455
	N	252	252	252	252	252	252	251	251	252	252	252	252	252	252	251	252	252	252	252	252
CQ10	Pearson Correlation	.351**	.334**	.214**	.364**	.261**	.222**	.255**	.233**	.161*	1.000	.392**	.360**	.396**	.387**	.449**	.475**	.602**	.049	.122	.095
	Sig. (2-tailed)	.000	.000	.001	.000	.000	.000	.000	.000	.010	.	.000	.000	.000	.000	.000	.000	.000	.443	.053	.131
	N	252	252	252	252	252	252	251	251	252	252	252	252	252	252	251	252	252	252	252	252
CQ11	Pearson Correlation	.358**	.126*	.314**	.242**	.248**	.288**	.289**	.255**	.257**	.392**	1.000	.833**	.537**	.407**	.328**	.281**	.304**	.278**	.294**	.312**
	Sig. (2-tailed)	.000	.046	.000	.000	.000	.000	.000	.000	.000	.000	.	.000	.000	.000	.000	.000	.000	.000	.000	.000
	N	252	252	252	252	252	252	251	251	252	252	252	252	252	252	251	252	252	252	252	252
CQ12	Pearson Correlation	.353**	.072	.314**	.245**	.233**	.276**	.294**	.248**	.274**	.360**	.833**	1.000	.526**	.403**	.333**	.264**	.289**	.365**	.350**	.399**
	Sig. (2-tailed)	.000	.252	.000	.000	.000	.000	.000	.000	.000	.000	.000	.	.000	.000	.000	.000	.000	.000	.000	.000
	N	252	252	252	252	252	252	251	251	252	252	252	252	252	252	251	252	252	252	252	252
CQ13	Pearson Correlation	.364**	.189**	.230**	.338**	.352**	.261**	.332**	.332**	.335**	.396**	.537**	.526**	1.000	.466**	.355**	.639**	.445**	.202**	.276**	.260**
	Sig. (2-tailed)	.000	.003	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.	.000	.000	.000	.000	.001	.000	.000
	N	252	252	252	252	252	252	251	251	252	252	252	252	252	252	251	252	252	252	252	252
CQ14	Pearson Correlation	.265**	.249**	.172**	.168**	.261**	.214**	.225**	.257**	.245**	.387**	.407**	.403**	.466**	1.000	.611**	.525**	.508**	.165**	.192**	.196**
	Sig. (2-tailed)	.000	.000	.006	.008	.000	.001	.000	.000	.000	.000	.000	.000	.000	.	.000	.000	.000	.009	.002	.002
	N	252	252	252	252	252	252	251	251	252	252	252	252	252	252	251	252	252	252	252	252
CQ15	Pearson Correlation	.207**	.419**	.207**	.219**	.240**	.216**	.194**	.197**	.128*	.449**	.328**	.333**	.355**	.611**	1.000	.573**	.502**	.056	.139*	.154*
	Sig. (2-tailed)	.001	.000	.001	.000	.000	.001	.002	.002	.043	.000	.000	.000	.000	.000	.	.000	.000	.379	.027	.015
	N	251	251	251	251	251	251	250	250	251	251	251	251	251	251	251	251	251	251	251	251

Correlations - 57 variables

		CQ1	CQ2	CQ3	CQ4	CQ5	CQ6	CQ7	CQ8	CQ9	CQ10	CQ11	CQ12	CQ13	CQ14	CQ15	CQ16	CQ17	DQ1	DQ2	DQ3
CQ16	Pearson Correlation	.210**	.314**	.097	.298**	.365**	.256**	.324**	.256**	.260**	.475**	.281**	.264**	.639**	.525**	.573**	1.000	.648**	.049	.177**	.093
	Sig. (2-tailed)	.001	.000	.124	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.	.000	.439	.005	.143
	N	252	252	252	252	252	252	251	251	252	252	252	252	252	252	251	252	252	252	252	252
CQ17	Pearson Correlation	.272**	.323**	.085	.326**	.346**	.216**	.273**	.209**	.194**	.602**	.304**	.289**	.445**	.508**	.502**	.648**	1.000	.179**	.227**	.167**
	Sig. (2-tailed)	.000	.000	.177	.000	.000	.001	.000	.001	.002	.000	.000	.000	.000	.000	.000	.000	.	.004	.000	.008
	N	252	252	252	252	252	252	251	251	252	252	252	252	252	252	251	252	252	252	252	252
DQ1	Pearson Correlation	.221**	.030	.180**	.037	.087	.111	.152*	.219**	.226**	.049	.278**	.365**	.202**	.165**	.056	.049	.179**	1.000	.582**	.393**
	Sig. (2-tailed)	.000	.634	.004	.554	.166	.080	.016	.000	.000	.443	.000	.000	.001	.009	.379	.439	.004	.	.000	.000
	N	252	252	252	252	252	252	251	251	252	252	252	252	252	252	251	252	252	252	252	252
DQ2	Pearson Correlation	.251**	.056	.171**	.190**	.137*	.162*	.187**	.233**	.231**	.122	.294**	.350**	.276**	.192**	.139*	.177**	.227**	.582**	1.000	.494**
	Sig. (2-tailed)	.000	.376	.006	.003	.030	.010	.003	.000	.000	.053	.000	.000	.000	.002	.027	.005	.000	.000	.	.000
	N	252	252	252	252	252	252	251	251	252	252	252	252	252	252	251	252	252	252	252	252
DQ3	Pearson Correlation	.248**	.003	.281**	.165**	.053	.028	.098	.117	.047	.095	.312**	.399**	.260**	.196**	.154*	.093	.167**	.393**	.494**	1.000
	Sig. (2-tailed)	.000	.963	.000	.009	.405	.656	.121	.065	.455	.131	.000	.000	.000	.002	.015	.143	.008	.000	.000	.
	N	252	252	252	252	252	252	251	251	252	252	252	252	252	252	251	252	252	252	252	252
DQ4	Pearson Correlation	.205**	.004	.134*	.090	.021	.124*	.182**	.184**	.162*	.030	.284**	.353**	.190**	.164**	.060	-.025	.091	.473**	.657**	.539**
	Sig. (2-tailed)	.001	.954	.034	.153	.744	.049	.004	.004	.010	.635	.000	.000	.002	.009	.347	.694	.150	.000	.000	.000
	N	252	252	252	252	252	252	251	251	252	252	252	252	252	252	251	252	252	252	252	252
DQ5	Pearson Correlation	.199**	.173**	.164**	.124	.109	.057	.184**	.176**	.093	.139*	.079	.044	.199**	.090	.118	.203**	.175**	.116	.301**	.102
	Sig. (2-tailed)	.002	.006	.009	.050	.083	.368	.004	.005	.143	.028	.211	.485	.002	.156	.063	.001	.006	.067	.000	.105
	N	251	251	251	251	251	251	250	250	251	251	251	251	251	251	250	251	251	251	251	251
DQ6	Pearson Correlation	.155*	.138*	.144*	.077	.154*	.129*	.216**	.191**	.099	.113	.097	.034	.156*	.060	.068	.216**	.179**	.093	.286**	.087
	Sig. (2-tailed)	.014	.028	.022	.223	.015	.041	.001	.002	.117	.073	.125	.588	.013	.342	.283	.001	.004	.140	.000	.167
	N	252	252	252	252	252	252	251	251	252	252	252	252	252	252	251	252	252	252	252	252
DQ7	Pearson Correlation	.034	.057	.019	.100	.102	.014	.119	.034	-.006	.069	.119	.054	.151*	.022	-.007	.134*	.143*	.098	.237**	.114
	Sig. (2-tailed)	.589	.364	.759	.112	.106	.827	.059	.591	.927	.274	.059	.392	.016	.724	.917	.033	.023	.122	.000	.070
	N	252	252	252	252	252	252	251	251	252	252	252	252	252	252	251	252	252	252	252	252
EQ1	Pearson Correlation	.228**	.074	.145*	.131*	.133*	.148*	.219**	.160*	.086	.117	.151*	.215**	.291**	.154*	.129*	.147*	.154*	.289**	.481**	.426**
	Sig. (2-tailed)	.000	.243	.022	.038	.035	.019	.000	.011	.174	.064	.016	.001	.000	.015	.042	.020	.014	.000	.000	.000
	N	252	252	252	252	252	252	251	251	252	252	252	252	252	252	251	252	252	252	252	252
EQ2	Pearson Correlation	.240**	.118	.159*	.195**	.132*	.144*	.217**	.187**	.071	.198**	.169**	.218**	.237**	.182**	.182**	.169**	.193**	.249**	.459**	.385**
	Sig. (2-tailed)	.000	.062	.012	.002	.037	.022	.001	.003	.260	.002	.007	.000	.000	.004	.004	.007	.002	.000	.000	.000
	N	252	252	252	252	252	252	251	251	252	252	252	252	252	252	251	252	252	252	252	252
EQ3	Pearson Correlation	.202**	.127*	.210**	.154*	.083	.066	.143*	.042	.081	.179**	.136*	.186**	.197**	.210**	.170**	.145*	.183**	.193**	.328**	.295**
	Sig. (2-tailed)	.001	.044	.001	.014	.190	.296	.024	.503	.197	.004	.030	.003	.002	.001	.007	.021	.004	.002	.000	.000
	N	252	252	252	252	252	252	251	251	252	252	252	252	252	252	251	252	252	252	252	252
EQ4	Pearson Correlation	.197**	.144*	.198**	.240**	.114	.083	.109	.081	.116	.232**	.211**	.252**	.166**	.177**	.230**	.083	.206**	.161*	.235**	.411**
	Sig. (2-tailed)	.002	.022	.002	.000	.070	.188	.085	.201	.065	.000	.001	.000	.008	.005	.000	.187	.001	.010	.000	.000
	N	252	252	252	252	252	252	251	251	252	252	252	252	252	252	251	252	252	252	252	252
EQ5	Pearson Correlation	.130*	.039	.185**	.179**	.147*	.215**	.172**	.157*	.142*	.124*	.123	.140*	.154*	.161*	.097	.050	.056	.200**	.404**	.225**
	Sig. (2-tailed)	.039	.536	.003	.004	.020	.001	.006	.013	.024	.049	.050	.026	.015	.010	.126	.429	.379	.001	.000	.000
	N	252	252	252	252	252	252	251	251	252	252	252	252	252	252	251	252	252	252	252	252
EQ6	Pearson Correlation	.176**	.012	.133*	.200**	.110	.130*	.177**	.173**	.156*	.125*	.121	.159*	.177**	.148*	.082	.074	.071	.176**	.436**	.292**
	Sig. (2-tailed)	.005	.849	.035	.001	.082	.040	.005	.006	.013	.047	.056	.011	.005	.019	.194	.242	.264	.005	.000	.000
	N	252	252	252	252	252	252	251	251	252	252	252	252	252	252	251	252	252	252	252	252

Correlations - 57 variables

		CQ1	CQ2	CQ3	CQ4	CQ5	CQ6	CQ7	CQ8	CQ9	CQ10	CQ11	CQ12	CQ13	CQ14	CQ15	CQ16	CQ17	DQ1	DQ2	DQ3
EQ7	Pearson Correlation	.172**	.076	.216**	.195**	.058	.030	.087	.140*	.123	.179**	.132*	.132*	.224**	.137*	.108	.121	.126*	.088	.278**	.296**
	Sig. (2-tailed)	.006	.227	.001	.002	.359	.635	.171	.026	.052	.004	.037	.036	.000	.029	.089	.055	.046	.162	.000	.000
	N	252	252	252	252	252	252	251	251	252	252	252	252	252	252	251	252	252	252	252	252
EQ8	Pearson Correlation	.176**	.085	.211**	.220**	.107	.109	.101	.069	.116	.169**	.199**	.251**	.159*	.177**	.141*	.066	.094	.147*	.189**	.387**
	Sig. (2-tailed)	.005	.180	.001	.000	.090	.086	.112	.280	.066	.008	.002	.000	.012	.005	.026	.298	.140	.020	.003	.000
	N	250	250	250	250	250	250	249	249	250	250	250	250	250	250	249	250	250	250	250	250
EQ9	Pearson Correlation	.199**	.042	.196**	.164**	.163**	.183**	.217**	.137*	.193**	.196**	.130*	.214**	.216**	.129*	.113	.143*	.128*	.194**	.401**	.241**
	Sig. (2-tailed)	.002	.509	.002	.009	.010	.004	.001	.030	.002	.002	.040	.001	.001	.040	.075	.023	.043	.002	.000	.000
	N	252	252	252	252	252	252	251	251	252	252	252	252	252	252	251	252	252	252	252	252
EQ10	Pearson Correlation	.219**	.052	.208**	.148*	.160*	.170**	.220**	.171**	.192**	.185**	.115	.202**	.211**	.112	.087	.117	.133*	.190**	.393**	.272**
	Sig. (2-tailed)	.000	.410	.001	.019	.011	.007	.000	.006	.002	.003	.068	.001	.001	.076	.169	.063	.035	.002	.000	.000
	N	252	252	252	252	252	252	251	251	252	252	252	252	252	252	251	252	252	252	252	252
EQ11	Pearson Correlation	.140*	.055	.156*	.173**	.110	.051	.073	.138*	.136*	.177**	.104	.136*	.223**	.116	.082	.130*	.103	.048	.218**	.214**
	Sig. (2-tailed)	.026	.388	.013	.006	.082	.417	.250	.029	.031	.005	.100	.031	.000	.066	.198	.039	.104	.444	.000	.001
	N	252	252	252	252	252	252	251	251	252	252	252	252	252	252	251	252	252	252	252	252
EQ12	Pearson Correlation	.144*	.077	.163**	.260**	.104	.114	.103	.114	.127*	.229**	.166**	.188**	.079	.063	.126*	-.012	.065	.099	.125*	.313**
	Sig. (2-tailed)	.023	.225	.010	.000	.099	.071	.103	.072	.043	.000	.008	.003	.209	.319	.046	.853	.301	.117	.047	.000
	N	252	252	252	252	252	252	251	251	252	252	252	252	252	252	251	252	252	252	252	252
EQ13	Pearson Correlation	.171**	.131*	.146*	.201**	.080	.114	.109	.160*	.186**	.098	.106	.153*	.134*	.117	.070	.039	.074	.172**	.409**	.285**
	Sig. (2-tailed)	.007	.038	.021	.001	.208	.071	.085	.011	.003	.121	.095	.015	.034	.066	.270	.541	.243	.006	.000	.000
	N	250	250	250	250	250	250	249	249	250	250	250	250	250	250	249	250	250	250	250	250
EQ14	Pearson Correlation	.146*	.144*	.199**	.175**	.169**	.110	.166**	.148*	.127*	.169**	.187**	.225**	.174**	.099	.072	.074	.128*	.224**	.279**	.248**
	Sig. (2-tailed)	.020	.022	.002	.005	.007	.081	.008	.019	.043	.007	.003	.000	.006	.117	.256	.241	.043	.000	.000	.000
	N	252	252	252	252	252	252	251	251	252	252	252	252	252	252	251	252	252	252	252	252
FQ1	Pearson Correlation	.095	.003	.110	.001	.119	.013	.110	.115	.066	.084	.158*	.177**	.234**	.176**	.147*	.143*	.136*	.138*	.136*	.197**
	Sig. (2-tailed)	.133	.962	.082	.988	.060	.840	.083	.069	.295	.182	.012	.005	.000	.005	.020	.023	.030	.029	.031	.002
	N	252	252	252	252	252	252	251	251	252	252	252	252	252	252	251	252	252	252	252	252
FQ2	Pearson Correlation	.169**	.013	.068	.083	.120	.054	.166**	.096	.051	.080	.096	.223**	.219**	.180**	.153*	.175**	.173**	.199**	.213**	.198**
	Sig. (2-tailed)	.007	.837	.281	.190	.057	.396	.008	.129	.419	.208	.127	.000	.000	.004	.015	.005	.006	.002	.001	.002
	N	252	252	252	252	252	252	251	251	252	252	252	252	252	252	251	252	252	252	252	252
FQ3	Pearson Correlation	.197**	.039	.188**	.101	.130*	.173**	.185**	.154*	.132*	.137*	.193**	.304**	.215**	.232**	.212**	.119	.145*	.190**	.265**	.232**
	Sig. (2-tailed)	.002	.539	.003	.109	.039	.006	.003	.015	.036	.030	.002	.000	.001	.000	.001	.060	.021	.002	.000	.000
	N	252	252	252	252	252	252	251	251	252	252	252	252	252	252	251	252	252	252	252	252
FQ4	Pearson Correlation	-.091	.114	-.079	-.007	-.048	.011	-.084	.021	.027	.028	-.039	-.153*	-.055	-.066	.035	-.064	-.075	-.073	-.109	-.048
	Sig. (2-tailed)	.148	.071	.213	.911	.444	.867	.185	.745	.667	.659	.538	.015	.384	.295	.586	.315	.233	.246	.084	.452
	N	252	252	252	252	252	252	251	251	252	252	252	252	252	252	251	252	252	252	252	252
FQ5	Pearson Correlation	.075	-.046	.033	.099	.052	.075	.025	.161*	-.070	.066	.119	.116	.132*	.100	.003	.089	.054	.073	.104	.012
	Sig. (2-tailed)	.233	.468	.603	.116	.409	.237	.694	.011	.270	.299	.058	.067	.036	.114	.968	.159	.396	.247	.099	.856
	N	252	252	252	252	252	252	251	251	252	252	252	252	252	252	251	252	252	252	252	252
FQ6	Pearson Correlation	.259**	.072	.034	.021	.074	.076	.072	.198**	.101	.006	.085	.100	.161*	.085	.003	.101	.020	.160*	.179**	.064
	Sig. (2-tailed)	.000	.253	.596	.738	.243	.229	.257	.002	.108	.923	.178	.114	.010	.180	.967	.109	.755	.011	.004	.313
	N	252	252	252	252	252	252	251	251	252	252	252	252	252	252	251	252	252	252	252	252
FQ7	Pearson Correlation	.198**	.155*	.200**	.196**	.179**	.178**	.165**	.086	.071	.143*	.171**	.240**	.249**	.118	.095	.139*	.151*	.193**	.206**	.230**
	Sig. (2-tailed)	.002	.014	.001	.002	.004	.005	.009	.173	.261	.023	.006	.000	.000	.062	.132	.027	.016	.002	.001	.000
	N	252	252	252	252	252	252	251	251	252	252	252	252	252	252	251	252	252	252	252	252

Correlations - 57 variables

		CQ1	CQ2	CQ3	CQ4	CQ5	CQ6	CQ7	CQ8	CQ9	CQ10	CQ11	CQ12	CQ13	CQ14	CQ15	CQ16	CQ17	DQ1	DQ2	DQ3
GQ1	Pearson Correlation	.177**	.196**	.086	.139*	.290**	.210**	.366**	.197**	.245**	.215**	.158*	.187**	.217**	.141*	.222**	.188**	.206**	.136*	.164**	.240**
	Sig. (2-tailed)	.005	.002	.172	.027	.000	.001	.000	.002	.000	.001	.012	.003	.001	.025	.000	.003	.001	.031	.009	.000
	N	252	252	252	252	252	252	251	251	252	252	252	252	252	252	251	252	252	252	252	252
GQ2	Pearson Correlation	.327**	.140*	.130*	.199**	.253**	.191**	.296**	.239**	.193**	.330**	.255**	.271**	.293**	.190**	.182**	.215**	.221**	.146*	.265**	.301**
	Sig. (2-tailed)	.000	.026	.039	.002	.000	.002	.000	.000	.002	.000	.000	.000	.000	.003	.004	.001	.000	.020	.000	.000
	N	252	252	252	252	252	252	251	251	252	252	252	252	252	252	251	252	252	252	252	252
GQ3	Pearson Correlation	.020	.031	-.066	-.007	.015	.030	-.013	-.071	.041	-.032	-.038	-.037	-.130*	-.019	.037	-.079	-.088	-.058	-.084	-.020
	Sig. (2-tailed)	.756	.620	.294	.911	.812	.639	.834	.263	.516	.609	.543	.558	.039	.769	.560	.214	.163	.361	.182	.747
	N	252	252	252	252	252	252	251	251	252	252	252	252	252	252	251	252	252	252	252	252
GQ4	Pearson Correlation	.238**	.259**	.066	.218**	.225**	.205**	.279**	.211**	.186**	.315**	.250**	.270**	.270**	.180**	.225**	.231**	.288**	.161*	.248**	.163**
	Sig. (2-tailed)	.000	.000	.295	.001	.000	.001	.000	.001	.003	.000	.000	.000	.000	.004	.000	.000	.000	.011	.000	.009
	N	251	251	251	251	251	251	250	250	251	251	251	251	251	251	250	251	251	251	251	251
GQ5	Pearson Correlation	.141*	.249**	.154*	.059	.148*	.105	.185**	.183**	.122	.305**	.179**	.129*	.161*	.224**	.298**	.189**	.304**	.220**	.229**	.248**
	Sig. (2-tailed)	.025	.000	.014	.350	.019	.099	.003	.004	.053	.000	.005	.042	.010	.000	.000	.003	.000	.000	.000	.000
	N	251	251	251	251	251	251	250	250	251	251	251	251	251	251	250	251	251	251	251	251
GQ6	Pearson Correlation	.055	-.022	.049	.035	.078	.093	.076	.026	-.016	-.139*	-.044	-.050	-.095	-.054	-.094	-.082	-.123	.036	.011	-.053
	Sig. (2-tailed)	.382	.725	.440	.579	.220	.140	.230	.681	.795	.028	.490	.425	.133	.394	.137	.195	.051	.570	.866	.401
	N	252	252	252	252	252	252	251	251	252	252	252	252	252	252	251	252	252	252	252	252
GQ7	Pearson Correlation	.128*	.244**	.125*	.149*	.197**	.170**	.207**	.157*	.141*	.234**	.263**	.262**	.152*	.118	.170**	.225**	.264**	.124*	.231**	.197**
	Sig. (2-tailed)	.043	.000	.047	.018	.002	.007	.001	.013	.025	.000	.000	.000	.015	.062	.007	.000	.000	.049	.000	.002
	N	252	252	252	252	252	252	251	251	252	252	252	252	252	252	251	252	252	252	252	252
GQ8	Pearson Correlation	.162**	.217**	.145*	.218**	.215**	.174**	.195**	.179**	.167**	.166**	.292**	.309**	.213**	.234**	.187**	.232**	.239**	.161*	.300**	.259**
	Sig. (2-tailed)	.010	.001	.021	.001	.001	.006	.002	.004	.008	.008	.000	.000	.001	.000	.003	.000	.000	.011	.000	.000
	N	252	252	252	252	252	252	251	251	252	252	252	252	252	252	251	252	252	252	252	252
GQ9	Pearson Correlation	.144*	.095	.136*	.027	.139*	.130*	.196**	.034	.029	.094	.032	.005	.086	.037	.115	.107	.062	.121	.075	.064
	Sig. (2-tailed)	.023	.134	.031	.670	.028	.039	.002	.594	.650	.139	.614	.931	.174	.560	.068	.091	.325	.055	.233	.309
	N	252	252	252	252	252	252	251	251	252	252	252	252	252	252	251	252	252	252	252	252
GQ10	Pearson Correlation	.148*	.101	.094	.097	.201**	.184**	.186**	.134*	.039	.115	.183**	.198**	.156*	.164**	.143*	.192**	.119	.094	.321**	.284**
	Sig. (2-tailed)	.019	.109	.138	.126	.001	.003	.003	.034	.539	.069	.004	.002	.013	.009	.024	.002	.059	.139	.000	.000
	N	251	251	251	251	251	251	250	250	251	251	251	251	251	251	250	251	251	251	251	251
GQ11	Pearson Correlation	.128*	.084	.107	.113	.209**	.202**	.227**	.095	.079	.138*	.265**	.241**	.223**	.174**	.157*	.208**	.161*	.081	.341**	.324**
	Sig. (2-tailed)	.043	.186	.092	.073	.001	.001	.000	.136	.211	.029	.000	.000	.000	.006	.013	.001	.010	.198	.000	.000
	N	251	251	251	251	251	251	250	250	251	251	251	251	251	251	250	251	251	251	251	251
GQ12	Pearson Correlation	-.031	.001	-.082	-.098	-.079	-.030	-.066	-.004	-.051	-.151*	-.013	-.005	-.085	-.027	-.004	-.037	-.159*	-.035	-.123	-.064
	Sig. (2-tailed)	.626	.986	.196	.123	.215	.632	.297	.953	.420	.017	.842	.937	.182	.672	.944	.557	.012	.578	.052	.311
	N	251	251	251	251	251	251	250	250	251	251	251	251	251	251	250	251	251	251	251	251
REVF Q4	Pearson Correlation	.091	-.114	.079	.007	.048	-.011	.084	-.021	-.027	-.028	.039	.153*	.055	.066	-.035	.064	.075	.073	.109	.048
	Sig. (2-tailed)	.148	.071	.213	.911	.444	.867	.185	.745	.667	.659	.538	.015	.384	.295	.586	.315	.233	.246	.084	.452
	N	252	252	252	252	252	252	251	251	252	252	252	252	252	252	251	252	252	252	252	252
REVG Q6	Pearson Correlation	-.055	.022	-.049	-.035	-.078	-.093	-.076	-.026	.016	.139*	.044	.050	.095	.054	.094	.082	.123	-.036	-.011	.053
	Sig. (2-tailed)	.382	.725	.440	.579	.220	.140	.230	.681	.795	.028	.490	.425	.133	.394	.137	.195	.051	.570	.866	.401
	N	252	252	252	252	252	252	251	251	252	252	252	252	252	252	251	252	252	252	252	252
REVG Q12	Pearson Correlation	.031	-.001	.082	.098	.079	.030	.066	.004	.051	.151*	.013	.005	.085	.027	.004	.037	.159*	.035	.123	.064
	Sig. (2-tailed)	.626	.986	.196	.123	.215	.632	.297	.953	.420	.017	.842	.937	.182	.672	.944	.557	.012	.578	.052	.311
	N	251	251	251	251	251	251	250	250	251	251	251	251	251	251	250	251	251	251	251	251

Correlations - 57 variables

		DQ4	DQ5	DQ6	DQ7	EQ1	EQ2	EQ3	EQ4	EQ5	EQ6	EQ7	EQ8	EQ9	EQ10	EQ11	EQ12	EQ13	EQ14	FQ1	FQ2
CQ1	Pearson Correlation	.205**	.199**	.155*	.034	.228**	.240**	.202**	.197**	.130*	.176**	.172**	.176**	.199**	.219**	.140*	.144*	.171**	.146*	.095	.169**
	Sig. (2-tailed)	.001	.002	.014	.589	.000	.000	.001	.002	.039	.005	.006	.005	.002	.000	.026	.023	.007	.020	.133	.007
	N	252	251	252	252	252	252	252	252	252	252	252	250	252	252	252	252	250	252	252	252
CQ2	Pearson Correlation	.004	.173**	.138*	.057	.074	.118	.127*	.144*	.039	.012	.076	.085	.042	.052	.055	.077	.131*	.144*	.003	.013
	Sig. (2-tailed)	.954	.006	.028	.364	.243	.062	.044	.022	.536	.849	.227	.180	.509	.410	.388	.225	.038	.022	.962	.837
	N	252	251	252	252	252	252	252	252	252	252	252	250	252	252	252	252	250	252	252	252
CQ3	Pearson Correlation	.134*	.164**	.144*	.019	.145*	.159*	.210**	.198**	.185**	.133*	.216**	.211**	.196**	.208**	.156*	.163**	.146*	.199**	.110	.068
	Sig. (2-tailed)	.034	.009	.022	.759	.022	.012	.001	.002	.003	.035	.001	.001	.002	.001	.013	.010	.021	.002	.082	.281
	N	252	251	252	252	252	252	252	252	252	252	252	250	252	252	252	252	250	252	252	252
CQ4	Pearson Correlation	.090	.124	.077	.100	.131*	.195**	.154*	.240**	.179**	.200**	.195**	.220**	.164**	.148*	.173**	.260**	.201**	.175**	.001	.083
	Sig. (2-tailed)	.153	.050	.223	.112	.038	.002	.014	.000	.004	.001	.002	.000	.009	.019	.006	.000	.001	.005	.988	.190
	N	252	251	252	252	252	252	252	252	252	252	252	250	252	252	252	252	250	252	252	252
CQ5	Pearson Correlation	.021	.109	.154*	.102	.133*	.132*	.083	.114	.147*	.110	.058	.107	.163**	.160*	.110	.104	.080	.169**	.119	.120
	Sig. (2-tailed)	.744	.083	.015	.106	.035	.037	.190	.070	.020	.082	.359	.090	.010	.011	.082	.099	.208	.007	.060	.057
	N	252	251	252	252	252	252	252	252	252	252	252	250	252	252	252	252	250	252	252	252
CQ6	Pearson Correlation	.124*	.057	.129*	.014	.148*	.144*	.066	.083	.215**	.130*	.030	.109	.183**	.170**	.051	.114	.114	.110	.013	.054
	Sig. (2-tailed)	.049	.368	.041	.827	.019	.022	.296	.188	.001	.040	.635	.086	.004	.007	.417	.071	.071	.081	.840	.396
	N	252	251	252	252	252	252	252	252	252	252	252	250	252	252	252	252	250	252	252	252
CQ7	Pearson Correlation	.182**	.184**	.216**	.119	.219**	.217**	.143*	.109	.172**	.177**	.087	.101	.217**	.220**	.073	.103	.109	.166**	.110	.166**
	Sig. (2-tailed)	.004	.004	.001	.059	.000	.001	.024	.085	.006	.005	.171	.112	.001	.000	.250	.103	.085	.008	.083	.008
	N	251	250	251	251	251	251	251	251	251	251	251	249	251	251	251	251	249	251	251	251
CQ8	Pearson Correlation	.184**	.176**	.191**	.034	.160*	.187**	.042	.081	.157*	.173**	.140*	.069	.137*	.171**	.138*	.114	.160*	.148*	.115	.096
	Sig. (2-tailed)	.004	.005	.002	.591	.011	.003	.503	.201	.013	.006	.026	.280	.030	.006	.029	.072	.011	.019	.069	.129
	N	251	250	251	251	251	251	251	251	251	251	251	249	251	251	251	251	249	251	251	251
CQ9	Pearson Correlation	.162*	.093	.099	-.006	.086	.071	.081	.116	.142*	.156*	.123	.116	.193**	.192**	.136*	.127*	.186**	.127*	.066	.051
	Sig. (2-tailed)	.010	.143	.117	.927	.174	.260	.197	.065	.024	.013	.052	.066	.002	.002	.031	.043	.003	.043	.295	.419
	N	252	251	252	252	252	252	252	252	252	252	252	250	252	252	252	252	250	252	252	252
CQ10	Pearson Correlation	.030	.139*	.113	.069	.117	.198**	.179**	.232**	.124*	.125*	.179**	.169**	.196**	.185**	.177**	.229**	.098	.169**	.084	.080
	Sig. (2-tailed)	.635	.028	.073	.274	.064	.002	.004	.000	.049	.047	.004	.008	.002	.003	.005	.000	.121	.007	.182	.208
	N	252	251	252	252	252	252	252	252	252	252	252	250	252	252	252	252	250	252	252	252
CQ11	Pearson Correlation	.284**	.079	.097	.119	.151*	.169**	.136*	.211**	.123	.121	.132*	.199**	.130*	.115	.104	.166**	.106	.187**	.158*	.096
	Sig. (2-tailed)	.000	.211	.125	.059	.016	.007	.030	.001	.050	.056	.037	.002	.040	.068	.100	.008	.095	.003	.012	.127
	N	252	251	252	252	252	252	252	252	252	252	252	250	252	252	252	252	250	252	252	252
CQ12	Pearson Correlation	.353**	.044	.034	.054	.215**	.218**	.186**	.252**	.140*	.159*	.132*	.251**	.214**	.202**	.136*	.188**	.153*	.225**	.177**	.223**
	Sig. (2-tailed)	.000	.485	.588	.392	.001	.000	.003	.000	.026	.011	.036	.000	.001	.001	.031	.003	.015	.000	.005	.000
	N	252	251	252	252	252	252	252	252	252	252	252	250	252	252	252	252	250	252	252	252
CQ13	Pearson Correlation	.190**	.199**	.156*	.151*	.291**	.237**	.197**	.166**	.154*	.177**	.224**	.159*	.216**	.211**	.223**	.079	.134*	.174**	.234**	.219**
	Sig. (2-tailed)	.002	.002	.013	.016	.000	.000	.002	.008	.015	.005	.000	.012	.001	.001	.000	.209	.034	.006	.000	.000
	N	252	251	252	252	252	252	252	252	252	252	252	250	252	252	252	252	250	252	252	252
CQ14	Pearson Correlation	.164**	.090	.060	.022	.154*	.182**	.210**	.177**	.161*	.148*	.137*	.177**	.129*	.112	.116	.063	.117	.099	.176**	.180**
	Sig. (2-tailed)	.009	.156	.342	.724	.015	.004	.001	.005	.010	.019	.029	.005	.040	.076	.066	.319	.066	.117	.005	.004
	N	252	251	252	252	252	252	252	252	252	252	252	250	252	252	252	252	250	252	252	252
CQ15	Pearson Correlation	.060	.118	.068	-.007	.129*	.182**	.170**	.230**	.097	.082	.108	.141*	.113	.087	.082	.126*	.070	.072	.147*	.153*
	Sig. (2-tailed)	.347	.063	.283	.917	.042	.004	.007	.000	.126	.194	.089	.026	.075	.169	.198	.046	.270	.256	.020	.015
	N	251	250	251	251	251	251	251	251	251	251	251	249	251	251	251	251	249	251	251	251

Correlations - 57 variables

		DQ4	DQ5	DQ6	DQ7	EQ1	EQ2	EQ3	EQ4	EQ5	EQ6	EQ7	EQ8	EQ9	EQ10	EQ11	EQ12	EQ13	EQ14	FQ1	FQ2
CQ16	Pearson Correlation	-.025	.203**	.216**	.134*	.147*	.169**	.145*	.083	.050	.074	.121	.066	.143*	.117	.130*	-.012	.039	.074	.143*	.175**
	Sig. (2-tailed)	.694	.001	.001	.033	.020	.007	.021	.187	.429	.242	.055	.298	.023	.063	.039	.853	.541	.241	.023	.005
	N	252	251	252	252	252	252	252	252	252	252	252	250	252	252	252	252	250	252	252	252
CQ17	Pearson Correlation	.091	.175**	.179**	.143*	.154*	.193**	.183**	.206**	.056	.071	.126*	.094	.128*	.133*	.103	.065	.074	.128*	.136*	.173**
	Sig. (2-tailed)	.150	.006	.004	.023	.014	.002	.004	.001	.379	.264	.046	.140	.043	.035	.104	.301	.243	.043	.030	.006
	N	252	251	252	252	252	252	252	252	252	252	252	250	252	252	252	252	250	252	252	252
DQ1	Pearson Correlation	.473**	.116	.093	.098	.289**	.249**	.193**	.161*	.200**	.176**	.088	.147*	.194**	.190**	.048	.099	.172**	.224**	.138*	.199**
	Sig. (2-tailed)	.000	.067	.140	.122	.000	.000	.002	.010	.001	.005	.162	.020	.002	.002	.444	.117	.006	.000	.029	.002
	N	252	251	252	252	252	252	252	252	252	252	252	250	252	252	252	252	250	252	252	252
DQ2	Pearson Correlation	.657**	.301**	.286**	.237**	.481**	.459**	.328**	.235**	.404**	.436**	.278**	.189**	.401**	.393**	.218**	.125*	.409**	.279**	.136*	.213**
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.003	.000	.000	.000	.047	.000	.000	.031	.001
	N	252	251	252	252	252	252	252	252	252	252	252	250	252	252	252	252	250	252	252	252
DQ3	Pearson Correlation	.539**	.102	.087	.114	.426**	.385**	.295**	.411**	.225**	.292**	.296**	.387**	.241**	.272**	.214**	.313**	.285**	.248**	.197**	.198**
	Sig. (2-tailed)	.000	.105	.167	.070	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.001	.000	.000	.000	.002	.002
	N	252	251	252	252	252	252	252	252	252	252	252	250	252	252	252	252	250	252	252	252
DQ4	Pearson Correlation	1.000	.182**	.250**	.187**	.479**	.507**	.335**	.314**	.404**	.426**	.273**	.281**	.434**	.432**	.209**	.210**	.444**	.259**	.106	.179**
	Sig. (2-tailed)	.	.004	.000	.003	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.001	.001	.000	.000	.092	.004
	N	252	251	252	252	252	252	252	252	252	252	252	250	252	252	252	252	250	252	252	252
DQ5	Pearson Correlation	.182**	1.000	.821**	.522**	.312**	.352**	.276**	.126*	.251**	.344**	.219**	.090	.230**	.284**	.227**	.061	.294**	.149*	.226**	.219**
	Sig. (2-tailed)	.004	.	.000	.000	.000	.000	.000	.046	.000	.000	.000	.155	.000	.000	.000	.336	.000	.018	.000	.000
	N	251	251	251	251	251	251	251	251	251	251	251	249	251	251	251	251	249	251	251	251
DQ6	Pearson Correlation	.250**	.821**	1.000	.580**	.333**	.417**	.300**	.128*	.312**	.368**	.236**	.069	.291**	.369**	.294**	.081	.361**	.165**	.191**	.179**
	Sig. (2-tailed)	.000	.000	.	.000	.000	.000	.000	.042	.000	.000	.000	.275	.000	.000	.000	.198	.000	.009	.002	.004
	N	252	251	252	252	252	252	252	252	252	252	252	250	252	252	252	252	250	252	252	252
DQ7	Pearson Correlation	.187**	.522**	.580**	1.000	.140*	.188**	.273**	.206**	.181**	.169**	.272**	.033	.146*	.155*	.206**	-.015	.227**	.074	.083	.042
	Sig. (2-tailed)	.003	.000	.000	.	.026	.003	.000	.001	.004	.007	.000	.601	.020	.014	.001	.808	.000	.244	.188	.507
	N	252	251	252	252	252	252	252	252	252	252	252	250	252	252	252	252	250	252	252	252
EQ1	Pearson Correlation	.479**	.312**	.333**	.140*	1.000	.790**	.448**	.329**	.502**	.466**	.277**	.294**	.481**	.474**	.305**	.224**	.380**	.240**	.194**	.237**
	Sig. (2-tailed)	.000	.000	.000	.026	.	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.002	.000
	N	252	251	252	252	252	252	252	252	252	252	252	250	252	252	252	252	250	252	252	252
EQ2	Pearson Correlation	.507**	.352**	.417**	.188**	.790**	1.000	.544**	.403**	.514**	.553**	.340**	.345**	.525**	.589**	.424**	.304**	.507**	.250**	.247**	.269**
	Sig. (2-tailed)	.000	.000	.000	.003	.000	.	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
	N	252	251	252	252	252	252	252	252	252	252	252	250	252	252	252	252	250	252	252	252
EQ3	Pearson Correlation	.335**	.276**	.300**	.273**	.448**	.544**	1.000	.478**	.386**	.376**	.542**	.314**	.422**	.429**	.535**	.258**	.450**	.216**	.052	.098
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000	.	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.001	.412	.119
	N	252	251	252	252	252	252	252	252	252	252	252	250	252	252	252	252	250	252	252	252
EQ4	Pearson Correlation	.314**	.126*	.128*	.206**	.329**	.403**	.478**	1.000	.374**	.342**	.438**	.688**	.396**	.380**	.395**	.669**	.379**	.311**	.195**	.130*
	Sig. (2-tailed)	.000	.046	.042	.001	.000	.000	.000	.	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.002	.039
	N	252	251	252	252	252	252	252	252	252	252	252	250	252	252	252	252	250	252	252	252
EQ5	Pearson Correlation	.404**	.251**	.312**	.181**	.502**	.514**	.386**	.374**	1.000	.798**	.582**	.507**	.562**	.541**	.477**	.390**	.557**	.394**	.160*	.226**
	Sig. (2-tailed)	.000	.000	.000	.004	.000	.000	.000	.000	.	.000	.000	.000	.000	.000	.000	.000	.000	.000	.011	.000
	N	252	251	252	252	252	252	252	252	252	252	252	250	252	252	252	252	250	252	252	252
EQ6	Pearson Correlation	.426**	.344**	.368**	.169**	.466**	.553**	.376**	.342**	.798**	1.000	.639**	.484**	.545**	.600**	.488**	.363**	.594**	.369**	.183**	.276**
	Sig. (2-tailed)	.000	.000	.000	.007	.000	.000	.000	.000	.000	.	.000	.000	.000	.000	.000	.000	.000	.000	.004	.000
	N	252	251	252	252	252	252	252	252	252	252	252	250	252	252	252	252	250	252	252	252

Correlations - 57 variables

		DQ4	DQ5	DQ6	DQ7	EQ1	EQ2	EQ3	EQ4	EQ5	EQ6	EQ7	EQ8	EQ9	EQ10	EQ11	EQ12	EQ13	EQ14	FQ1	FQ2
EQ7	Pearson Correlation	.273**	.219**	.236**	.272**	.277**	.340**	.542**	.438**	.582**	.639**	1.000	.507**	.448**	.467**	.625**	.428**	.538**	.312**	.081	.126*
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.	.000	.000	.000	.000	.000	.000	.000	.201	.047
	N	252	251	252	252	252	252	252	252	252	252	252	250	252	252	252	252	250	252	252	252
EQ8	Pearson Correlation	.281**	.090	.069	.033	.294**	.345**	.314**	.688**	.507**	.484**	.507**	1.000	.406**	.383**	.371**	.721**	.379**	.379**	.210**	.252**
	Sig. (2-tailed)	.000	.155	.275	.601	.000	.000	.000	.000	.000	.000	.000	.	.000	.000	.000	.000	.000	.000	.001	.000
	N	250	249	250	250	250	250	250	250	250	250	250	250	250	250	250	250	248	250	250	250
EQ9	Pearson Correlation	.434**	.230**	.291**	.146*	.481**	.525**	.422**	.396**	.562**	.545**	.448**	.406**	1.000	.848**	.633**	.391**	.538**	.233**	.082	.179**
	Sig. (2-tailed)	.000	.000	.000	.020	.000	.000	.000	.000	.000	.000	.000	.000	.	.000	.000	.000	.000	.000	.197	.004
	N	252	251	252	252	252	252	252	252	252	252	252	250	252	252	252	252	250	252	252	252
EQ10	Pearson Correlation	.432**	.284**	.369**	.155*	.474**	.589**	.429**	.380**	.541**	.600**	.467**	.383**	.848**	1.000	.668**	.383**	.578**	.245**	.162*	.238**
	Sig. (2-tailed)	.000	.000	.000	.014	.000	.000	.000	.000	.000	.000	.000	.000	.000	.	.000	.000	.000	.000	.010	.000
	N	252	251	252	252	252	252	252	252	252	252	252	250	252	252	252	252	250	252	252	252
EQ11	Pearson Correlation	.209**	.227**	.294**	.206**	.305**	.424**	.535**	.395**	.477**	.488**	.625**	.371**	.633**	.668**	1.000	.450**	.543**	.225**	.130*	.151*
	Sig. (2-tailed)	.001	.000	.000	.001	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.	.000	.000	.000	.039	.017
	N	252	251	252	252	252	252	252	252	252	252	252	250	252	252	252	252	250	252	252	252
EQ12	Pearson Correlation	.210**	.061	.081	-.015	.224**	.304**	.258**	.669**	.390**	.363**	.428**	.721**	.391**	.383**	.450**	1.000	.369**	.313**	.181**	.186**
	Sig. (2-tailed)	.001	.336	.198	.808	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.	.000	.000	.004	.003
	N	252	251	252	252	252	252	252	252	252	252	252	250	252	252	252	252	250	252	252	252
EQ13	Pearson Correlation	.444**	.294**	.361**	.227**	.380**	.507**	.450**	.379**	.557**	.594**	.538**	.379**	.538**	.578**	.543**	.369**	1.000	.393**	.136*	.197**
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.	.000	.032	.002
	N	250	249	250	250	250	250	250	250	250	250	250	248	250	250	250	250	250	250	250	250
EQ14	Pearson Correlation	.259**	.149*	.165**	.074	.240**	.250**	.216**	.311**	.394**	.369**	.312**	.379**	.233**	.245**	.225**	.313**	.393**	1.000	.264**	.264**
	Sig. (2-tailed)	.000	.018	.009	.244	.000	.000	.001	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.	.000	.000
	N	252	251	252	252	252	252	252	252	252	252	252	250	252	252	252	252	250	252	252	252
FQ1	Pearson Correlation	.106	.226**	.191**	.083	.194**	.247**	.052	.195**	.160*	.183**	.081	.210**	.082	.162*	.130*	.181**	.136*	.264**	1.000	.753**
	Sig. (2-tailed)	.092	.000	.002	.188	.002	.000	.412	.002	.011	.004	.201	.001	.197	.010	.039	.004	.032	.000	.	.000
	N	252	251	252	252	252	252	252	252	252	252	252	250	252	252	252	252	250	252	252	252
FQ2	Pearson Correlation	.179**	.219**	.179**	.042	.237**	.269**	.098	.130*	.226**	.276**	.126*	.252**	.179**	.238**	.151*	.186**	.197**	.264**	.753**	1.000
	Sig. (2-tailed)	.004	.000	.004	.507	.000	.000	.119	.039	.000	.000	.047	.000	.004	.000	.017	.003	.002	.000	.000	.
	N	252	251	252	252	252	252	252	252	252	252	252	250	252	252	252	252	250	252	252	252
FQ3	Pearson Correlation	.248**	.230**	.218**	.055	.256**	.327**	.201**	.208**	.315**	.355**	.202**	.297**	.252**	.328**	.223**	.209**	.305**	.280**	.618**	.811**
	Sig. (2-tailed)	.000	.000	.001	.383	.000	.000	.001	.001	.000	.000	.001	.000	.000	.000	.000	.001	.000	.000	.000	.000
	N	252	251	252	252	252	252	252	252	252	252	252	250	252	252	252	252	250	252	252	252
FQ4	Pearson Correlation	-.072	-.113	-.153*	-.058	-.119	-.126*	-.082	.084	-.056	-.099	.053	.057	-.132*	-.117	-.072	.129*	-.116	-.013	-.205**	-.359**
	Sig. (2-tailed)	.256	.074	.015	.357	.059	.045	.192	.183	.379	.115	.406	.368	.036	.063	.256	.041	.067	.841	.001	.000
	N	252	251	252	252	252	252	252	252	252	252	252	250	252	252	252	252	250	252	252	252
FQ5	Pearson Correlation	.038	.211**	.165**	.170**	.128*	.133*	.000	.013	.158*	.133*	.019	.086	-.007	.050	.065	.071	.017	.054	.144*	.223**
	Sig. (2-tailed)	.544	.001	.009	.007	.042	.035	.997	.838	.012	.035	.761	.174	.907	.434	.305	.262	.789	.394	.022	.000
	N	252	251	252	252	252	252	252	252	252	252	252	250	252	252	252	252	250	252	252	252
FQ6	Pearson Correlation	.167**	.155*	.195**	.158*	.134*	.192**	.073	.053	.159*	.190**	.049	-.004	.094	.156*	.119	-.010	.102	.004	.138*	.175**
	Sig. (2-tailed)	.008	.014	.002	.012	.033	.002	.247	.398	.012	.002	.439	.956	.137	.013	.059	.875	.108	.947	.029	.005
	N	252	251	252	252	252	252	252	252	252	252	252	250	252	252	252	252	250	252	252	252
FQ7	Pearson Correlation	.201**	.168**	.173**	.135*	.277**	.246**	.138*	.232**	.281**	.232**	.161*	.310**	.230**	.257**	.185**	.235**	.273**	.265**	.333**	.388**
	Sig. (2-tailed)	.001	.008	.006	.032	.000	.000	.028	.000	.000	.000	.010	.000	.000	.000	.003	.000	.000	.000	.000	.000
	N	252	251	252	252	252	252	252	252	252	252	252	250	252	252	252	252	250	252	252	252

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		DQ4	DQ5	DQ6	DQ7	EQ1	EQ2	EQ3	EQ4	EQ5	EQ6	EQ7	EQ8	EQ9	EQ10	EQ11	EQ12	EQ13	EQ14	FQ1	FQ2
GQ1	Pearson Correlation	.216**	.066	.062	.052	.234**	.230**	.275**	.320**	.120	.120	.162**	.210**	.202**	.221**	.153*	.210**	.100	.082	.115	.149*
	Sig. (2-tailed)	.001	.300	.330	.410	.000	.000	.000	.000	.057	.056	.010	.001	.001	.000	.015	.001	.113	.193	.067	.018
	N	252	251	252	252	252	252	252	252	252	252	252	250	252	252	252	252	250	252	252	252
GQ2	Pearson Correlation	.242**	.155*	.165**	.061	.330**	.300**	.215**	.316**	.211**	.294**	.216**	.248**	.258**	.273**	.254**	.225**	.220**	.141*	.188**	.240**
	Sig. (2-tailed)	.000	.014	.009	.337	.000	.000	.001	.000	.001	.000	.001	.000	.000	.000	.000	.000	.000	.026	.003	.000
	N	252	251	252	252	252	252	252	252	252	252	252	250	252	252	252	252	250	252	252	252
GQ3	Pearson Correlation	-.099	-.147*	-.182**	-.232**	-.077	-.095	-.070	-.111	-.026	-.046	-.068	-.067	-.042	-.027	-.058	-.016	-.003	.059	-.076	-.047
	Sig. (2-tailed)	.116	.020	.004	.000	.226	.132	.271	.080	.682	.467	.283	.290	.507	.672	.362	.796	.966	.353	.231	.457
	N	252	251	252	252	252	252	252	252	252	252	252	250	252	252	252	252	250	252	252	252
GQ4	Pearson Correlation	.232**	.289**	.318**	.192**	.226**	.305**	.259**	.211**	.191**	.260**	.198**	.177**	.260**	.287**	.246**	.197**	.294**	.109	.190**	.229**
	Sig. (2-tailed)	.000	.000	.000	.002	.000	.000	.000	.001	.002	.000	.002	.005	.000	.000	.000	.002	.000	.084	.003	.000
	N	251	250	251	251	251	251	251	251	251	251	251	249	251	251	251	251	249	251	251	251
GQ5	Pearson Correlation	.180**	.103	.144*	-.010	.271**	.250**	.199**	.238**	.156*	.147*	.148*	.195**	.135*	.157*	.138*	.239**	.158*	.188**	.197**	.182**
	Sig. (2-tailed)	.004	.104	.022	.870	.000	.000	.002	.000	.014	.020	.019	.002	.032	.013	.029	.000	.013	.003	.002	.004
	N	251	250	251	251	251	251	251	251	251	251	251	249	251	251	251	251	249	251	251	251
GQ6	Pearson Correlation	.011	.034	.001	-.039	.040	.030	-.063	-.041	.099	.095	-.001	.004	.014	-.031	-.115	-.033	-.035	-.021	-.149*	-.144*
	Sig. (2-tailed)	.863	.594	.985	.538	.527	.638	.320	.521	.116	.133	.992	.948	.819	.622	.069	.606	.586	.746	.018	.023
	N	252	251	252	252	252	252	252	252	252	252	252	250	252	252	252	252	250	252	252	252
GQ7	Pearson Correlation	.200**	.183**	.277**	.152*	.233**	.272**	.185**	.199**	.105	.142*	.054	.135*	.188**	.201**	.146*	.144*	.208**	.216**	.151*	.211**
	Sig. (2-tailed)	.001	.004	.000	.016	.000	.000	.003	.001	.095	.024	.398	.032	.003	.001	.020	.022	.001	.001	.017	.001
	N	252	251	252	252	252	252	252	252	252	252	252	250	252	252	252	252	250	252	252	252
GQ8	Pearson Correlation	.278**	.264**	.316**	.165**	.282**	.350**	.186**	.182**	.201**	.253**	.115	.178**	.236**	.255**	.231**	.126*	.308**	.239**	.170**	.272**
	Sig. (2-tailed)	.000	.000	.000	.009	.000	.000	.003	.004	.001	.000	.068	.005	.000	.000	.000	.046	.000	.000	.007	.000
	N	252	251	252	252	252	252	252	252	252	252	252	250	252	252	252	252	250	252	252	252
GQ9	Pearson Correlation	.163**	.204**	.109	.006	.183**	.177**	.169**	.209**	.113	.044	.075	.153*	.160*	.171**	.094	.175**	.108	-.003	.065	-.003
	Sig. (2-tailed)	.010	.001	.083	.924	.004	.005	.007	.001	.075	.487	.235	.015	.011	.007	.137	.005	.088	.966	.304	.962
	N	252	251	252	252	252	252	252	252	252	252	252	250	252	252	252	252	250	252	252	252
GQ10	Pearson Correlation	.291**	.222**	.299**	.197**	.379**	.450**	.227**	.223**	.264**	.274**	.149*	.179**	.260**	.292**	.212**	.167**	.342**	.126*	.231**	.249**
	Sig. (2-tailed)	.000	.000	.000	.002	.000	.000	.000	.000	.000	.000	.019	.005	.000	.000	.001	.008	.000	.046	.000	.000
	N	251	250	251	251	251	251	251	251	251	251	251	249	251	251	251	251	249	251	251	251
GQ11	Pearson Correlation	.333**	.220**	.300**	.236**	.390**	.450**	.252**	.265**	.292**	.371**	.209**	.230**	.272**	.296**	.265**	.203**	.385**	.181**	.234**	.272**
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.001	.000	.000	.000	.000	.001	.000	.004	.000	.000
	N	251	250	251	251	251	251	251	251	251	251	251	249	251	251	251	251	249	251	251	251
GQ12	Pearson Correlation	-.038	-.030	-.115	-.064	-.147*	-.131*	-.164**	-.115	-.115	-.179**	-.176**	-.091	-.166**	-.227**	-.159*	-.145*	-.113	-.033	-.072	-.095
	Sig. (2-tailed)	.549	.635	.069	.310	.020	.037	.009	.068	.069	.004	.005	.153	.008	.000	.012	.021	.075	.598	.258	.132
	N	251	250	251	251	251	251	251	251	251	251	251	249	251	251	251	251	249	251	251	251
REVF Q4	Pearson Correlation	.072	.113	.153*	.058	.119	.126*	.082	-.084	.056	.099	-.053	-.057	.132*	.117	.072	-.129*	.116	.013	.205**	.359**
	Sig. (2-tailed)	.256	.074	.015	.357	.059	.045	.192	.183	.379	.115	.406	.368	.036	.063	.256	.041	.067	.841	.001	.000
	N	252	251	252	252	252	252	252	252	252	252	252	250	252	252	252	252	250	252	252	252
REVG Q6	Pearson Correlation	-.011	-.034	-.001	.039	-.040	-.030	.063	.041	-.099	-.095	.001	-.004	-.014	.031	.115	.033	.035	.021	.149*	.144*
	Sig. (2-tailed)	.863	.594	.985	.538	.527	.638	.320	.521	.116	.133	.992	.948	.819	.622	.069	.606	.586	.746	.018	.023
	N	252	251	252	252	252	252	252	252	252	252	252	250	252	252	252	252	250	252	252	252
REVG Q12	Pearson Correlation	.038	.030	.115	.064	.147*	.131*	.164**	.115	.115	.179**	.176**	.091	.166**	.227**	.159*	.145*	.113	.033	.072	.095
	Sig. (2-tailed)	.549	.635	.069	.310	.020	.037	.009	.068	.069	.004	.005	.153	.008	.000	.012	.021	.075	.598	.258	.132
	N	251	250	251	251	251	251	251	251	251	251	251	249	251	251	251	251	249	251	251	251

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		FQ3	FQ4	FQ5	FQ6	FQ7	GQ1	GQ2	GQ3	GQ4	GQ5	GQ6	GQ7	GQ8	GQ9	GQ10	GQ11	GQ12	REVFQ4
CQ1	Pearson Correlation	.197**	-.091	.075	.259**	.198**	.177**	.327**	.020	.238**	.141*	.055	.128*	.162**	.144*	.148*	.128*	-.031	.091
	Sig. (2-tailed)	.002	.148	.233	.000	.002	.005	.000	.756	.000	.025	.382	.043	.010	.023	.019	.043	.626	.148
	N	252	252	252	252	252	252	252	252	251	251	252	252	252	252	251	251	251	252
CQ2	Pearson Correlation	.039	.114	-.046	.072	.155*	.196**	.140*	.031	.259**	.249**	-.022	.244**	.217**	.095	.101	.084	.001	-.114
	Sig. (2-tailed)	.539	.071	.468	.253	.014	.002	.026	.620	.000	.000	.725	.000	.001	.134	.109	.186	.986	.071
	N	252	252	252	252	252	252	252	252	251	251	252	252	252	252	251	251	251	252
CQ3	Pearson Correlation	.188**	-.079	.033	.034	.200**	.086	.130*	-.066	.066	.154*	.049	.125*	.145*	.136*	.094	.107	-.082	.079
	Sig. (2-tailed)	.003	.213	.603	.596	.001	.172	.039	.294	.295	.014	.440	.047	.021	.031	.138	.092	.196	.213
	N	252	252	252	252	252	252	252	252	251	251	252	252	252	252	251	251	251	252
CQ4	Pearson Correlation	.101	-.007	.099	.021	.196**	.139*	.199**	-.007	.218**	.059	.035	.149*	.218**	.027	.097	.113	-.098	.007
	Sig. (2-tailed)	.109	.911	.116	.738	.002	.027	.002	.911	.001	.350	.579	.018	.001	.670	.126	.073	.123	.911
	N	252	252	252	252	252	252	252	252	251	251	252	252	252	252	251	251	251	252
CQ5	Pearson Correlation	.130*	-.048	.052	.074	.179**	.290**	.253**	.015	.225**	.148*	.078	.197**	.215**	.139*	.201**	.209**	-.079	.048
	Sig. (2-tailed)	.039	.444	.409	.243	.004	.000	.000	.812	.000	.019	.220	.002	.001	.028	.001	.001	.215	.444
	N	252	252	252	252	252	252	252	252	251	251	252	252	252	252	251	251	251	252
CQ6	Pearson Correlation	.173**	.011	.075	.076	.178**	.210**	.191**	.030	.205**	.105	.093	.170**	.174**	.130*	.184**	.202**	-.030	-.011
	Sig. (2-tailed)	.006	.867	.237	.229	.005	.001	.002	.639	.001	.099	.140	.007	.006	.039	.003	.001	.632	.867
	N	252	252	252	252	252	252	252	252	251	251	252	252	252	252	251	251	251	252
CQ7	Pearson Correlation	.185**	-.084	.025	.072	.165**	.366**	.296**	-.013	.279**	.185**	.076	.207**	.195**	.196**	.186**	.227**	-.066	.084
	Sig. (2-tailed)	.003	.185	.694	.257	.009	.000	.000	.834	.000	.003	.230	.001	.002	.002	.003	.000	.297	.185
	N	251	251	251	251	251	251	251	251	250	250	251	251	251	251	250	250	250	251
CQ8	Pearson Correlation	.154*	.021	.161*	.198**	.086	.197**	.239**	-.071	.211**	.183**	.026	.157*	.179**	.034	.134*	.095	-.004	-.021
	Sig. (2-tailed)	.015	.745	.011	.002	.173	.002	.000	.263	.001	.004	.681	.013	.004	.594	.034	.136	.953	.745
	N	251	251	251	251	251	251	251	251	250	250	251	251	251	251	250	250	250	251
CQ9	Pearson Correlation	.132*	.027	-.070	.101	.071	.245**	.193**	.041	.186**	.122	-.016	.141*	.167**	.029	.039	.079	-.051	-.027
	Sig. (2-tailed)	.036	.667	.270	.108	.261	.000	.002	.516	.003	.053	.795	.025	.008	.650	.539	.211	.420	.667
	N	252	252	252	252	252	252	252	252	251	251	252	252	252	252	251	251	251	252
CQ10	Pearson Correlation	.137*	.028	.066	.006	.143*	.215**	.330**	-.032	.315**	.305**	-.139*	.234**	.166**	.094	.115	.138*	-.151*	-.028
	Sig. (2-tailed)	.030	.659	.299	.923	.023	.001	.000	.609	.000	.000	.028	.000	.008	.139	.069	.029	.017	.659
	N	252	252	252	252	252	252	252	252	251	251	252	252	252	252	251	251	251	252
CQ11	Pearson Correlation	.193**	-.039	.119	.085	.171**	.158*	.255**	-.038	.250**	.179**	-.044	.263**	.292**	.032	.183**	.265**	-.013	.039
	Sig. (2-tailed)	.002	.538	.058	.178	.006	.012	.000	.543	.000	.005	.490	.000	.000	.614	.004	.000	.842	.538
	N	252	252	252	252	252	252	252	252	251	251	252	252	252	252	251	251	251	252
CQ12	Pearson Correlation	.304**	-.153*	.116	.100	.240**	.187**	.271**	-.037	.270**	.129*	-.050	.262**	.309**	.005	.198**	.241**	-.005	.153*
	Sig. (2-tailed)	.000	.015	.067	.114	.000	.003	.000	.558	.000	.042	.425	.000	.000	.931	.002	.000	.937	.015
	N	252	252	252	252	252	252	252	252	251	251	252	252	252	252	251	251	251	252
CQ13	Pearson Correlation	.215**	-.055	.132*	.161*	.249**	.217**	.293**	-.130*	.270**	.161*	-.095	.152*	.213**	.086	.156*	.223**	-.085	.055
	Sig. (2-tailed)	.001	.384	.036	.010	.000	.001	.000	.039	.000	.010	.133	.015	.001	.174	.013	.000	.182	.384
	N	252	252	252	252	252	252	252	252	251	251	252	252	252	252	251	251	251	252
CQ14	Pearson Correlation	.232**	-.066	.100	.085	.118	.141*	.190**	-.019	.180**	.224**	-.054	.118	.234**	.037	.164**	.174**	-.027	.066
	Sig. (2-tailed)	.000	.295	.114	.180	.062	.025	.003	.769	.004	.000	.394	.062	.000	.560	.009	.006	.672	.295
	N	252	252	252	252	252	252	252	252	251	251	252	252	252	252	251	251	251	252
CQ15	Pearson Correlation	.212**	.035	.003	.003	.095	.222**	.182**	.037	.225**	.298**	-.094	.170**	.187**	.115	.143*	.157*	-.004	-.035
	Sig. (2-tailed)	.001	.586	.968	.967	.132	.000	.004	.560	.000	.000	.137	.007	.003	.068	.024	.013	.944	.586
	N	251	251	251	251	251	251	251	251	250	250	251	251	251	251	250	250	250	251

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		FQ3	FQ4	FQ5	FQ6	FQ7	GQ1	GQ2	GQ3	GQ4	GQ5	GQ6	GQ7	GQ8	GQ9	GQ10	GQ11	GQ12	REVFQ4
CQ16	Pearson Correlation	.119	-.064	.089	.101	.139*	.188**	.215**	-.079	.231**	.189**	-.082	.225**	.232**	.107	.192**	.208**	-.037	.064
	Sig. (2-tailed)	.060	.315	.159	.109	.027	.003	.001	.214	.000	.003	.195	.000	.000	.091	.002	.001	.557	.315
	N	252	252	252	252	252	252	252	252	251	251	252	252	252	252	251	251	251	252
CQ17	Pearson Correlation	.145*	-.075	.054	.020	.151*	.206**	.221**	-.088	.288**	.304**	-.123	.264**	.239**	.062	.119	.161*	-.159*	.075
	Sig. (2-tailed)	.021	.233	.396	.755	.016	.001	.000	.163	.000	.000	.051	.000	.000	.325	.059	.010	.012	.233
	N	252	252	252	252	252	252	252	252	251	251	252	252	252	252	251	251	251	252
DQ1	Pearson Correlation	.190**	-.073	.073	.160*	.193**	.136*	.146*	-.058	.161*	.220**	.036	.124*	.161*	.121	.094	.081	-.035	.073
	Sig. (2-tailed)	.002	.246	.247	.011	.002	.031	.020	.361	.011	.000	.570	.049	.011	.055	.139	.198	.578	.246
	N	252	252	252	252	252	252	252	252	251	251	252	252	252	252	251	251	251	252
DQ2	Pearson Correlation	.265**	-.109	.104	.179**	.206**	.164**	.265**	-.084	.248**	.229**	.011	.231**	.300**	.075	.321**	.341**	-.123	.109
	Sig. (2-tailed)	.000	.084	.099	.004	.001	.009	.000	.182	.000	.000	.866	.000	.000	.233	.000	.000	.052	.084
	N	252	252	252	252	252	252	252	252	251	251	252	252	252	252	251	251	251	252
DQ3	Pearson Correlation	.232**	-.048	.012	.064	.230**	.240**	.301**	-.020	.163**	.248**	-.053	.197**	.259**	.064	.284**	.324**	-.064	.048
	Sig. (2-tailed)	.000	.452	.856	.313	.000	.000	.000	.747	.009	.000	.401	.002	.000	.309	.000	.000	.311	.452
	N	252	252	252	252	252	252	252	252	251	251	252	252	252	252	251	251	251	252
DQ4	Pearson Correlation	.248**	-.072	.038	.167**	.201**	.216**	.242**	-.099	.232**	.180**	.011	.200**	.278**	.163**	.291**	.333**	-.038	.072
	Sig. (2-tailed)	.000	.256	.544	.008	.001	.001	.000	.116	.000	.004	.863	.001	.000	.010	.000	.000	.549	.256
	N	252	252	252	252	252	252	252	252	251	251	252	252	252	252	251	251	251	252
DQ5	Pearson Correlation	.230**	-.113	.211**	.155*	.168**	.066	.155*	-.147*	.289**	.103	.034	.183**	.264**	.204**	.222**	.220**	-.030	.113
	Sig. (2-tailed)	.000	.074	.001	.014	.008	.300	.014	.020	.000	.104	.594	.004	.000	.001	.000	.000	.635	.074
	N	251	251	251	251	251	251	251	251	250	250	251	251	251	251	250	250	250	251
DQ6	Pearson Correlation	.218**	-.153*	.165**	.195**	.173**	.062	.165**	-.182**	.318**	.144*	.001	.277**	.316**	.109	.299**	.300**	-.115	.153*
	Sig. (2-tailed)	.001	.015	.009	.002	.006	.330	.009	.004	.000	.022	.985	.000	.000	.083	.000	.000	.069	.015
	N	252	252	252	252	252	252	252	252	251	251	252	252	252	252	251	251	251	252
DQ7	Pearson Correlation	.055	-.058	.170**	.158*	.135*	.052	.061	-.232**	.192**	-.010	-.039	.152*	.165**	.006	.197**	.236**	-.064	.058
	Sig. (2-tailed)	.383	.357	.007	.012	.032	.410	.337	.000	.002	.870	.538	.016	.009	.924	.002	.000	.310	.357
	N	252	252	252	252	252	252	252	252	251	251	252	252	252	252	251	251	251	252
EQ1	Pearson Correlation	.256**	-.119	.128*	.134*	.277**	.234**	.330**	-.077	.226**	.271**	.040	.233**	.282**	.183**	.379**	.390**	-.147*	.119
	Sig. (2-tailed)	.000	.059	.042	.033	.000	.000	.000	.226	.000	.000	.527	.000	.000	.004	.000	.000	.020	.059
	N	252	252	252	252	252	252	252	252	251	251	252	252	252	252	251	251	251	252
EQ2	Pearson Correlation	.327**	-.126*	.133*	.192**	.246**	.230**	.300**	-.095	.305**	.250**	.030	.272**	.350**	.177**	.450**	.450**	-.131*	.126*
	Sig. (2-tailed)	.000	.045	.035	.002	.000	.000	.000	.132	.000	.000	.638	.000	.000	.005	.000	.000	.037	.045
	N	252	252	252	252	252	252	252	252	251	251	252	252	252	252	251	251	251	252
EQ3	Pearson Correlation	.201**	-.082	.000	.073	.138*	.275**	.215**	-.070	.259**	.199**	-.063	.185**	.186**	.169**	.227**	.252**	-.164**	.082
	Sig. (2-tailed)	.001	.192	.997	.247	.028	.000	.001	.271	.000	.002	.320	.003	.003	.007	.000	.000	.009	.192
	N	252	252	252	252	252	252	252	252	251	251	252	252	252	252	251	251	251	252
EQ4	Pearson Correlation	.208**	.084	.013	.053	.232**	.320**	.316**	-.111	.211**	.238**	-.041	.199**	.182**	.209**	.223**	.265**	-.115	-.084
	Sig. (2-tailed)	.001	.183	.838	.398	.000	.000	.000	.080	.001	.000	.521	.001	.004	.001	.000	.000	.068	.183
	N	252	252	252	252	252	252	252	252	251	251	252	252	252	252	251	251	251	252
EQ5	Pearson Correlation	.315**	-.056	.158*	.159*	.281**	.120	.211**	-.026	.191**	.156*	.099	.105	.201**	.113	.264**	.292**	-.115	.056
	Sig. (2-tailed)	.000	.379	.012	.012	.000	.057	.001	.682	.002	.014	.116	.095	.001	.075	.000	.000	.069	.379
	N	252	252	252	252	252	252	252	252	251	251	252	252	252	252	251	251	251	252
EQ6	Pearson Correlation	.355**	-.099	.133*	.190**	.232**	.120	.294**	-.046	.260**	.147*	.095	.142*	.253**	.044	.274**	.371**	-.179**	.099
	Sig. (2-tailed)	.000	.115	.035	.002	.000	.056	.000	.467	.000	.020	.133	.024	.000	.487	.000	.000	.004	.115
	N	252	252	252	252	252	252	252	252	251	251	252	252	252	252	251	251	251	252

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		FQ3	FQ4	FQ5	FQ6	FQ7	GQ1	GQ2	GQ3	GQ4	GQ5	GQ6	GQ7	GQ8	GQ9	GQ10	GQ11	GQ12	REVFQ4
EQ7	Pearson Correlation	.202**	.053	.019	.049	.161*	.162**	.216**	-.068	.198**	.148*	-.001	.054	.115	.075	.149*	.209**	-.176**	-.053
	Sig. (2-tailed)	.001	.406	.761	.439	.010	.010	.001	.283	.002	.019	.992	.396	.068	.235	.019	.001	.005	.406
	N	252	252	252	252	252	252	252	252	251	251	252	252	252	252	251	251	251	252
EQ8	Pearson Correlation	.297**	.057	.086	-.004	.310**	.210**	.248**	-.067	.177**	.195**	.004	.135*	.178**	.153*	.179**	.230**	-.091	-.057
	Sig. (2-tailed)	.000	.368	.174	.956	.000	.001	.000	.290	.005	.002	.948	.032	.005	.015	.005	.000	.153	.368
	N	250	250	250	250	250	250	250	250	249	249	250	250	250	250	249	249	249	250
EQ9	Pearson Correlation	.252**	-.132*	-.007	.094	.230**	.202**	.258**	-.042	.260**	.135*	.014	.188**	.236**	.160*	.260**	.272**	-.166**	.132*
	Sig. (2-tailed)	.000	.036	.907	.137	.000	.001	.000	.507	.000	.032	.819	.003	.000	.011	.000	.000	.008	.036
	N	252	252	252	252	252	252	252	252	251	251	252	252	252	252	251	251	251	252
EQ10	Pearson Correlation	.328**	-.117	.050	.156*	.257**	.221**	.273**	-.027	.287**	.157*	-.031	.201**	.255**	.171**	.292**	.296**	-.227**	.117
	Sig. (2-tailed)	.000	.063	.434	.013	.000	.000	.000	.672	.000	.013	.622	.001	.000	.007	.000	.000	.000	.063
	N	252	252	252	252	252	252	252	252	251	251	252	252	252	252	251	251	251	252
EQ11	Pearson Correlation	.223**	-.072	.065	.119	.185**	.153*	.254**	-.058	.246**	.138*	-.115	.146*	.231**	.094	.212**	.265**	-.159*	.072
	Sig. (2-tailed)	.000	.256	.305	.059	.003	.015	.000	.362	.000	.029	.069	.020	.000	.137	.001	.000	.012	.256
	N	252	252	252	252	252	252	252	252	251	251	252	252	252	252	251	251	251	252
EQ12	Pearson Correlation	.209**	.129*	.071	-.010	.235**	.210**	.225**	-.016	.197**	.239**	-.033	.144*	.126*	.175**	.167**	.203**	-.145*	-.129*
	Sig. (2-tailed)	.001	.041	.262	.875	.000	.001	.000	.796	.002	.000	.606	.022	.046	.005	.008	.001	.021	.041
	N	252	252	252	252	252	252	252	252	251	251	252	252	252	252	251	251	251	252
EQ13	Pearson Correlation	.305**	-.116	.017	.102	.273**	.100	.220**	-.003	.294**	.158*	-.035	.208**	.308**	.108	.342**	.385**	-.113	.116
	Sig. (2-tailed)	.000	.067	.789	.108	.000	.113	.000	.966	.000	.013	.586	.001	.000	.088	.000	.000	.075	.067
	N	250	250	250	250	250	250	250	250	249	249	250	250	250	250	249	249	249	250
EQ14	Pearson Correlation	.280**	-.013	.054	.004	.265**	.082	.141*	.059	.109	.188**	-.021	.216**	.239**	-.003	.126*	.181**	-.033	.013
	Sig. (2-tailed)	.000	.841	.394	.947	.000	.193	.026	.353	.084	.003	.746	.001	.000	.966	.046	.004	.598	.841
	N	252	252	252	252	252	252	252	252	251	251	252	252	252	252	251	251	251	252
FQ1	Pearson Correlation	.618**	-.205**	.144*	.138*	.333**	.115	.188**	-.076	.190**	.197**	-.149*	.151*	.170**	.065	.231**	.234**	-.072	.205**
	Sig. (2-tailed)	.000	.001	.022	.029	.000	.067	.003	.231	.003	.002	.018	.017	.007	.304	.000	.000	.258	.001
	N	252	252	252	252	252	252	252	252	251	251	252	252	252	252	251	251	251	252
FQ2	Pearson Correlation	.811**	-.359**	.223**	.175**	.388**	.149*	.240**	-.047	.229**	.182**	-.144*	.211**	.272**	-.003	.249**	.272**	-.095	.359**
	Sig. (2-tailed)	.000	.000	.000	.005	.000	.018	.000	.457	.000	.004	.023	.001	.000	.962	.000	.000	.132	.000
	N	252	252	252	252	252	252	252	252	251	251	252	252	252	252	251	251	251	252
FQ3	Pearson Correlation	1.000	-.346**	.180**	.196**	.407**	.143*	.237**	-.013	.289**	.151*	-.103	.229**	.330**	-.038	.246**	.311**	-.141*	.346**
	Sig. (2-tailed)	.	.000	.004	.002	.000	.024	.000	.838	.000	.017	.103	.000	.000	.550	.000	.000	.026	.000
	N	252	252	252	252	252	252	252	252	251	251	252	252	252	252	251	251	251	252
FQ4	Pearson Correlation	-.346**	1.000	-.092	-.186**	-.108	.046	-.059	.176**	-.137*	.016	.129*	-.121	-.213**	.111	-.103	-.151*	.097	-1.000**
	Sig. (2-tailed)	.000	.	.144	.003	.087	.468	.352	.005	.029	.805	.041	.056	.001	.079	.104	.017	.126	.000
	N	252	252	252	252	252	252	252	252	251	251	252	252	252	252	251	251	251	252
FQ5	Pearson Correlation	.180**	-.092	1.000	.401**	.262**	-.056	.074	-.052	.020	-.026	.062	.146*	.190**	.123	.268**	.169**	.125*	.092
	Sig. (2-tailed)	.004	.144	.	.000	.000	.379	.239	.415	.757	.688	.329	.021	.002	.051	.000	.007	.048	.144
	N	252	252	252	252	252	252	252	252	251	251	252	252	252	252	251	251	251	252
FQ6	Pearson Correlation	.196**	-.186**	.401**	1.000	.414**	.065	.188**	-.081	.194**	.039	-.040	.173**	.215**	.008	.237**	.188**	.034	.186**
	Sig. (2-tailed)	.002	.003	.000	.	.000	.302	.003	.202	.002	.543	.523	.006	.001	.902	.000	.003	.595	.003
	N	252	252	252	252	252	252	252	252	251	251	252	252	252	252	251	251	251	252
FQ7	Pearson Correlation	.407**	-.108	.262**	.414**	1.000	.147*	.229**	.048	.171**	.156*	-.040	.223**	.212**	.045	.246**	.254**	-.043	.108
	Sig. (2-tailed)	.000	.087	.000	.000	.	.020	.000	.448	.007	.014	.524	.000	.001	.479	.000	.000	.496	.087
	N	252	252	252	252	252	252	252	252	251	251	252	252	252	252	251	251	251	252

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		FQ3	FQ4	FQ5	FQ6	FQ7	GQ1	GQ2	GQ3	GQ4	GQ5	GQ6	GQ7	GQ8	GQ9	GQ10	GQ11	GQ12	REVFQ4
GQ1	Pearson Correlation	.143*	.046	-.056	.065	.147*	1.000	.612**	-.095	.381**	.368**	-.149*	.280**	.176**	.329**	.252**	.242**	-.068	-.046
	Sig. (2-tailed)	.024	.468	.379	.302	.020	.	.000	.133	.000	.000	.018	.000	.005	.000	.000	.000	.281	.468
	N	252	252	252	252	252	252	252	252	251	251	252	252	252	252	251	251	251	252
GQ2	Pearson Correlation	.237**	-.059	.074	.188**	.229**	.612**	1.000	-.148*	.554**	.380**	-.114	.428**	.382**	.207**	.415**	.448**	-.126*	.059
	Sig. (2-tailed)	.000	.352	.239	.003	.000	.000	.	.019	.000	.000	.070	.000	.000	.001	.000	.000	.047	.352
	N	252	252	252	252	252	252	252	252	251	251	252	252	252	252	251	251	251	252
GQ3	Pearson Correlation	-.013	.176**	-.052	-.081	.048	-.095	-.148*	1.000	-.162**	-.108	.489**	-.207**	-.111	-.053	-.171**	-.221**	.331**	-.176**
	Sig. (2-tailed)	.838	.005	.415	.202	.448	.133	.019	.	.010	.089	.000	.001	.078	.399	.007	.000	.000	.005
	N	252	252	252	252	252	252	252	252	251	251	252	252	252	252	251	251	251	252
GQ4	Pearson Correlation	.289**	-.137*	.020	.194**	.171**	.381**	.554**	-.162**	1.000	.338**	-.169**	.451**	.516**	.137*	.401**	.480**	-.190**	.137*
	Sig. (2-tailed)	.000	.029	.757	.002	.007	.000	.000	.010	.	.000	.007	.000	.000	.030	.000	.000	.003	.029
	N	251	251	251	251	251	251	251	251	251	250	251	251	251	251	250	250	250	251
GQ5	Pearson Correlation	.151*	.016	-.026	.039	.156*	.368**	.380**	-.108	.338**	1.000	-.215**	.358**	.286**	.268**	.277**	.284**	-.169**	-.016
	Sig. (2-tailed)	.017	.805	.688	.543	.014	.000	.000	.089	.000	.	.001	.000	.000	.000	.000	.000	.007	.805
	N	251	251	251	251	251	251	251	251	250	251	251	251	251	251	250	250	250	251
GQ6	Pearson Correlation	-.103	.129*	.062	-.040	-.040	-.149*	-.114	.489**	-.169**	-.215**	1.000	-.244**	-.124*	-.035	-.161*	-.156*	.370**	-.129*
	Sig. (2-tailed)	.103	.041	.329	.523	.524	.018	.070	.000	.007	.001	.	.000	.050	.581	.011	.013	.000	.041
	N	252	252	252	252	252	252	252	252	251	251	252	252	252	252	251	251	251	252
GQ7	Pearson Correlation	.229**	-.121	.146*	.173**	.223**	.280**	.428**	-.207**	.451**	.358**	-.244**	1.000	.771**	.142*	.484**	.500**	-.100	.121
	Sig. (2-tailed)	.000	.056	.021	.006	.000	.000	.000	.001	.000	.000	.000	.	.000	.025	.000	.000	.114	.056
	N	252	252	252	252	252	252	252	252	251	251	252	252	252	252	251	251	251	252
GQ8	Pearson Correlation	.330**	-.213**	.190**	.215**	.212**	.176**	.382**	-.111	.516**	.286**	-.124*	.771**	1.000	.126*	.557**	.598**	-.006	.213**
	Sig. (2-tailed)	.000	.001	.002	.001	.001	.005	.000	.078	.000	.000	.050	.000	.	.046	.000	.000	.920	.001
	N	252	252	252	252	252	252	252	252	251	251	252	252	252	252	251	251	251	252
GQ9	Pearson Correlation	-.038	.111	.123	.008	.045	.329**	.207**	-.053	.137*	.268**	-.035	.142*	.126*	1.000	.372**	.262**	.050	-.111
	Sig. (2-tailed)	.550	.079	.051	.902	.479	.000	.001	.399	.030	.000	.581	.025	.046	.	.000	.000	.427	.079
	N	252	252	252	252	252	252	252	252	251	251	252	252	252	252	251	251	251	252
GQ10	Pearson Correlation	.246**	-.103	.268**	.237**	.246**	.252**	.415**	-.171**	.401**	.277**	-.161*	.484**	.557**	.372**	1.000	.808**	-.051	.103
	Sig. (2-tailed)	.000	.104	.000	.000	.000	.000	.000	.007	.000	.000	.011	.000	.000	.000	.	.000	.422	.104
	N	251	251	251	251	251	251	251	251	250	250	251	251	251	251	251	251	251	251
GQ11	Pearson Correlation	.311**	-.151*	.169**	.188**	.254**	.242**	.448**	-.221**	.480**	.284**	-.156*	.500**	.598**	.262**	.808**	1.000	-.166**	.151*
	Sig. (2-tailed)	.000	.017	.007	.003	.000	.000	.000	.000	.000	.000	.013	.000	.000	.000	.000	.	.009	.017
	N	251	251	251	251	251	251	251	251	250	250	251	251	251	251	251	251	251	251
GQ12	Pearson Correlation	-.141*	.097	.125*	.034	-.043	-.068	-.126*	.331**	-.190**	-.169**	.370**	-.100	-.006	.050	-.051	-.166**	1.000	-.097
	Sig. (2-tailed)	.026	.126	.048	.595	.496	.281	.047	.000	.003	.007	.000	.114	.920	.427	.422	.009	.	.126
	N	251	251	251	251	251	251	251	251	250	250	251	251	251	251	251	251	251	251
REVFQ4	Pearson Correlation	.346**	-1.000**	.092	.186**	.108	-.046	.059	-.176**	.137*	-.016	-.129*	.121	.213**	-.111	.103	.151*	-.097	1.000
	Sig. (2-tailed)	.000	.000	.144	.003	.087	.468	.352	.005	.029	.805	.041	.056	.001	.079	.104	.017	.126	.
	N	252	252	252	252	252	252	252	252	251	251	252	252	252	252	251	251	251	252
REVGQ6	Pearson Correlation	.103	-.129*	-.062	.040	.040	.149*	.114	-.489**	.169**	.215**	-1.000**	.244**	.124*	.035	.161*	.156*	-.370**	.129*
	Sig. (2-tailed)	.103	.041	.329	.523	.524	.018	.070	.000	.007	.001	.000	.000	.050	.581	.011	.013	.000	.041
	N	252	252	252	252	252	252	252	252	251	251	252	252	252	252	251	251	251	252
REVGQ12	Pearson Correlation	.141*	-.097	-.125*	-.034	.043	.068	.126*	-.331**	.190**	.169**	-.370**	.100	.006	-.050	.051	.166**	-1.000**	.097
	Sig. (2-tailed)	.026	.126	.048	.595	.496	.281	.047	.000	.003	.007	.000	.114	.920	.427	.422	.009	.000	.126
	N	251	251	251	251	251	251	251	251	250	250	251	251	251	251	251	251	251	251

Correlations - 57 variables

		REVG Q6	REVG Q12
CQ1	Pearson Correlation	-.055	.031
	Sig. (2-tailed)	.382	.626
	N	252	251
CQ2	Pearson Correlation	.022	-.001
	Sig. (2-tailed)	.725	.986
	N	252	251
CQ3	Pearson Correlation	-.049	.082
	Sig. (2-tailed)	.440	.196
	N	252	251
CQ4	Pearson Correlation	-.035	.098
	Sig. (2-tailed)	.579	.123
	N	252	251
CQ5	Pearson Correlation	-.078	.079
	Sig. (2-tailed)	.220	.215
	N	252	251
CQ6	Pearson Correlation	-.093	.030
	Sig. (2-tailed)	.140	.632
	N	252	251
CQ7	Pearson Correlation	-.076	.066
	Sig. (2-tailed)	.230	.297
	N	251	250
CQ8	Pearson Correlation	-.026	.004
	Sig. (2-tailed)	.681	.953
	N	251	250
CQ9	Pearson Correlation	.016	.051
	Sig. (2-tailed)	.795	.420
	N	252	251
CQ10	Pearson Correlation	.139*	.151*
	Sig. (2-tailed)	.028	.017
	N	252	251
CQ11	Pearson Correlation	.044	.013
	Sig. (2-tailed)	.490	.842
	N	252	251
CQ12	Pearson Correlation	.050	.005
	Sig. (2-tailed)	.425	.937
	N	252	251
CQ13	Pearson Correlation	.095	.085
	Sig. (2-tailed)	.133	.182
	N	252	251
CQ14	Pearson Correlation	.054	.027
	Sig. (2-tailed)	.394	.672
	N	252	251
CQ15	Pearson Correlation	.094	.004
	Sig. (2-tailed)	.137	.944
	N	251	250

Correlations - 57 variables

		REVG Q6	REVG Q12
CQ16	Pearson Correlation	.082	.037
	Sig. (2-tailed)	.195	.557
	N	252	251
CQ17	Pearson Correlation	.123	.159*
	Sig. (2-tailed)	.051	.012
	N	252	251
DQ1	Pearson Correlation	-.036	.035
	Sig. (2-tailed)	.570	.578
	N	252	251
DQ2	Pearson Correlation	-.011	.123
	Sig. (2-tailed)	.866	.052
	N	252	251
DQ3	Pearson Correlation	.053	.064
	Sig. (2-tailed)	.401	.311
	N	252	251
DQ4	Pearson Correlation	-.011	.038
	Sig. (2-tailed)	.863	.549
	N	252	251
DQ5	Pearson Correlation	-.034	.030
	Sig. (2-tailed)	.594	.635
	N	251	250
DQ6	Pearson Correlation	-.001	.115
	Sig. (2-tailed)	.985	.069
	N	252	251
DQ7	Pearson Correlation	.039	.064
	Sig. (2-tailed)	.538	.310
	N	252	251
EQ1	Pearson Correlation	-.040	.147*
	Sig. (2-tailed)	.527	.020
	N	252	251
EQ2	Pearson Correlation	-.030	.131*
	Sig. (2-tailed)	.638	.037
	N	252	251
EQ3	Pearson Correlation	.063	.164**
	Sig. (2-tailed)	.320	.009
	N	252	251
EQ4	Pearson Correlation	.041	.115
	Sig. (2-tailed)	.521	.068
	N	252	251
EQ5	Pearson Correlation	-.099	.115
	Sig. (2-tailed)	.116	.069
	N	252	251
EQ6	Pearson Correlation	-.095	.179**
	Sig. (2-tailed)	.133	.004
	N	252	251

Correlations - 57 variables

		REVG Q6	REVG Q12
EQ7	Pearson Correlation	.001	.176**
	Sig. (2-tailed)	.992	.005
	N	252	251
EQ8	Pearson Correlation	-.004	.091
	Sig. (2-tailed)	.948	.153
	N	250	249
EQ9	Pearson Correlation	-.014	.166**
	Sig. (2-tailed)	.819	.008
	N	252	251
EQ10	Pearson Correlation	.031	.227**
	Sig. (2-tailed)	.622	.000
	N	252	251
EQ11	Pearson Correlation	.115	.159*
	Sig. (2-tailed)	.069	.012
	N	252	251
EQ12	Pearson Correlation	.033	.145*
	Sig. (2-tailed)	.606	.021
	N	252	251
EQ13	Pearson Correlation	.035	.113
	Sig. (2-tailed)	.586	.075
	N	250	249
EQ14	Pearson Correlation	.021	.033
	Sig. (2-tailed)	.746	.598
	N	252	251
FQ1	Pearson Correlation	.149*	.072
	Sig. (2-tailed)	.018	.258
	N	252	251
FQ2	Pearson Correlation	.144*	.095
	Sig. (2-tailed)	.023	.132
	N	252	251
FQ3	Pearson Correlation	.103	.141*
	Sig. (2-tailed)	.103	.026
	N	252	251
FQ4	Pearson Correlation	-.129*	-.097
	Sig. (2-tailed)	.041	.126
	N	252	251
FQ5	Pearson Correlation	-.062	-.125*
	Sig. (2-tailed)	.329	.048
	N	252	251
FQ6	Pearson Correlation	.040	-.034
	Sig. (2-tailed)	.523	.595
	N	252	251
FQ7	Pearson Correlation	.040	.043
	Sig. (2-tailed)	.524	.496
	N	252	251

Correlations - 57 variables

		REVG Q6	REVG Q12
GQ1	Pearson Correlation	.149*	.068
	Sig. (2-tailed)	.018	.281
	N	252	251
GQ2	Pearson Correlation	.114	.126*
	Sig. (2-tailed)	.070	.047
	N	252	251
GQ3	Pearson Correlation	-.489**	-.331**
	Sig. (2-tailed)	.000	.000
	N	252	251
GQ4	Pearson Correlation	.169**	.190**
	Sig. (2-tailed)	.007	.003
	N	251	250
GQ5	Pearson Correlation	.215**	.169**
	Sig. (2-tailed)	.001	.007
	N	251	250
GQ6	Pearson Correlation	-1.000**	-.370**
	Sig. (2-tailed)	.000	.000
	N	252	251
GQ7	Pearson Correlation	.244**	.100
	Sig. (2-tailed)	.000	.114
	N	252	251
GQ8	Pearson Correlation	.124*	.006
	Sig. (2-tailed)	.050	.920
	N	252	251
GQ9	Pearson Correlation	.035	-.050
	Sig. (2-tailed)	.581	.427
	N	252	251
GQ10	Pearson Correlation	.161*	.051
	Sig. (2-tailed)	.011	.422
	N	251	251
GQ11	Pearson Correlation	.156*	.166**
	Sig. (2-tailed)	.013	.009
	N	251	251
GQ12	Pearson Correlation	-.370**	-1.000**
	Sig. (2-tailed)	.000	.000
	N	251	251
REVF Q4	Pearson Correlation	.129*	.097
	Sig. (2-tailed)	.041	.126
	N	252	251
REVG Q6	Pearson Correlation	1.000	.370**
	Sig. (2-tailed)	.	.000
	N	252	251
REVG Q12	Pearson Correlation	.370**	1.000
	Sig. (2-tailed)	.000	.
	N	251	251

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Rotated Component Matrix - 57 items[a]

	Component														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
EQ10 suppliers can implement product design changes in a short time	.826														
EQ9 suppliers can implement product design changes easily	.816														
EQ11 suppliers can implement product design changes at a low cost	.783														
EQ6 suppliers can modify their product mix in a short time	.728														
EQ5 suppliers can modify their product mix easily	.697														
EQ13 short time required for suppliers to switch parts mix	.683														
EQ7 suppliers can modify their product mix at a low cost	.667						.391								
EQ2 suppliers can deliver new components / materials in a short time	.597			.406											
EQ3 suppliers can deliver new components / materials at a low price	.572														
CQ16 information sent to our suppliers is in real time		.809													
CQ17 it is easy for us to send information to our suppliers		.774													
CQ15 information sent to our suppliers is accurate		.773													
CQ14 information sent to our suppliers is timely		.731													
CQ10 easy for our suppliers to send information to us		.628													
CQ13 information received from our suppliers is in real time		.560													
GQ8 this flexibility is quick to implement										.412					
GQ7 this flexibility is easy to implement			.833												
GQ11 this responsive action can be implemented in a short time			.785												
GQ10 this responsive action is easy to implement			.712												
GQ5 org structure flexible to improve operational relationships with suppliers			.691												.360
DQ1 suppliers carry sufficient inventory to cater to our demands				.747											
DQ2 suppliers can easily adjust to changes in demand schedules	.308			.744											
DQ4 suppliers are capable of flexible delivery at short notice	.356			.714											
DQ3 suppliers maintain high quality standards at all levels of demand				.604											
EQ1 suppliers can deliver new components / materials easily	.487			.521											
CQ5 our IS is well integrated with that of prominent supplier					.836										
CQ6 our IS data structure is same as prominent supplier					.826										
CQ7 high connectivity of the IS with our suppliers					.820										
CQ4 data transfer with prominent supplier does not need translation					.461										

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

Rotated Component Matrix - 57 items[a]

	Component														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
FQ2 suppliers can modify these routes easily						.894									
FQ1 suppliers can deliver materials and components along various routes						.830									
FQ3 suppliers can modify these routes in a short time						.815									
REVFQ4						.434	-.424								
EQ12 suppliers can implement product design changes with same quality	.380						.731								
EQ8 suppliers can modify their product mix with same quality	.405						.723								
EQ4 suppliers can deliver new components / materials with same quality	.358						.670								
EQ14 suppliers can deliver wide range of component parts							.450								
DQ5 we can change to different supplier easily								.812							
DQ7 we can change to different suppliers at a low cost								.811							
DQ6 we can change to different suppliers in a short time	.303							.793							
GQ1 have a range of organisational strategies for supplier integration									.746						
GQ2 these strategies are easy to implement			.340						.685						
GQ4 these strategies can be implemented in a short time			.489						.503						
CQ12 information received from our suppliers is reliable										.747					
CQ11 information received from our suppliers is accurate		.316								.730					
GQ3 these strategies are very costly no implement											-.778				
REVGQ6											.751				
REVGQ12											.713				
FQ6 choice of handling routes does not affect transport costs												.783			
FQ5 all materials handling routes exhibit similar performance levels												.742			
FQ7 transport facilities for materials of different sizes are flexible						.359						.497			
CQ3 suppliers are willing to share critical information with us										.324			.670		
CQ1 we receive sufficient range of information from suppliers		.397											.627		
CQ2 we provide sufficient range of information to suppliers					.373								.619		
CQ9 routine transfer of ordering info done without human intervention														.741	
CQ8 routine transfer of invoicing info done without human intervention					.360									.692	
GQ9 strategies are designed to respond to environmental uncertainties															.776

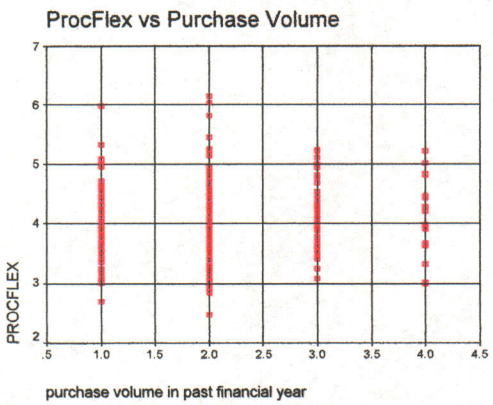
Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
a. Rotation converged in 9 iterations.

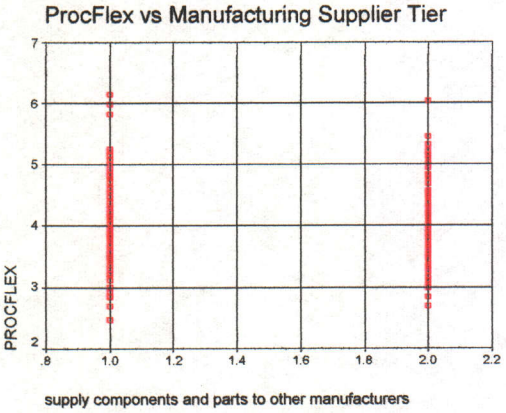
APPENDIX 15 - SIC CODE FREQUENCIES

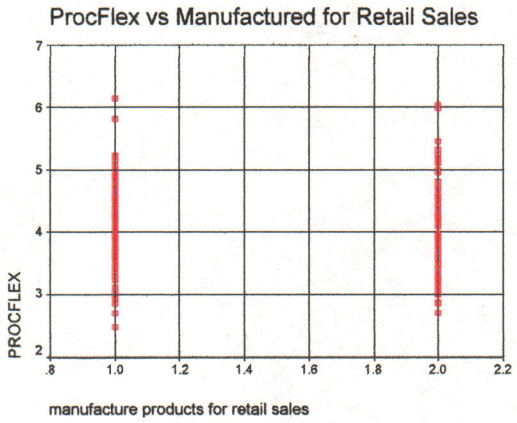
FREQUENCY of SIC CODE (HQ3)

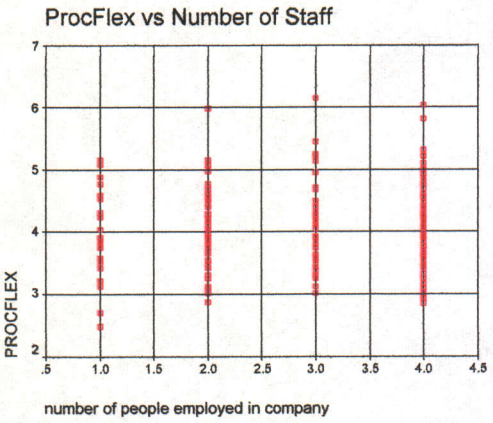
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	20 food and kindred products	50	19.8	19.8	19.8
	24 lumber and wood products	12	4.8	4.8	24.6
	25 furniture and fixtures	10	4.0	4.0	28.6
	26 paper and allied products	10	4.0	4.0	32.5
	27 printing, publishing industries	7	2.8	2.8	35.3
	28 chemicals and allied products	27	10.7	10.7	46.0
	30 rubber and misc plastics	15	6.0	6.0	52.0
	31 leather & leather products	2	.8	.8	52.8
	32 stone, clay, glass & concrete prods	10	4.0	4.0	56.7
	33 primary metal industries	11	4.4	4.4	61.1
	34 fabricated metal products	51	20.2	20.2	81.3
	35 industrial & commercial machinery	14	5.6	5.6	86.9
	36 electronic & electrical equipment	19	7.5	7.5	94.4
	37 transport equipment	8	3.2	3.2	97.6
	38 measuring, analysing, controlling	2	.8	.8	98.4
	39 pharmaceutical	3	1.2	1.2	99.6
	40 textile	1	.4	.4	100.0
	Total	252	100.0	100.0	

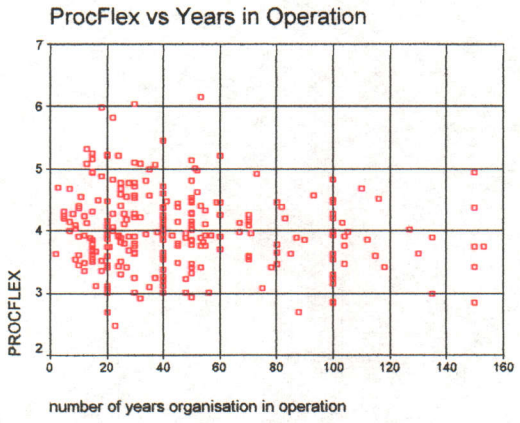
APPENDIX 16 - SCATTERPLOT OF PROCFLEX VS DEMOGRAPHICS



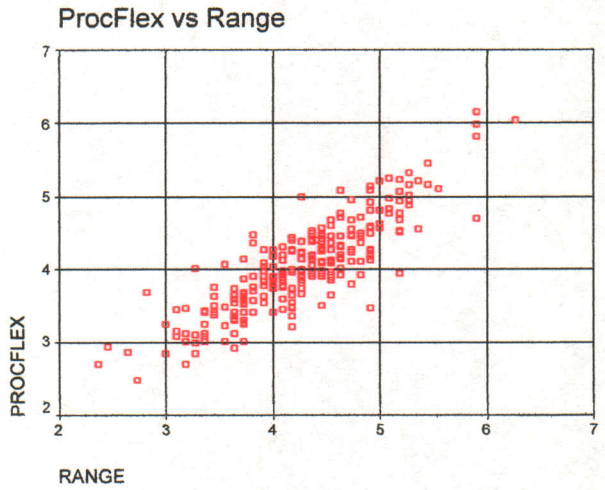


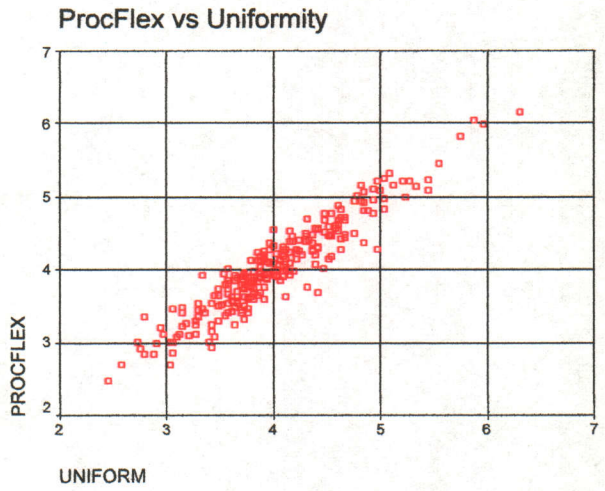


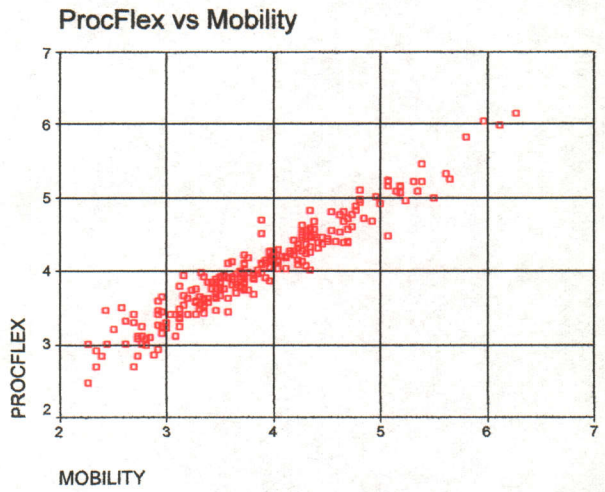




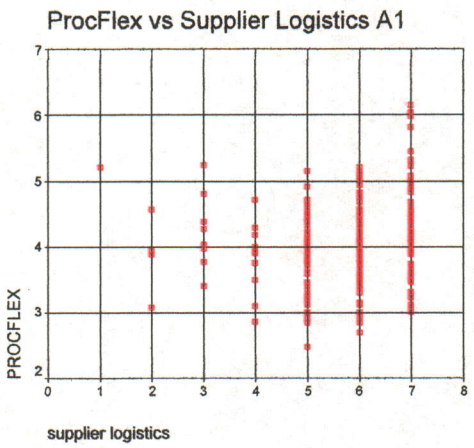
APPENDIX 17 - SCATTERPLOT OF PROCFLEX VS DIMENSIONS

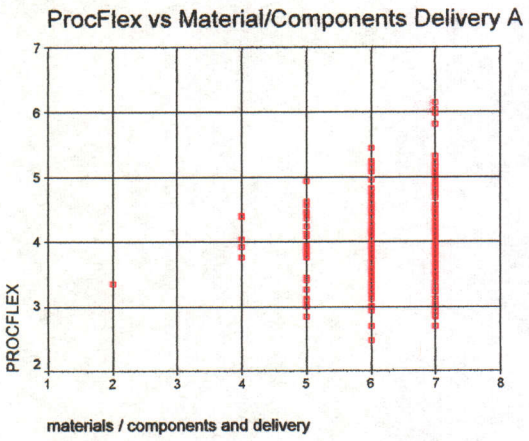


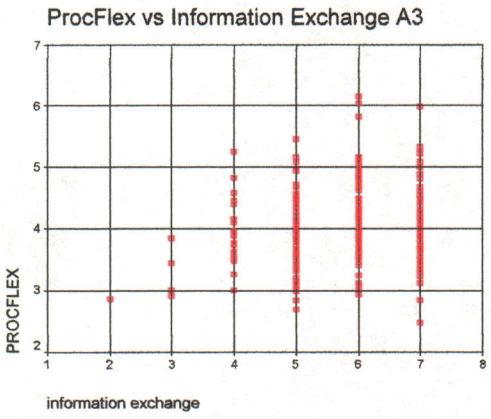


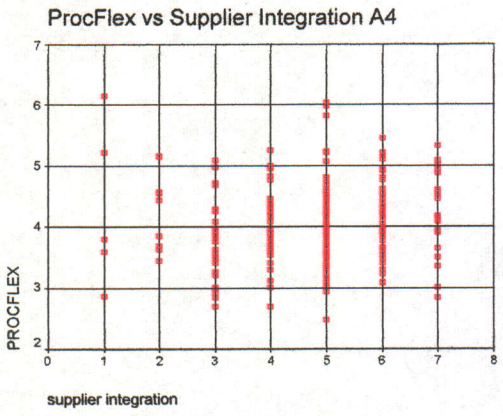


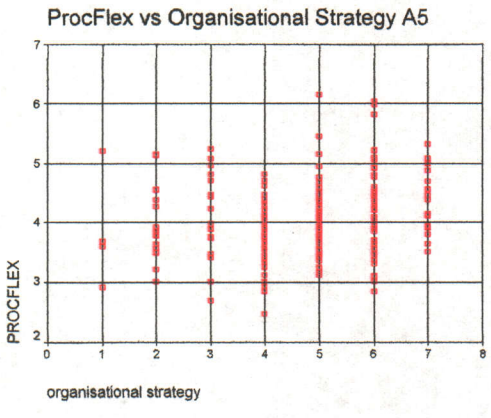
APPENDIX 18 - SCATTERPLOT OF PROCFLEX VS SECTION A





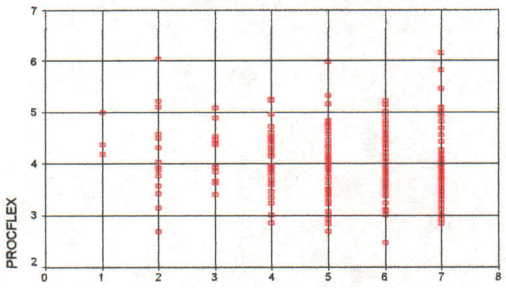






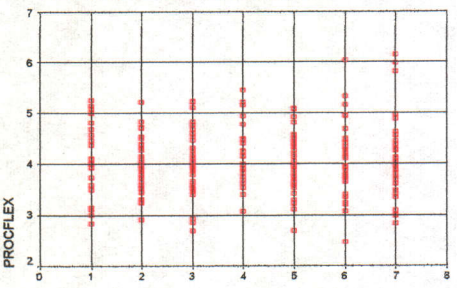
APPENDIX 19 - SCATTERPLOT OF PROCFLEX VS SECTION B

ProcFlex vs Customer Demand Uncertainty B1



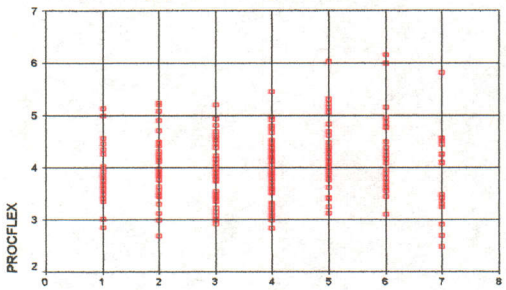
fluctuating customer demand is affecting manufacturing strategy

ProcFlex vs Substitute Imports B2



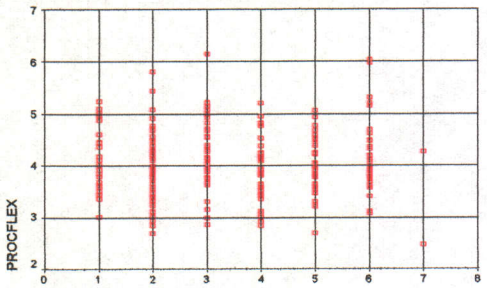
substitute imported producrs are affecting our product sales

ProcFlex vs Changing Government Regulations B3



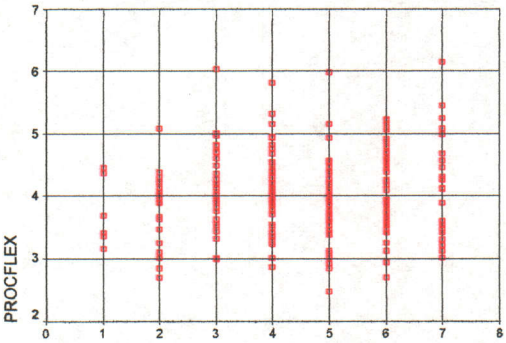
changing govt regulations & tariffs are affecting our plant

ProcFlex vs Environmental Concerns B4



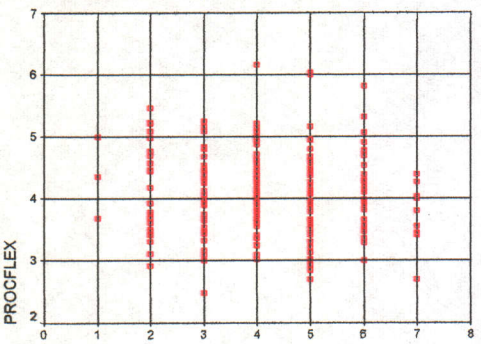
environmental concerns are affecting manufacturing strategy

ProcFlex vs Product Obsolescence Rate B5



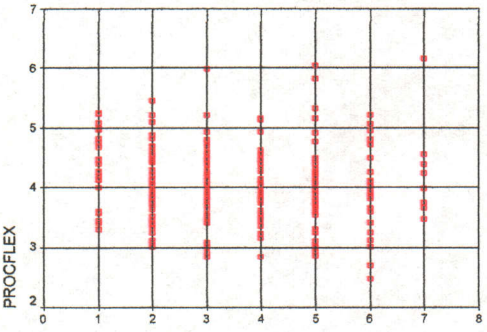
our product obsolescence rate is very low

ProcFlex vs Uncertainty of Competitors Action B6



difficult to predict competitors' actions

ProcFlex vs Supplier Price Uncertainty B7



our suppliers frequently change their prices

APPENDIX 20 - SCATTERPLOT OF PROCFLEX VS SECTION C