AN EXPLORATORY STUDY OF, MAINLY, LONG SUPPLY CHAIN COMPETITION: SELECTED CASES IN THE SOUTH AFRICAN AEROSPACE SECTOR

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I declare that this dissertation is my own unaided work. It is being submitted to the degree of Master of Science to the University of the Witwatersrand. Johannesburg. It has not been submitted before for any degree or examination to any other University

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ABSTRACT

This dissertation investigates how mainly long supply chains compete in the South African aerospace industry. Speed, dependability, quality and flexibility dimensions provide the framework for exploration of competitive criteria.

The dissertation employs a multiple case study methodology in six selected firms. Semi-structured interviews are conducted with nineteen participants, providing the primary source of data. Multiple case analysis identifies similarities in competitive dimension criteria for supplier-firm and customer-firm units in the long supply chain.

Results indicate supplier-firm units compete on aspects of speed, dependability, quality and flexibility. In addition, supplier-firm units also compete on aspects of cost. Customer-firm units compete on aspects of speed, quality and flexibility.

Conclusions from results should not be generalised due to small sample size, data not being random, and difficulty in fulfilling long supply chain criteria for all cases. Within results obtained, focus areas for future research into how long supply chains compete in the South African aerospace industry have been identified.

DEDICATION

I dedicate this to my mom and dad, who supported and motivated me during this research.

ACKNOWLEDGEMENTS

I thank my supervisor Professor Roy Snaddon for his guidance and input both in this research and beyond.

I thank the interviewees from the firms who participated in this study. As interviewees cannot be named for confidentiality reasons, I extend my thanks in a general manner.

I am grateful for funding and support supplied by the National Aerospace Centre of Excellence (NACoE) - this research would not exist without it. I thank Philip Haupt and Marie Botha for their contributions to this study.

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LIST OF ABBREVIATIONS

Built-to-Order..... BTO
Business Process Reengineering..... BPR
Business-to-Business..... B2B
Cost of Quality..... COQ
Electronic Data Interchange..... EDI
Enterprise Resource Planning..... ERP
Information Technology..... IT
International Standards Organisation..... ISO
Just In Time..... JIT
Make-to-Stock..... MTS
Original Equipment Manufacturer..... OEM
Plan Do Check Act..... PDCA
Price of Non-Conformance..... PONC
Quality Management..... QM
Strategic Supply Management..... SSM
Supply Chain Management..... SCM
Total Quality Management..... TQM
Vendor Managed Inventory..... VMI
Web-Based Interchange..... WBI

1. INTRODUCTION

1.1 Objective

The objective of this dissertation is to find what contributes to the competitiveness of long supply chains in the South African aerospace industry.

1.2 General approach

This research investigates long supply chains in the South African aerospace industry. A multiple case study methodology is employed, with semi-structured interviews used as the primary source of data. The semi-structured interviews are conducted with selected South African aerospace firms with long supply chains. A literature survey provides the theoretical framework for the research. The theoretical framework uses competitive dimensions from manufacturing strategy literature to provide measurement categories for data collection and analysis. Similarities between the competitive dimensions for aerospace supply chains are identified. These are discussed and conclusions are drawn. Further research is suggested.

1.3 Research Problem

With case study research being exploratory in nature, there are no initial hypotheses or propositions examined (Yin, 2003, p. 22). The research is guided by problem statements. The main problem statement to be researched is: “How do long supply chains compete?”

1.4 Research Sub-problems

The competitive dimensions of speed, dependability, quality and flexibility are critical success factors that impact on firm profit for competitive firms (Snaddon, 1996, p. 387). Assessing how a firm performs on these competitive dimensions can help in determining how to manage aspects of the supply chain (Harland

et al, 1999). This leads to the research subproblems that contribute to the main research problem:

Suproblem 1: “How do long supply chains compete on speed?”

Subproblem 2: “How do long supply chains compete on dependability?”

Subproblem 3: “How do long supply chains compete on quality?”

Subproblem 4: “How do long supply chains compete on flexibility?”

1.5 Research limitations

The research confines itself to the South African aerospace industry. Generalisation of findings is not appropriate outside of this.

Limited case studies exist in the South African aerospace industry having long supply chains from the supplier to the firm, and the firm to the customer. As a result, the study *mainly* addresses long supply chains, but some short supply chain cases are included.

The study examines the direct relationship that the focus firm under investigation has with its direct suppliers and direct customers. It does not directly examine the relationship with the supplier’s supplier, or the customer’s customer, or beyond.

Only the literature survey is used to provide a theoretical base for case study analysis.

1.6 Importance of outcomes

According to Shi and Gregory (1998, p. 195), “The design and operation of international manufacturing networks (long supply chains) is an increasingly important issue for transnational corporations faced with rapid changes in global market opportunity, competition and new managerial mechanisms.” Whilst the importance of long supply chains has been identified, little research has been done in this field (Jain and Benyoucef,

2008, p. 484). This research will add to the limited body of long supply chain knowledge.

Frohlich and Westbrook (2001) note that greater emphasis is placed on research into the supplier-firm side rather than the customer-firm side of supply chains. This research equally addresses both the supplier-firm and customer-firm sides of the supply chain.

Competitive dimensions are the primary basis for competition and the foundation for creating, combating, and sustaining competitive advantage (Gunasekaran and McGaughey, 2002, p. 1). This research identifies aspects within competitive dimensions to aid further investigation into long supply chains in the South African aerospace industry.

1.7 Outline of the report

A linear analytic structure (Yin, 2003) is used in reporting this multiple case study research. According to Yin (2003, p. 152), a linear analytic reporting structure is comfortable to most investigators and probably is the most advantageous when a dissertation committee comprises the main audience for the case study. Linear analytic structure is applicable in exploratory multiple case studies. The chapters of this dissertation are arranged as follows: introduction, literature review, research methodology, single case analysis, cross case analysis, discussion, conclusions and recommendations.

The introductory chapter states the objective of this research, the approach taken in the research, the research problems and sub-problems, limitations to the research, importance of the outcomes and the structure of the report.

The literature review first introduces the concept of a supply chain, followed by that of a long supply chain. Supply chain management is discussed. The competitive dimensions of speed, dependability, quality and flexibility and their role in long supply chain competitiveness are examined. An overview of the South African aerospace industry is provided. Finally a summary of the literature review and the framework it provides for the dissertation is introduced.

The research methodology initially explores the empirical research approach. This is followed by an explanation of case study research based on Yin (2003), which is used in this dissertation. The case studies into selected South African aerospace long supply chains are introduced. The case study protocol, which increases the reliability of the research and guides the investigator in carrying out data collection, is discussed. The case study protocol provides: a focus to the study; outlines data collection procedures; explains criteria to ensure the logic and quality of the research design is kept; describes interview guidelines; pilot study findings; the final interview tool; data analysis; and how the case studies are reported.

Single case analysis presents the results for each individual case study. Cross case analysis follows replication logic, where single case studies conclusions are compared to one another, and predictions from the theory are examined (Yin, 2003). Discussion of the cross case conclusions is undertaken, looking at where similarities and differences in the cases are found. Final conclusions are drawn, and further work is recommended.

2. LITERATURE REVIEW

The literature review provides an explanation of a supply chain, and a long supply chain. This is followed by a discussion on long supply chain management, where the goal is to control the flow of material and information to improve performance. Literature then examines the competitive dimensions of speed, dependability, quality and flexibility as applicable to the long supply chain, followed by an overview of the South African aerospace industry. Finally, a summary of the literature review and the framework it provides for the dissertation is given.

2.1 Supply chain

Stevens (1989) defines a supply chain as a system whose constituent parts include material suppliers, production facilities, distribution services and customers linked together via the feedforward flow of materials and the feedback flow of information. Jain and Benyoucef (2008, p. 470) view a supply chain as a transformation process, where raw material inputs from suppliers move through several stages of manufacturing, assembly and distribution to form outputs for customers. This transformation process includes material, information and financial flows. Beamonn (1998, p. 281) describes a supply chain as an integrated process, wherein a number of various business entities work together in an effort to acquire raw materials, convert these raw materials into specified final products, and deliver these final products to retailers. This chain is traditionally characterised by a feedforward flow of materials and a backward flow of information. The supply chain process can be seen in figure 1.

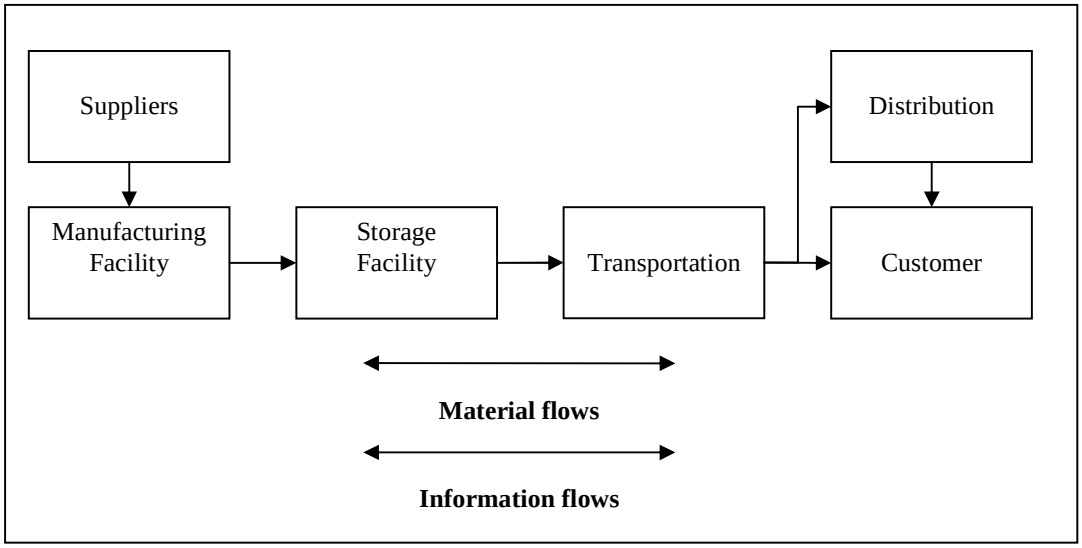

Figure 1: The supply chain process (Beamon, 1998, p. 282)

The flow of materials and information form the primary links across the supply chain system. Whilst the traditional supply chain view involves the *feedforward* flow of materials and the *feedback* flow of information, supply chains are really linked together by the *bi-directional* flow of materials and information:

- Finished goods materials flow towards the customer, but can also flow back towards the supplier as a result of reworks, recycling and remanufacturing (Beamon, 1998, p. 281). Material flows from supplier inputs through to customer outputs can be described at its highest level as the *production planning* and *inventory control process*, and the *distribution and logistics process* (p. 282). Production planning describes the design and management of the entire manufacturing process, including raw material acquisition and scheduling, manufacturing process design and scheduling, and material handling design and control. Inventory control describes the design and management of the storage policies and procedures for raw materials, work in process inventories, and, usually, final products. The distribution and logistics process determines how products are retrieved and transported from the warehouse to retailers. These products may be transported to retailers directly, or may be first moved to distribution facilities, which, in turn, transport products to retailers. This process

includes the management of inventory retrieval, transportation, and final product delivery.

- Bi-directional information flows occur when feedback between supply chain members is required (Holweg and Pil, 2007, p. 4). Bi-directional information flows from supplier inputs through to customer outputs can be described as *order* information and *downstream* information (Childerhouse *et al,* 2003a). Order information flows upstream towards the suppliers. This may include inventory and capacity levels, sales data, and sales forecasts (Lee *et al,* 2000). Downstream information flows towards the customer detail the progress of orders according to the stipulated criteria, volumes, delivery dates and quality. Bi-directional information flows occur in supply chain initiatives such as Vendor Managed Inventory (VMI) (Danese, 2006) and Electronic Data Interchange (EDI) (Hill and Scudder, 2002), where supply chain members share production and inventory data to reduce inventory levels and increase customer service. Bi-directional information flows can also occur when inadequate information is passed between supply chain members, resulting in exchanges for further information.

For the purposes of this research, aspects of bi-directional material and information flows between supply chain members is examined using strategic competitive dimensions. These aspects are mainly determined by the strategic competitive dimension literature. The literature initially makes direct reference to how the aspects relate to material and information flows, but for the most part are loosely coupled around these flows. As a general rule for this dissertation, material flows are concerned with ‘hard’ aspects like inventory, production planning, performance measurement and technologies. Information flows are concerned with ‘soft’ aspects like trust and communication.

2.2 Long supply chain

2.2.1 Long supply chain definition

A number of long supply chain descriptions can be found in the literature:

- Jain and Benyoucef (2008 p. 470) describe long supply chains in the global competition market as "very complex, with many parallel physical, information and financial flows occurring in order to ensure that products and/or services are delivered in the right quantities, with the requested quality to the right place in a cost effective manner at the right time."

- Bhatnagar and Viswanathan (2000, p. 13) say that "pressures like cost effectiveness, access to new markets and economies of scale, among others, has led to the emergence of a borderless organisation with globally located suppliers and production/distribution facilities."

- Schmidt and Wilhelm (1999, p. 2) say that rapid development in the world-wide marketplace is leading to the geographical dispersion of production, assembly and distribution operations, which requires a strategic, tactical and operational understanding of international logistics networks.

To cover the above descriptions from literature, *long supply chain* in this research will refer to:

Supply chains where members who trade goods and services are geographically distant from one another, generally on different continents.

2.2.2 Long supply chain characteristics

The long supply chain follows the same supply chain[1] process outlined in section 2.1, but with some distinguishing attributes and operational uncertainties as a result of globalisation (Jain and Benyoucef 2008, p. 471):

[1] The term "supply chain" will refer to the generic supply chain as outlined in section 2.1, and is synonymous with "short" supply chain operations, where no international trade occurs. Long supply chains will be referred to as such.

- The short supply chain has traditionally focused on efficiency. The use of Just in Time (JIT) has been used to reduce inventory in many operations. Reduced inventory results in lower costs, but also makes the long supply chain more vulnerable to interruptions in supply without buffer inventory. JIT is characterised by frequent deliveries, which may not be viable due to transportation distances and costs involved.

- Large geographical distances involved in long supply chains leads to a lack of visibility and control procedures. This results in supply chain partners taking decisions (e.g. building buffers) without having detailed knowledge of what is happening in the rest of the chain.

- Shorter product life cycles and volatility of demand, often as a result of changing technologies and consumer tastes, increase the risk of product obsolescence within a supply chain. These risks are even greater in the long supply chain: long lead times result in more inventories within the supply chain; and fragmented demand from global locations makes forecasting demand difficult.

Economic uncertainties such as interest rates, market prices, production costs and transportation costs (Schmidt and Wilhelm 1999) can be found in supply chain operations. But long supply chains need to deal with these factors on a larger scale, together with import tariffs, export taxes, different country specific income tax rates and duties, political conditions and trade barriers and regulations (Schmidt and Wilhelm 1999). Other uncertainties in the long supply chain business environment result from:

- greater product complexity, service complexity, and increasing energy prices (www.mckinseyquarterly.com);

- unpredictability of competitors, customers, and changes in production and technology (Vickery *et al,* 1999); and

- cultural differences that exist in selling goods and services in foreign countries (Bhatnagar and Viswanathan, 2000).

Bales *et al* (2004, p. 253) say that uncertainty is an intrinsic element of the aerospace supply chain, where elements of variation include build rate fluctuation, engineering change, product immaturity and issues relating to the accuracy, ownership and format of information. Variations and uncertainties can lead to forecast inaccuracy and supply chain vulnerability, which reduces firm control and frequently removes managers from their areas of competency (Bowersox *et al*, 2000, p. 14). This increases the potential for long supply chain failures. Whilst traditional mathematical and modelling approaches have attempted to account for these long supply chain uncertainties through the incorporation of stochastic features like uncertainty of lead times, reliability of transportation channels, uncertainty of market prices and exchange rate fluctuations (Schmidt and Wilhelm, 1999; Goetschalckx *et al*, 2002), Jain and Benyoucef (2008) claim that they have not been successful.

Multiple firms with different goals operating simultaneously within the long supply chain result in operational and structural complexities. These operational and structural complexities make prediction and control of material and information flows difficult, even with the use of traditional mathematical and modelling approaches (Jain and Benyoucef 2008). Whilst these complexities do exist, some basis for the management of material and information flows in the supply chain may try and control these effects. Supply chain management provides this basis.

2.3 Supply Chain Management

Having provided definitions for a supply chain and a long supply chain, the management of material and information flows in both these short and long supply chains is required. Supply Chain Management (SCM) may provide this basis.

2.3.1 Supply Chain Management definition

According to Ellram and Cooper (1993), Supply Chain Management is “an integrating philosophy to manage the total flow of a distribution channel from supplier to ultimate customer.” SCM has developed from the purchasing and supply perspective and the transportation and logistics perspective to form a common body of literature (Tan, 2001). Literature on ‘short’ SCM is very rich, but there is a scarcity of research dedicated to long supply chain systems (Jain and Benyoucef,

2008, p. 475; Shi and Gregory, 1998, p. 197). Some examples of contributions to the long SCM literature include:

- Mathematical long supply chain programming models that incorporate stochastic features (Schmidt and Wilhelm, 1999; Goetschalckx *et al*, 2002).

- Cost of overseas outsourcing (Song *et al*, 2007; Kumar and Arbi, 2008).

- International manufacturing network capabilities from an Original Equipment Manufacturer's (OEM's) perspective (Shi and Gregory, 1998; Colotla *et al*; 2003).

- De Toni *et al's* (1992) study of the implications on production strategy deriving from globalisation.

The literature examined in this study is primarily based on short supply chain systems, and attempts to incorporate long supply chain concepts where applicable. Within this literature a number of approaches to SCM exist:

- Value stream management, based on the lean manufacturing approach, looks at the parts of firms that add value to a product or service and involves the removal of waste from the supply chain (Hines *et al*, 2000).

- Li *et al (*2006) approach SCM and its practice using the dimensions of strategic supplier partnerships, customer relationships, level of information sharing, quality of information sharing and postponement.

- The Supply Chain Operations Reference (SCOR) model (www.supply-chain.org) takes a process based approach to supply chain management. The supply chain is standardised according to the operational processes of plan, source, make, deliver and return. The basis behind this is to measure, manage and control any supply chain configuration. Whilst the SCOR model is well recognised in industry due to its standardised approach to process and efficiency, it is not orientated towards strategy (Theeranuphattana and Tang, 2008, p. 126) and change management practices (Huan *et al*, 2004, *p*. 25).

- Supply chain maturity models (Stevens, 1989; Aryee *et al*, 2008), which take on an evolutionary approach to supply chain integration, incorporate both “hard issues” such as technology and “soft issues” such as supplier relationships.

- Lambert and Cooper (2000) approach supply chain management by initially looking at the supply chain network structure; followed by documenting the business processes that exist in the supply chain; and finally deciding the level of integration and management of the business processes required within the supply chain network structure.

Whilst the literature portrays SCM from a variety of perspectives, the common goal is to ultimately improve organisational performance and secure competitive advantage through effective SCM practices. This is because competition is no longer between organisations, but among supply chains (Li *et al*, 2006). SCM requires the control of material and information flows within and between supply chain members, both for *short* supply chains (Byrne and Heavey, 2006) and *long* supply chains (Jain and Benyoucef, 2008). Zhou and Benton Jr (2007) explain that effective material and information flows are two sources that can be used to improve supply chain performance. Material flows are considered as effective with best supply chain practice in areas such as supply chain planning, JIT production and delivery practice. Information flow is considered effective with best supply chain practice in areas such as information sharing support technology, information content and information quality. Sahin and Robinson Jr (2005, p. 580) say that it is well accepted by supply chain executives that information sharing and physical flow coordination are can lead to enhanced supply chain performance.

For the purposes of this research, the goal of SCM is the control of material and information flows to improve supply chain performance.

2.3.2 Supply Chain Management levels

Supply Chain Management is applicable on a number of levels. Distinguishing the levels helps to determine the relevant material and information flows between supply chain members. Harland (1996, S63) classifies these levels:

1. The management of the internal supply chain, which integrates business functions involved in the flow of material and information from inbound to outbound ends of the business.

2. The management of dyadic or two party relationships with immediate suppliers and customers.

3. The management of a chain of businesses, including a supplier, a supplier's suppliers, a customer and a customer's customer etc.

4. The management of a network of businesses involved in providing products and services to an end customer.

These classifications can be seen in figure 2.

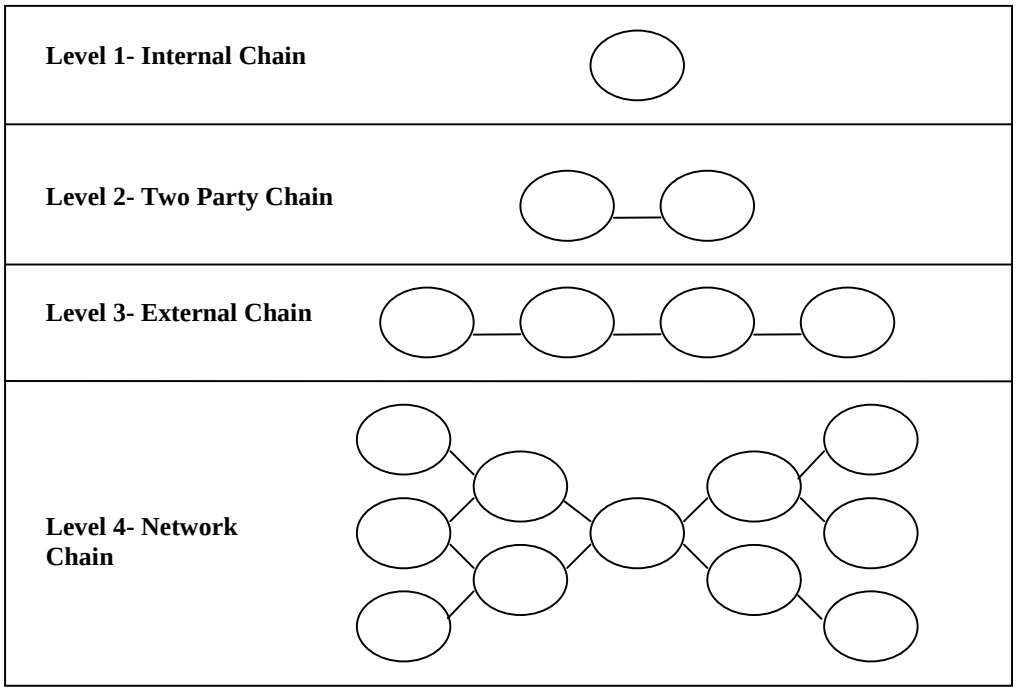

Figure 2: Classification of levels of Supply Chain Management (Harland, 1996, S72)

Whilst the management of a network of businesses is seen as the new arena of corporate competition (Jain and Benyoucef, 2008, p. 484; Harland, 1999), the most important links in the supply network are the dyadic relationships that the firm has with their

immediate suppliers and customers (Slack, 1991, p. 168). It is important to manage the immediate relationships effectively before developing an understanding of the complete supply network. With this in mind:

This research will be limited to looking at the management of the dyadic or two party relationships that the firm has with immediate suppliers and customers.

It is important to note that the focus of this research is the *inter*-organisational material and information flow links between supply chain members. However, as found in Bales *et al's* (2004) research into supply chain management in the aerospace sector, internal firm or *intra*-organisational operations may be indirectly examined in the process, as they have an affect on inter-organisational supply chain issues.

According to Slack (1991, p. 16) manufacturing activities, which are the decisions and tasks that define the extent of manufacturing's area of responsibility, can be clustered around three main areas. These are the management of process technology, the development and organisation of human resources, and the management of flow through the supply network (chain). *With this research focus on long supply chains, the management of flow through the supply chain, both by information flow and material flow will be examined using competitive dimensions.* Competitive dimensions are discussed below.

2.4 Competitive dimensions

Hayes and Wheelwright (1984, p. 40) identify competitive strategy as that a firm pursues to compete in the marketplace. Manufacturing strategy needs to support this overall competitive strategy (Slack, 1991, p. 185). Manufacturing strategy at its highest level can be divided into process and content literature (Voss, 1995, p. 5). Process is concerned with the procedure or pattern in which manufacturing strategy is developed or implemented. Content addresses issues of competitive dimensions, which includes manufacturing capabilities, strategic choices, best practices, trans-national comparison and performance measurement (Dangayach and Deshmukh, 2001, p. 887). According to Harland *et al* (1999), manufacturing strategy can also be applied to a supply network strategy, where

competitive dimensions extend to the end customer and each supply network actor. Harland *et al* (1999, p. 663) says that "supply strategy relates to the integration of supply activities within firms, in dyadic relationships, in chains of firms and in inter-organisational networks". *This research will take competitive dimensions at a manufacturing strategy content level and extend them to a supply chain strategy content level.*

Material and information flows between supply chain members are generally described at a tactical level (Schmidt and Wilhelm, 1999, p. 4). Frohlich and Westbrook (2001) investigated the integration and coordination of material and information flows between suppliers, manufacturers and customers, where integration is the linking of internal processes between supplier, manufacturer and customer. They found that higher levels of integration in the supply chain have a greater association with performance improvement. They say whilst integration and coordination of material and information flows between supply chain members exist on a tactical level, the direction (towards customer/supplier), and to what degree (degree of integration) is a strategic level decision. This research, whilst not looking directly at supply chain integration, will follow a similar approach. *Aspects of material and information flow, which exist at a tactical level, will be examined at a strategic level using strategic competitive dimensions as measurements for examining how long supply chains compete.*

According to Slack (1991, p. 7), the only way to guarantee long term competitive survival is to "make things better" than the competition. To understand how to make thinks better, a set of competitive dimensions can be used. Slack (1991, p. 8) explains that competitive dimensions provide the basic building blocks of competitiveness in manufacturing. Snaddon (1996, p. 387) describes competitive dimensions as the critical success factors that impact on firm profit and contribute to the overall goal of competitive firms. Gunasekaran and McGaughey (2002, p. 1) explain that the dimensions of cost, speed, dependability, quality and flexibility are the primary basis for competition and the very foundation for creating, combating, and sustaining competitive advantage. These competitive dimensions are explained:

- Hayes and Wheelwright (1984, p. 41) describe price, and therefore *cost*, as the most familiar competitive dimension, but as not the only basis on which a business can compete.

- Slack *et al* (2007, p 403) defines *speed* as "how fast customers can be served", and is the elapsed time between a customer requesting a product or service and receiving it in full.

- Slack (1991, p 61) explains *dependability* (sic), or reliability as keeping the delivery promises one makes to the customer. According to Slack (1991, p. 74), it is necessary to first improve dependability before speed of delivery.

- Slack (1991, p 22) describes *quality* as "doing things right." Poor quality slows down product throughput, which affects the speed objective, and poor quality makes the process or product unreliable, affecting the dependability objective.

- Upton (1994, p. 73) defines *flexibility* as "the ability to change or react with little penalty in time, effort, cost or performance".

Contributions from various authors to these competitive dimensions can be found in table 1.

Table 1: Competitive dimensions (adapted from Snaddon (1996, p.388)

Author	**Competitive dimensions**				
	Cost	**Speed**	**Dependability**	**Quality**	**Flexibility**
Hill (1994, p. 34)	price	delivery speed	delivery dependability	product quality and dependability	-
Hayes & Wheelwright (1984, p. 40)	price	-	dependability	quality	Flexibility
Slack (1991, p. 7)	cost	speed	dependability	quality	Flexibility
Chase *et al* (2006, p. 25)	cost	delivery speed	delivery reliability	quality	Flexibility

From table 1, it is assumed that cost is a competitive dimension that a firm would want to reduce. According to Slack (1991, p.

97), “low cost manufacture is a legitimate and desirable manufacturing aim, even when competitive success is not primarily a matter of undercutting the competition”. In addition, Slack (1991, p. 112) explains that the competitive dimensions of speed, dependability, quality and flexibility all contribute both directly and indirectly to low cost manufacture. Increasing speed means materials spend less time in inventory, where it would attract both direct material costs and overhead storage costs. Greater dependability results in reduced overhead costs from chasing late deliveries and rescheduling production. Higher quality reduces rework, scrap and waste. Better flexibility, when changing from the manufacture of one product to another, results in little loss of output.

Ferdows and De Meyer’s (1990) sand cone model describes how to create lasting manufacturing performance improvements using competitive dimensions. In this model, quality, dependability and flexibility (measured as speed of response) should first be in place, in that order, before considering cost efficiency. The idea of the model is that once some results from quality improvements are obtained, efforts should be made in improving the dependability of the production process. Quality improvement efforts still continue to expand whilst improving dependability. Improvement of flexibility is then undertaken, whilst efforts to improve quality and dependability are further enhanced and expanded. Finally, the firm should address cost efficiency improvements, whilst previous efforts continue to expand.

From Slack, it appears that cost can be closely linked to other competitive dimensions, and is assumed to be a competitive dimension that a firm would want to reduce. Ferdows and De Meyer’s sand cone model points out that other competitive dimensions should first be in place before cost can be considered. With this research being exploratory in nature, cost is addressed using Slack and Ferdows and De Meyer’s arguments. The competitive dimensions of speed, dependability, quality and flexibility, as per table 1, are examined in this research.

2.5 Speed

From an operational point of view, speed should be viewed as how long the operation will have to manage the flow of materials and information (Slack, 1991, p 44). The operation of a supply chain is complicated with uncertainties associated with perceived demand, with the quality of information, and the time delays associated with material and information flow (Towill, 1996, p. 16). Lead time reduction within the supply chain is a method of attempting to simplify the supply chain operation and increase overall competitiveness (Stalk and Hout, 1990). De Toni *et al* (1992) explain that the use of time compression can be used to gain competitive advantage in global operations. Stalk and Hout (1990) advocate that the best way to shorten the delivery lead time of the product or service to the final customer is to collapse the time that each member in the chain spends waiting for one another. Firms cannot work in isolation from one another and compress only their internal supply chain cycle time. Therefore these lead time changes need to be driven by a supply chain leader, which may be a supplier or major customer e.g. the OEM. The main ideas proposed by Stalk and Hout (1990) to convert to a time based supply chain are:

1. provide each firm with better and timelier information about product orders and needs;

2. shorten the lead times between firms by removing the obstacles to time compression; and

3. synchronize lead times and capacities among the levels or tiers of the supply chain so that more work can flow up and down the chain in a coordinated manner.

Stalk and Hout's (1990) first idea of providing each firm with better and timelier information about product orders and needs is important, as nothing else moves in manufacturing before information moves (Gunasekaran and Mcgaughey, 2002, p. 1). The first idea will be concerned with information flow from a communication and IT perspective. The second idea of shortening lead times between firms by removing obstacles to time compression is applicable to increasing the speed of both material and information flow. This is because separate methods and techniques that shorten material and information flow lead times exist. The third idea of synchronizing lead times and

capacities among the levels of the supply chain is concerned with material flow. This is because synchronisation of lead times and capacities deals with inventory in the supply chain. Each of Stalk and Hout's three ideas are discussed below. The use of the words *lead time reduction* and *time compression* within this section will be used to indicate an increase in the *speed* of the supply chain operation.

2.5.1 Providing firms with better and timelier information

2.5.1.1 Communication

The importance of information in improving supply chain competitiveness is well known (Stalk and Hout, (1990); Mason-Jones and Towill, (1999); Lee *et al*, (2000); Sahin and Robinson, (2002); Byrne and Heavey (2006)). Better and timelier information allows for effective planning, production and delivery (Zhou and Benton Jr, 2007). Information sharing can increase performance in a make to order environment (Sahin and Robinson, 2005). Information has been identified as a key ingredient in coordinating geographically dispersed firms (Voordjik and Meijboom, 2005, p. 109).

But information is often viewed as an ownership advantage, especially to the OEM, where any loss of control of this information will not allow it to be effectively exploited Childerhouse *et al* (2003a). Bowersox *et al* (2000, p. 10) say that the immediate gains that are generated from such information hoarding are small in comparison to the enhanced service that firms find attainable through sharing relevant information with supply chain partners. Clark and Hammond (1997) looked at the implementation of EDI in US grocery stores in a Business Process Reengineering (BPR) initiative. They find that a traditional win-lose adversarial relationship still exists between the firms, preventing the sharing of information. The firms "are only willing to share information if they perceive that the benefits of this information sharing offset the perceived risks involved." A number of typical information flow problems found in industrial supply chains can be seen in table 2.

Table 2: Typical information flow problems in industrial supply chains (Mason-Jones and Towill (1998), taken from Childerhouse et al, 2003b)

Information Flow Syndrome	**Typical Characteristics**
Information withheld	Supplier wins a contract for a year for 1000 units, but the customer refuses to supply a monthly or weekly forecast- the supplier must deliver what and when the customer wants.
Information masked	The supplier (3rd tier) delivers to an intermediary (2nd tier) before delivery to the customer without any knowledge of the market-the 3rd tier supplier has little opportunity for forward planning.
Information distorted	The customer or OEM supplies a detailed forecast throughout the chain but an intermediate firm (2nd tier) places cyclical demands on its supplier (3rd tier) as the intermediate firm believes that they know best.

Bowersox *et al* (2000, p. 10-11) outline four major shifts that are required to move from information hoarding to information sharing. Firstly, trust, as outlined in section 2.7.1.1, is required to overcome the cultural barriers that exist in enabling information flow. As trust develops between supply chain members, the scope of shared information usually expands. Trust between departments in a firm is required before it can expand to include trust between supply chain members. Secondly managers must take a long term view in sharing information, as the efficiencies obtained through information sharing substantially exceed the profits resulting from the scale of such information. Thirdly, organisations that view information as a key resource manage its exchange in a confidential manner to reduce conflict when conducting business with competing suppliers or in serving competing customers. This may be seen in the use of cross functional teams consisting of personnel from both organisations for the planning of joint operations. Finally, information sharing may take many forms. Information can be shared through the exchange of data files; direct access to databases; shared employees between organisations to facilitate information flow; and through the use of third party logistics providers. Whatever the form that information sharing takes, a substantial increase in

information is required to enhance supply chain integration and performance.

2.5.1.2 Information Technology

The use of Information Technology (IT) systems to enable better and timelier information has been recognised in outsourcing apparel manufacture to low cost countries (Kumar and Arbi, 2008), managing global engineering operations in a changing environment (Zhang *et al*, 2008), and integrating dispersed automotive firms into the global supply chain (Moodley, 2002). Jain and Benyoucef (2008, p. 486) say that whilst IT is an enabler of information sharing in short and long supply chains, the impact of IT technologies like internet, Enterprise Resource Planning (ERP), EDI, product data exchange and logistics management software on supplier buyer relationships is an emerging issue in the management of long supply chains.

IT technologies like Electronic Data Interchange (EDI), a dedicated computer network that links firms together by connecting with each firm's internal network (Slack *et al*, 2007, p 230); and Web-Based Interchange (WBI), which enables communication through the internet/web, can provide performance benefits when used in conjunction with "softer" issues such as trust, risk sharing and technology transfer (Aryee *et al*, 2008, Bailey and Francis, 2008). But technologies like EDI are complex to implement when the supply chain contains many members. (Childerhouse *et al*, 2003a). It is thus necessary to choose supply chain members who largely contribute to the benefit of the supply chain when implementing EDI, and whose involvement will be on a long term relationship basis. The likelihood of EDI adoption is also correlated with firm size, measured in both sales income and number of employees (Hill and Scudder, 2002, p. 383). Therefore the larger a firm, the more efficiency may be gained from automating supply chain activities, and the more likely it is to adopt and finance new technologies. Information from less strategic members can be obtained from traditional channels such as phone, fax and mail.

Business-to-business (B2B) e-commerce, through either internet based auction/procurement sites, or through an online purchasing function on the firm's website can lead to potential gains in the longer and more complicated supply chain (Moodley, 2002, p. 663). With face-to-face interaction in the long supply chain difficult due to geographical distances involved, e-commerce

applications can provide a coordination mechanism between supply chain members. Internet based portals such as covisint (www.covisint.com) and Exostar (www.exostar.com) are two such sites where online auction/procurement and collaborative activities can occur, and include solutions for manufacturing industries like automotive and aerospace. B2B e-commerce between supply chain members for purchasing and information sharing can benefit through the use of EDI, where format and content of the transmission are two issues that require consideration in the implementation process (Childerhouse *et al*, 2003a). Swaminathan and Tayur (2003) provide an overview of e-commerce and e-business activities in the supply chain, with focus on visibility, supplier relationships, distribution and pricing, customisation and real-time technologies.

Moodley (2002) investigated the potential of the internet to integrate South African automotive firms into the global automotive supply chain. Moodley (2002, p. 662) found that international automotive firms (i.e. not located in South Africa) are using the internet not only as a marketing tool, but also for the company's design, engineering, manufacturing, quality, finance, procurement, supply and sales activities. This allows the international automotive firm to create seamless collaborative global supply networks, aiding in information sharing; integrating business processes between supply chain members; and lowering costs. Whilst the international automotive firm is harnessing the internet to gain competitive advantage, it was found that South African automotive firms are primarily using the internet as an online static brochure for their products. Moodley's (2002, p. 671) research, using levels of inventory as a measure, found that supply chain integration in South Africa is behind that of its international competitors. Internet enabled supply chain integration could offer the possibility of reducing inventory levels and shortening cycle times in South African automotive firms.

This research will examine communication between supply chain members, and the use of IT as an enabler of information flow.

2.5.2 Shortening lead times in time compression

According to Towill (1996, p. 17), key improvements resulting from time compression include: improved demand forecasting; quicker defect detection; quicker to market; and the shifting of

the decoupling point towards the customer. These key improvements all contribute to reducing bottom line costs. Childerhouse *et al* (2002b) identified via a European automotive supply chain "best practice" audit that active process time compression and the use of the shortest possible planning period aids in simplifying material flow. Basic tactics for engineering time compression in the supply chain may be achieved by: removing a supply chain process, removing time within a process; operating processes in parallel, also in product development (Stalk and Hout, 1990, p. 241); and through reengineering interfaces between successive processes (Towill, 1996, p. 24). According to Slack (1991, p 54), it is better to focus on eliminating the 90 odd percent of throughput time that is not adding any value to the product before looking at the value adding time. A practical set of techniques to achieve time compression in supply chain echelons, as seen in table 3, is suggested by Evans *et al* (1995). Author contributions explaining these techniques in detail, and whether the technique is applicable to information or material flow is added to table 3 for reference.

Table 3: Practical ways to achieve time compression in supply chain echelons (Evans et al (1995), taken and adapted from Towill (1996, p. 25))

Strategy	Technique	Example	Applicable to material/information flow	Author contributions
Industrial engineering improvements	Set-up time reduction	Single minute exchange of dies	Material	Shingo (1985)
	Handling methods	Container design and conveyor use	Material	Meyers and Stephen (2000)
	Product design	Design for manufacture	Material	Bralla (1999)
Production engineering improvements	Integration of processes	Combine two processes into one	Material/Information	Chase *et al* (2006, p. 153-179)
	Sequencing of processes	Resequencing to postpone variety	Material/Information	Chase *et al* (2006, p. 153-179)
Information technology improvements	Quicker and more accurate data capture	Bar-coding on order paperwork and/or materials packaging	Information	McFarlane and Sheffi (2003)
	Electronic data interchange	Orders, funds transfer or engineering designs transferred instantly	Information	Gunasekaran and Mcgaughey (2002); Hill and Scudder (2006)

Table 3: Practical ways to achieve time compression in supply chain echelons (continued)

Operations engineering improvements	Kanban	Production controlled via actual orders	Material	Lu (1986)
	JIT supplies	Greater frequency and smaller quantities	Material	Womack *et al* (1990)
	Shared call off information	Improved service levels through lower forecast errors	Information	Lee *et al* (2000); Danese (2006)

An example of a production engineering improvement leading to lead time reduction in the long supply chain is seen in the alliance between Motorola and United Parcel Service (UPS), its logistics provider (Bhatnagar and Viswanathan, 2000). Long supply chain structure plays a significant role in the coordination of the distribution and logistics process. Transportation and warehousing add additional lead time in long supply chains due to the geographical distances involved. The number and location of warehouses and substitution of direct shipping for warehousing; distribution of inventory between supply chain tiers; changes in the transportation network, mode of transport and consolidation points; and the distribution of tasks and responsibilities between members in the supply chain impact on the speed competitive dimension. Motorola and UPS restructured its global transportation routes and reduced inbound and outbound logistics times from 111 hours to 72 hours, by changing logistics shipment routings and reducing the routing of goods through warehouses.

Inventory can serve as a buffer against market and operational uncertainties (Jammernegg and Reiner, 2007, p. 183; Jain and Benyoucef 2008, p. 471). Large inventories can aid in time compression by creating a buffer against supplier delivery uncertainty, allowing the firm to respond faster to customer needs. This goes against the Just in Time (JIT) philosophy, which focuses on inventory reduction to create leaner supply chains. But JIT may not be effective for long supply chains, as it makes it more vulnerable to interruptions in supply (Jain and Benyoucef 2008, p. 471).

Shortening lead times in this research will discuss the time barriers that exist between members in the supply chain, with the aim of identifying areas for time compression.

2.5.3 Synchronisation in time compression

Synchronisation of material and information flows is important in controlling and reducing the *bullwhip effect* in the supply chain (Holweg *et al*, 2005). The bullwhip effect, originally diagnosed by Forrester, is the variability magnification of product sales information as one moves from customer to manufacturer, resulting in inventory shortages, accumulations and delays in the supply chain (Chase *et al*, 2006, p 410). Whilst the bullwhip effect is a characteristic of complex supply chain operations, it is

especially evident in the grocery, computer, clothing and pharmaceutical industry where product demand is uncertain (Lee *et al*, 1997, p. 93).

Sharif *et al* (2007) investigates Built to Order (BTO) supply chains in developed and developing countries. Whilst product demand in Built to Order (BTO) environments like aerospace manufacture is more certain than that in Make to Stock (MTS) environments like computer and grocery manufacture, they are generally more complicated to manage due to limited levels of stock and shorter lead times. BTO supply chains in a global setting are even more complex to manage as a result of increased uncertainty. To try and better manage long BTO supply chains and reduce the bullwhip effect, synchronisation of material and information flows is required. A supply chain is fully synchronised if each firm's operational aspects (e.g. inventory replenishment) are visible to both the supplier and customer (Holweg *et al*, 2005). This allows each firm to better plan their own supply operations.

Stalk and Hout (1991) explain that synchronisation can be enabled by:

1. keeping order volumes and order frequencies between supply chain members regular;

2. balancing capacity at each firm in the supply chain; and

3. Keeping regular order lead times for all product varieties within a firm.

The first two of Stalk and Hout's ideas on enabling synchronisation will be examined in this research. Whilst planning and scheduling of product variety in the home appliance or furniture industry could be addressed by keeping regular order lead times (Stalk and Hout, 1991, p. 246), this may not be so within aerospace. This is due to uncertainty being an intrinsic element of the aerospace supply chain (Bales *et al*, 2004, p. 253), as well as process choice in the aerospace industry (discussed in section 2.9). The third of Stalk and Hout's ideas will therefore not be examined in this research.

2.5.3.1 Order volumes and frequencies

Irregular order volumes and order frequencies lead to difficulties in production planning and scheduling activities. If a firm knows when orders are going to be placed, as well as the amount of material contained in the order, internal stability of the firm is increased. The production planning process can be simplified by keeping batch sizes and order points from suppliers regular (Stalk and Hout, 1990). But order volumes may be affected by the economics of transportation (Lee *et al*, 1997, p. 96). A firm may order a full truckload or container of material to save on the costs of transport, which goes against the JIT philosophy of greater delivery frequency and smaller order quantities. In addition, bi-weekly and monthly shipping schedules, especially when transporting goods to and from international destinations, may affect production planning and scheduling (Moodley, 2002). To try and reduce order batching of materials, Lee *et al* (1997) suggest the use of EDI in the ordering process to cut down on the problems and costs of ordering smaller batches of materials; consolidation of smaller batches of goods with other suppliers, possibly using a third party logistics (3PL) provider; and customers spreading their periodic orders from suppliers evenly over time.

2.5.3.2 Capacity constraints

Balancing capacity at each firm in the supply chain is difficult, especially with large product variety. Capacity relates to flexibility, as each firms capacity has to be flexible enough to cope with both volume and product mix changes. A delay in one part of the chain results in a bottleneck, dropping the throughput capacity of the entire supply chain. An awareness of supplier capacity can help identify problems earlier. Stalk and Hout (1990, p. 248) attribute the majority of bottlenecks to firms not using their capacity effectively. Capacity is strongly related to information, as (transparent and pure) timely information allows for early production and capacity planning, resulting in fewer problems.

Synchronisation in time compression in this research will investigate how material order volumes and order frequencies are determined between supply chain members. Possible reasons for capacity constraints in the supply chain will be investigated.

Stalk and Hout's (1990) three main ideas to convert to a time based supply chain lead to the first subproblem to be investigated in this research:

"How do long supply chains compete on speed?"

2.6 Dependability

Uncertainties in the long supply chain have an impact on overall dependability. Consolidation of material goods at central warehouses (Bhatnagar and Viswanathan (2000); ocean freight and customs clearance times (Kumar and Arbi, 2008); supplier delivery uncertainties (Song *et al*, 2007); and quality reworks and machine breakdowns (Slack, 1991) all impact on the ability to achieve dependable operations. According to Slack (1991, p. 63), the focus of dependability should be to meet the required delivery conditions decided by the firm from the supplier, and to the customer. Planning ahead with suppliers and customers and managing internal firm and supplier capacity effectively is the key to meeting required delivery conditions.

Coordination between firms is a requirement to respond to uncertainty in the long supply chain (Shi and Gregory, 1998; Williams *et al*, 2002; Colotla *et al*, 2003; Zhang *et al*, 2008). Processes and procedures to achieve coordination between firms can therefore aid in ensuring dependable operations, as uncertainty affects dependability. A supply chain is fully coordinated when all decisions are aligned to accomplish global system objectives (Sahin and Robinson, 2002, p. 507). Mechanisms need to be developed that can align the objectives of independent supply chain members and coordinate their decisions and activities to improve system performance (Li and Wang, 2007, p. 1). Supply chain coordination mechanisms may be *centralised*, where one entity manages the entire system performance (such as an OEM); or *decentralised*, where entities act independently to manage their individual system performance (Li and Wang, 2007).

Centralised coordination determines the optimal production and inventory policies for all members in the supply chain, and allows for greater bargaining power for the members in volume purchasing (Kraljic, 1983, p. 116). But centralised coordination decreases flexibility of the members within the supply chain, as different regions have different needs and standards. Centralised

coordination also does not take into account that members are separate economic entities that act opportunistically to improve their individual performance (Li and Wang, 2007, p. 11). This of course can lead to issues of governance, where some firms have contracts with competitor firms and conflicting issues can arise (Childerhouse *et al* 2003a). Thus centralising the coordination of all decisions and activities of members in the supply chain is often unrealistic.

Decentralised coordination means independent members within the supply chain may determine optimal production and inventory policies to locally improve performance. Even though many firms have realised that collaboration with supply chain partners does work through the formalisation of relationships and information sharing (Daugherty *et al*, 2006), Li and Wang (2007, p. 12) say that centralisation of inventory and production decisions for a decentralised supply chain is often unrealistic. Li and Wang go on to explain that a decentralised coordination mechanism for a supply chain system should include: an operational plan to coordinate decisions and activities of the supply chain members; a structure to share information among members; and an incentive scheme to allocate the benefits of coordination so as to entice cooperation of all members.

Supply chain dependability can be improved by planning ahead; managing firm and supplier capacity effectively; and measuring delivering dependability (Slack, 1991, p. 72). Planning ahead requires firms to look internally and at suppliers and customers using checklists, maintenance databases and charts to track trends and possible future problems. Managing the firm and its supplier's capacity effectively helps prevent uncertainty in the operation. This is achieved by scheduling a set amount of work that is less than the allocated shift time and using the remaining time for operational improvements. The amount of work is increased incrementally as gains are made. Delivery dependability needs to account for each delivery, and reasons for late or early delivery need to be noted to make possible improvements to increase on time delivery.

Dependability in this research will investigate what processes and procedures are in place between supply chain members to ensure the on-time reliable delivery of goods.

The second subproblem to be investigated is:

“How do long supply chains compete on dependability?”

2.7 Quality

Quality is a multi-dimensional competitive dimension in that it can be interpreted in a number of ways:

- Garvin (1988, p. 49) identified eight dimensions of quality that can provide a framework for strategic quality management. The dimensions of performance, features, reliability, conformance, durability, serviceability, aesthetics and perceived quality can help identify the order winners and possible tradeoffs in meeting the customer’s needs.

- Crosby (1996, p. 24) defined quality as “conformance to requirements”, where requirements are the details of the business that result in customers and co-workers receiving what they have been led to expect.

- Juran (1999), through his quality message of “fitness for use”, approached quality as having an external and internal dimension. External dimensions are concerned with whether the features of the products meet the customer needs and provide customer satisfaction. External dimensions take a strategic view of product quality, following a longer term orientation to ensure the technical specifications of the product are adequate for the customer (Slack, 1991, p. 37). Internal dimensions are concerned with the product being free from deficiencies, thereby preventing reworks, customer claims, field failures etc. (Juran, 1999, p. 2.1). Internal dimensions take a performance view of product quality, are operationally practical and can be used on a regular basis for manufacturing departments (Slack, 1991, p. 37).

Because quality can be interpreted in a number of ways, this research will initially investigate what quality means to each supply chain member. This will establish a context for how quality is managed between supplier, firm and customer.

2.7.1 Quality management

With quality management literature primarily geared towards the internal workings of the firm, supply chain quality management research is limited (Foster Jr, 2008). Quality management literature has often focused on the internal versus external views of quality, with the internal view focusing on process and the external view focusing on the customer (Foster Jr, 2008, p. 461). Supply chain management requires these views to be merged together, with supplier and customer processes incorporated into the firms processes. *Aspects of both internal firm quality and supply chain quality will be addressed in this dissertation.*

Writers such as Deming, Juran, Crosby, Feigenbaum, Ishikawa, Garvin, Shingo, Taguchi, Shainin and Bhote (Bicheno and Catherwood 2005) have especially contributed to internal firm quality management literature, which has lead to the Total Quality Management (TQM) and Six Sigma quality approach known today. TQM approaches quality as affecting all parts of an organisation, and is based on three fundamental concepts of customer focus, continuous improvement, and value of every associate in the firm (Godfrey, 1999, p. 14.6). Six Sigma is the removal of variation in processes to improve quality (Bicheno and Catherwood 2005). Deming's (1982, p. 16) 14 point plan for quality management, where "adoption and action on the 14 points is a signal that management intends to stay in business"; and Crosby's (1996, p. 185) 14 step guideline to quality improvement are significant contributions to quality management literature.

The process of quality management can be guided using Deming's (2000, p. 88) Plan, Do, Check, and Act (PDCA) cycle, or the Juran trilogy (Juran, 1999). The PDCA cycle is a simple but robust embodiment of management as an activity (Marquardt, 1999, p. 11.17), and aids in the continual reduction of waste and improvement of material and information flows between suppliers, manufacturers and customers. The Juran trilogy of quality planning, quality control and quality improvement outlines a quality plan which is achieved through managerial processes. Managerial processes are sequences of activities that convert goals into results (Juran, 1999, p. 2.5). This is a continuous process, where quality improvement results are fed back into the quality planning process. The Juran trilogy has also been applied to supplier relationship management (Donovan and Maresca, 1999), highlighting its applicability in a supply chain

setting. *For this reason, the Juran trilogy will be used to examine the quality competitive dimension with respect to material and information flows in this research.*

The Juran trilogy of quality planning, control and improvement is applicable to aspects of material and information flow as outlined above. Quality planning, which is concerned with determining quality requirements and understanding relationships and trust between supply chain members, relates to information flows. Quality control, concerned with physical quality measurements and systems to evaluate product quality, relates to material flows. Quality improvement, which attempts to improve product quality through management and leadership actions, relates to information flows. Whilst these quality processes may be concerned with either material flow or information flow, the ultimate goal is to improve incoming material quality from suppliers, and outgoing material quality to customers.

2.7.1.1 Quality planning

Quality planning process

Godfrey (1999, p. 14.11) explains that quality planning begins with the identification of customers and their needs, to produce products that respond to those needs. Industry data, expenditure data and total cost of ownership data together with the customer's needs provide the initial inputs into the quality planning process. Processes are then designed that can produce these products. Research and data collection regarding the alternative processes available to satisfy these needs should be undertaken. These processes are run by operations staff in the firm to make the products, which are distributed to customers.

A primary output of the quality planning process is a recommended sourcing strategy, which looks at the procurement methodology for both commodity and strategic items (Donovan and Maresca, 1999, p. 21.19). Deming (1982, p. 23) believed that the firm should take into account the quality of the product, delivery speed and dependability, as well as the willingness of the supplier to cooperate and improve when developing a sourcing strategy. Sourcing strategies like the continuity-involvement matrix (Childerhouse *et al*, 2002, p. 498) and the Kraljic matrix (Kraljic, 1983) can be used to determine how relationships should be structured between supplier and customer. Williamson's (1981) transaction cost economics

framework can be used to determine “make or buy” decisions in the firm. A transaction occurs “when a good or service is transferred across a technologically separable interface” (Williamson, 1981, p. 1544), the technologically separable interface possibly between buyer and seller in different firms. Transaction costs can be used in the administering, directing, negotiating and monitoring of the joint productive teamwork in a firm, as well as in assuring the quality or performance of contractual agreements (Alchian and Woodward, 1988, p. 66).

The creation of long term relationships between supply chain members as a sourcing strategy needs to consider the tradeoffs between establishing long term relationships with suppliers to reduce the costs of selection, negotiation, and transaction execution; and the benefits of spot purchasing in the market (Jain and Benyoucef 2008, p. 480). Bensaou (1997, p. 3) explains that “while strategic partnerships create new value, they are also extremely costly relations to develop, nurture and maintain, in addition of (sic) being extremely dangerous and risky options given the specialised investments or ‘hostages’ tied in”. Bales *et al’s* (2004) case study research into the development of supply chain management within the aerospace manufacturing sector found that partnering is a factor in the evolving structure of the aerospace supply chain. The research found that partnering, a move from traditional adversarial relationships with suppliers, puts in place agreements that facilitate interdependent cooperative relationships. Agreements, possibly including material “buy back” processes, force a high level of cooperation to ensure that material traceability meets tight quality requirements (p. 253). This was done by establishing single points of contact and intra-organisational work groups with key customers and suppliers.

Trust

The establishment of trust between supply chain members is fundamental to the quality planning, control and improvement process (Donovan and Maresca, 1999). According to Illes and Platts (2006, p. 2), “(t)rust means unlimited liability relationships.” Trust reflects the confidence of one party in a two-way relationship that the other party will not exploit its vulnerabilities (Sako, 1991, from Ghosh and Fedorowicz, 2008). Donovan and Maresca (1999, p. 21.23) state that trust cannot be achieved by a single act of signing a long term contract; it must be demonstrated by behaviours and actions over an extended

period of time. As cooperation grows, the degree of trust between supply chain participants increases. This can lead to opportunities for value creation, joint problem solving and innovation. Jain and Benyoucef (2008, p. 480) say that the presence of trust can reduce the specification and monitoring of contracts, provide material incentives for cooperation, and reduce uncertainty. Dyer and Nobeoka (2000) found that some trust is a required condition for knowledge transfer between Toyota and its suppliers, and as one party begins to share with the other party, trust increases. Ghosh and Fedorowicz (2008) looked at the role of governance mechanisms in information sharing among supply chain members in the retail distribution industry. It was found that whilst contracts and bargaining power support the governance of information sharing and material flow coordination in supply chains, trust as a governance mechanism plays a crucial role in sharing information among business partners.

Ghosh and Fedorowicz (2008) identify four types of trust from literature, namely *calculative trust, competence trust, trust in integrity* and *trust in predictability* that explain organisational-level performance and coordination differences within supply chain relationships. Calculative trust reflects an assessment of a partner's likely cooperation, based on the partner's qualities and social constraints. Calculative trust develops in the beginning phases of the business relationship (Kim and Prabhakar, 2004). Competence trust refers to the ability of a supply chain member to perform a task that it says it can perform. Competence trust covers technical, operational, human and financial aspects of a supply chain relationship. Competence trust develops during the early interaction phase (Heffernon, 2004). Trust in integrity is the belief that a supply chain member makes good faith agreements, tells the truth and fulfils their promises in the relationship. Integrity in the supply chain is based on past experiences in the relationship between supply chain members. Trust in predictability is the belief that actions in a supply chain relationship, whether positive or negative, are consistent enough to be forecasted in a given situation. The ability to predict outcomes with a high probability of success is key to the effective and uninterrupted operation of the supply chain.

Quality planning in this research will examine how the case study firm plans for quality with its suppliers and customers, and the role of trust in achieving the planned quality.

2.7.1.2 Quality Control

Quality control process

Quality control is the activity of evaluating actual performance, comparing actual performance to the customers needs, and taking action on the difference (Donovan and Maresca, 1999, p. 21.19). Juran's (1999, 4.5-4.8) quality control process is fundamental to any problem in quality control. The initial step in the process is to ensure a clear definition of quality exists, as outlined in the quality planning stage. The means of measuring this definition of quality then needs to be established, where the critical performance metrics and processes for capturing this information are determined. The critical performance metrics and processes can be established into a performance measurement system.

Performance measurement

A performance measurement system is defined as a "set of metrics used to quantify both the efficiency and effectiveness of actions" (Neely *et al*, 2000, p. 1229). Performance measurement systems such as Kaplan and Norton's (1992) balanced scorecard and the performance prism (Neely *et al*, 2000) try to take a holistic view of a firm's operations. Metrics within these performance measurement systems must link with the strategy of an organisation, be part of an integrated control system, have internal validity and enable proactive management (Morgan, 2004, p. 532). Neely *et al's* (1994) study into the realisation of UK manufacturing firm strategies through performance measurement systems found that managers will attribute greatest importance to those performance measures which most closely match their firm's manufacturing task. So a firm whose competitive strategy is based on quality will attribute greatest importance to quality based performance measures; a firm whose competitive strategy is based on time will attribute greatest importance to time based performance measures. Graham and Ahmed (2000) say that because of stringent standards required in the aerospace industry, a narrow focus on quality assurance is required. A performance measurement system that emphasises quality is therefore to be expected in aerospace manufacture, and needs to encompass incoming supplier materials, manufacturing activities within the firm, and outgoing finished goods to customers. Examples of quality metrics that can be incorporated into performance measurement systems include percentage of

rework, rejects, errors, conformance and scrap; and costs associated with product recalls, liabilities and prevention of defects in the first place (Morgan, 2004, p. 524).

Once the required performance measures are established, the minimum required standards of quality performance e.g. financial, legal, operational and environmental need to be determined. Minimum standards of performance or order qualifiers (Hill, 1994) may be related to the International Standards Organisation (ISO) 9000 quality system, the ISO 14000 environmental system (Donovan and Maresca, 1999, p. 21.22) or specific quality systems required for aerospace manufacture. The actual performance of the defined quality then needs to be measured, and compared to the standard. Deming (1982, p. 22) believed that a firm needs to cease dependence on mass inspection in quality measurement, where routine 100 % inspection is acknowledging that a process cannot make a product correctly, or the specifications make no sense in the first place. The use of statistical control methods like SPC to check whether process quality is in control should be used, because to improve product quality, the variations in process quality must first be in control. Crosby (1996) emphasised prevention and cooperation in quality control, rather than detection and discipline. Quality should have a performance standard of zero defects, which is achieved through the prevention of defects in the first place.

Whilst quality systems like ISO 9000 are important in the establishment of minimum standards of quality performance, it is not the only factor. Yeung's (2008) research into the strategic management of the supplier-firm relationship looked at the effect of Strategic Supply Management (SSM) on company size, process type, ISO 9000 certification and Quality Management (QM) implementation. SSM requires a long term planned effort to create a capable supplier base to meet the buyer's requirements. ISO 9000 requires an organisation to ensure that its supplied components meet the required specifications for its products through the evaluation of a supplier's capabilities and quality systems. QM is viewed as a philosophy that aims to continuously improve the quality of products and processes to achieve customer satisfaction. It was found that ISO 9000 is not significantly related to SSM. This may be because ISO 9000 provides tighter controls on suppliers and provides a more formal inspection process, but does not necessarily lead to a single or a few trusted sources with long term relationships. It was found

that QM practices may facilitate SSM, as it helps a buyer company to develop trust and work closely with its suppliers.

If the actual performance of the defined quality does not meet the standard, action needs to be taken on the difference. Incoming supplier material defects may be analysed through data collection and analysis, supplier site visits or third party evaluations (Donovan and Maresca, 1999, p. 21.22). With greater geographical distances involved in long supply chains, quality control for incoming and outgoing goods to the firm is far more complex than that in short supply chains. Face to face communication or supplier site visits by the firm are not always possible due to these distance constraints, making the rectification of quality problems more difficult. Bi-directional flows of material as a result of incorrect quality goods and documentation from distant supply chain members' impacts heavily on the dependability and speed competitive dimensions. This makes quality control that identifies problems at the source a vital aspect in the long supply chain. No information, to the knowledge of this author, was found in the literature survey to directly address quality control in long supply chains.

Quality control in this research will investigate the quality control process and performance measures used to prevent poor incoming material quality to the firm, and poor outgoing material quality to the customer in the long supply chain.

2.7.1.3 Quality Improvement

According to Juran (1999, p. 5.3), quality improvement is "the activity of raising quality performance to unprecedented levels." Customers are increasingly demanding improved quality from supply chain members, and the demands may go beyond product improvement and extend to improving the system of managing for quality (Juran, 1999, p. 5.7). Juran (1999) approached quality improvement "project by project", using a Cost of Quality (COQ) approach. Cost of Quality helps to quantify the size of the quality problem to help justify an improvement effort; to guide the development of that effort; and to track progress in the improvement activities (Gryna, 1999, p. 8.1). COQ quantifies the effects of poor quality according to failure, prevention and appraisal costs. Similar to the COQ approach, Crosby (1996) classified the cost of not getting the product or service correct as "PONC", or the Price of Non-conformance. PONC allows

management to determine where to concentrate prevention efforts.

While justification of quality improvement efforts can be done using the COQ or PONC approach, upper management participation is required to achieve a high rate of annual quality improvement. This is advocated by Juran (1999) in his Quality Council, Deming (1982) in his 14 point plan for quality management, as well as in Crosby's (1996) 14 step guideline to quality improvement. Kuei *et al's* (2001) investigation into the relationship between supply chain quality management practices and organizational performance found that top management leadership leads to improved organisational performance. Top management leadership and the coordination of quality improvement activities may be provided by a main member in the supply chain, possibly the OEM.

Dyer and Nobeoka's (2000) research into the Toyota supply chain found that Toyota, as an OEM, facilitates continuous improvement with its suppliers to reduce waste and improve its competitive position. This is primarily achieved through the use of the *kyoryoku kai*, or supplier association. According to Hines and Rich (1998, p. 526), a supplier association "may be defined as a mutually benefiting group of a company's most important suppliers brought together on a regular basis in order to achieve strategic and operational alignment through the development of awareness, education and implementation programmes designed to achieve both radical and incremental improvements." Toyota's dependence on meetings as an integrating mechanism in the supplier association ensures direct person to person contact and provides an open channel of communication both at work and in later social encounters. The senior team, which meets every two months, is made up of presidents of major suppliers and key Toyota management. The purpose of the senior team is to set policies, steers the direction, and discuss target areas for the supplier community. This information is then used to direct the activities of the three process teams (Hines and Rich, 1998, p. 527-530):

- The first process team, consisting of all suppliers, involves information exchange and discussions of how outline targets might be achieved.

- The second process team is concerned with the externalisation of key internal processes within Toyota. The purpose is to identify how respective cross-organisational processes can be coordinated between individual suppliers and Toyota, as well as seeking ways to improve similar processes within their own company.

- The third process team, or action team, are series of small splinter groups that actually implement improvements in one or more companies.

The supplier association has developed from Toyota and its direct suppliers alone, through to Toyota's direct suppliers developing supplier associations with their own suppliers. This has resulted in virtually all members of Toyota's complete supplier network of direct and indirect component suppliers being involved in at least one Toyota deployed supplier association. In this way know-how or "learning" knowledge, as well as explicit or "day-to-day" knowledge that leads to sustainable advantage can be shared (Dyer and Nobeoka's, 2000).

The supplier association, which relies heavily on face to face meetings, may be difficult to centralise in the long supply chain. Toyota response to global operations was to create overseas supplier associations based around Toyota's overseas facilities, as in supplier associations developed by US or UK plants (Hines and Rich, 1998, p. 527). In this way a localised supplier association based on geographical location is formed, facilitating improvement activities. Adoption of supplier associations by other industries besides automotive in North America and Europe include telecommunications, steel, medical equipment and aerospace. Potential problems found by Hines and Rich (1998) in emulating supplier associations in North America and Europe can be seen in table 4.

Table 4: Potential problems in emulating supplier associations (Hines and Rich, 1998, p. 531)

1. Lack of understanding of the supplier association concept and its Japanese precursors
2. Traditional inertia in changing from arms-length buyer-supplier relationships
3. A lack of necessary sophistication, knowledge, skills and ability within the buyer's purchasing department
4. A lack of cross functional involvement from the buying (and supplier) companies
5. Lack of motivation among suppliers to increase their technological ability to develop new methods
6. Defensive attitude towards Japanese inspired methods
7. A tendency for suppliers to reject large commitments and too much dependency on one customer
8. Cultural differences between Japan and the West
9. Wholesale copying of Japanese approaches without sufficiently localising them
10. The development of unrealistic expectations, particularly in the early stages of implementation
11. Inability of firms to share the strategies, skills and benefits of improvements
12. The generally short term focus of European and North American companies meaning that investments such as supplier association involving primarily medium and long term gain are often shunned
13. A lack of checks and balances within an implementation programme
14. A failure to explain the requirements of the customer to the suppliers or of the suppliers to the customer
15. A suspicion among suppliers as to the motives of the customer organisation

To try and overcome problems in setting up supplier associations, the objectives, approach, timing and methods deployed must be developed for each particular case (Hines and Rich, 1998, p. 532). Hines *et al* (1998) put forward the value stream model as a method of developing a supplier association. Suppliers for the association are identified according to a Pareto split, where supplier product or value streams for analysis are based on volume and value of sales. Value stream mapping is then used to identify wastes in the supplier value stream, with the aim of integrating suppliers and making improvements in the supply

chain. Wastes involved in the supplier value stream are: overproduction; waiting; transportation; inappropriate processing; unnecessary inventory; unnecessary motions and defects (Bicheno, 2004, p. 14-18). A support structure is put in place to steer the programme, and ensure that a critical target based on waste minimisation is set for the supplier association. Suggested improvement goals are proposed by both the buyer firm and the suppliers, with action taken on the top rated suggestions. The team of Hines *et al* (1998), the buyer and the supplier initially monitors these improvement goals. A final step in the development of the supplier association is to put in place a self sustaining future action plan that is not dependent on outside facilitation.

Quality improvement in this research will address improvement activities that the firm undergoes with its long supply chain suppliers and customers.

Using the Juran trilogy of quality planning, quality control and quality improvement, the third subproblem to be investigated is:

"How do long supply chains compete on quality?"

2.8 Flexibility

In the literature below, the meaning of flexibility is first examined, followed by how flexibility can be achieved by supply chain members.

2.8.1 Meaning of flexibility

Flexibility is often viewed as an adaptive response to environmental uncertainty (Gupta and Goyal 1989; Gerwin 1993), and is required for a firm to respond quickly and efficiently to a dynamic market (Vickery *et al* 1999, p 18). Jain and Benyoucef (2008, p. 481) say that to be competitive in a dynamic and uncertain business environment, long supply chains must be flexible and responsive.

Flexibility is applicable to the internal or manufacturing firm, as well as the supply chain. The large amount of research on the topic of flexibility has generally been confined to the firm itself (Duclos *et al* 2003, p. 446), with manufacturing flexibility

contributions from Slack, (1991), Gerwin (1993) and Upton (1994). Little work has been done specifically on supply chain flexibility, with contributions from Vickery *et al* (1999), Das and Abdel-Malek (2003), Duclos *et al* (2003), Garavelli (2003) and Sánchez and Pérez (2005). But supply chains, which are seen as a source of competitive advantage, extend beyond a firms boundaries, and require flexibility strategies to do so as well.

This research will initially investigate what flexibility means to the supplier-firm and customer-firm units in this study. For the purposes of this study, flexibility will mean an adaptive response to environmental uncertainty. This environmental uncertainty may be found in the firm (manufacturing flexibility) or outside of the firm (supply chain flexibility).

2.8.2 Achieving flexibility

Flexibility in this research is considered in a cross enterprise setting, so components of manufacturing and supply chain flexibility are discussed below. Greater emphasis is placed on the supply chain flexibility literature, as the focus of this research is on the supply chain. Flexibility will apply to material or information flows where relevant, due to the diverse nature of elements of flexibility.

Manufacturing flexibility

Manufacturing flexibility allows operations to maintain and improve performance in spite of *variety, uncertainty and ignorance* (Slack, 1991, p. 79). *Variety* is the range of product, volume, processing characteristics etc. with which a manufacturing operation has to cope with. *Short term uncertainty* can be seen as the deviations from the expected supply, demand and processing characteristics. *Long term uncertainty* is the lack of certainty over emerging product and market conditions. *Ignorance* may result from a lack of overall firm strategy, and manufacturing flexibility allows the manufacturing function to adapt to future conditions that it may not have anticipated. A number of authors have approached manufacturing flexibility from different perspectives:

- Slack (1991) takes a systems perspective on flexibility dimensions that affect a firm's competitiveness. Systems flexibilities outlined by Slack (1991, p. 83) are composed of new product flexibility, mix flexibility, volume

flexibility and delivery flexibility, and have range and response components to them.

- Gerwin (1993) looks at manufacturing flexibility from a strategic and a systems perspective, proposing a framework that can be used as a basis for identifying specific flexibility dimensions. The flexibility framework links environmental uncertainty, strategy, required manufacturing flexibility, methods for delivering flexibility and performance measurement.

- Upton (1994) looks at internal flexibility as the capabilities that a firm nurtures in order to respond to its external environment. These internal flexibilities are characterised in terms of dimension, time horizon, and elements.

Supply chain flexibility

Supply chain flexibility is an important dimension within the supply chain network as an adaptive response to uncertainty. Sources of uncertainty may be found in supplier lead times, market demand, product quality and information delays (Giannoccaro *et al*, 2003). A number of authors have approached supply chain flexibility from different perspectives:

- Vickery *et al* (1999) looks at supply chain flexibility from an integrative customer-oriented perspective. From this perspective supply chain flexibility encompasses those flexibilities that directly impact a firm's customers, and are the shared responsibility of two or more functions along the supply chain. Functions along the supply chain can be internal, such as marketing, or external, such as suppliers or distributors. Supply chain flexibility dimensions include product, volume, launch, access and distribution flexibility.

- Duclos *et al* (2003) proposes a conceptual model of supply chain flexibility which looks at the cross-enterprise nature of supply chain flexibility. Supply chain flexibility includes the flexibility within firm and between partners in the chain, including internal firm departments, suppliers, 3PL logistics providers and customers. It also includes the ability to gather and transmit information throughout the supply chain. Supply chain flexibility dimensions include

operations, market, logistics, supply, organisational and information systems flexibility.

- Garavelli (2003) looks at process flexibility and logistics flexibility as the two main aspects of supply chain flexibility. Process flexibility of each plant in the supply chain is concerned with the number of product and types that can be manufactured at the supplier or assembler. Logistics flexibility is related to the logistics strategy which can be adopted to release a product to market (downstream flexibility), or to procure a component from a supplier (procurement flexibility). Logistics flexibility is the possibility of shifting the production of either a component or final product to different sites in a given stage of the supply chain. This logistics flexibility helps to reduce the impact of customer demand and process variabilities on supply chain performance.

- Sánchez and Pérez (2005) framework of supply chain flexibility dimensions includes process and logistics flexibility. This framework looks at the supply chain from three levels, these being the basic, system and aggregate levels. This is a similar approach as taken by the manufacturing flexibility literature (Gerwin 1993). Sánchez and Pérez look at the effect of supply chain flexibility on firm performance in the automotive industry. It was found that supply chain flexibilities have an impact on firm performance, although not all flexibilities are equally important. Supply chain flexibility dimensions include product, volume, routing, delivery, responsiveness to target market, transhipment, postponement, sourcing, launch and access flexibility.

- Slack's (1991, p. 84) system flexibilities of product, mix, volume and delivery flexibility also dictate the supply chain resources required to compete effectively. Resources include product, mix, volume and delivery flexibility.

Table 5 provides a classification of some common manufacturing and supply chain flexibility dimensions across the literature. Each of the dimensions is explained below the table.

Table 5: Classification of manufacturing and supply chain flexibility dimensions across the literature

Author	**Flexibility dimensions**				
	Product	**Volume**	**Delivery**	**Logistics**	**Supply**
Slack (1991)	New product	Volume	Delivery	-	-
Vickery *et al* (1999)	Product	Volume	Delivery	-	-
Duclos *et al* (2003)	Operations	Operations	-	Logistics	Supply
Garavelli (2003)	Process	Process	-	Logistics	Sourcing
Sánchez and Pérez (2005),	Product	Volume	Delivery	Transhipment	Procurement

Product flexibility, as defined by Vickery *et al* (1999, p. 17) above is "the ability to handle difficult, nonstandard orders, to meet special customer specifications, and to produce products characterized by numerous features, options, sizes and colours." Product flexibility requires the effective collaboration of all of the players in the supply chain, including marketing, product design and development and engineering. Product flexibility in this framework is taken to include *mix flexibility*, which is the ability to change the variety of products being made by the operation (Slack, 1991).

Volume flexibility is the ability to effectively increase or decrease production quickly in order to meet customer demand (Hayes and Wheelwright 1984, p. 40). Volume flexibility directly impacts customer's perceptions by preventing stock outs for products that may suddenly be in high demand. Volume flexibility may require close coordination between a manufacturer and its suppliers, especially during increasing demand.

Delivery flexibility is the firms' capability to adapt lead times to the customer's requirements (Sanchez and Perez, 2005), by having the ability to change planned or assumed delivery dates (Slack, 1991).

Logistics flexibility is the ability to cost effectively deliver and receive products as sources of supply and customers change (Garavelli, 2003). Logistics flexibility is highly dependent on the capabilities of outsourced logistics providers in long supply chains.

Supply flexibility is related to the firms' ability to find another supplier for each specific component or raw material. Sourcing flexibility or supplier flexibility can also be seen as the robustness of the buyer supplier relationship under changing supply conditions (Das and Abdel-Malek, 2003, p. 171). A highly flexible relationship is one in which there is little deterioration in procurement price under varying order quantities and varying supply lead times.

A number of manufacturing and supply chain flexibility dimensions are found in literature. With the possible line of questioning to explore all these dimensions to achieve flexibility being large, this research will not address individual dimensions. Instead, ways of achieving flexibility will be based on the interviewee's opinion, which will be linked back to literature where possible.

The fourth subproblem to be investigated is:

"How do long supply chains compete on flexibility?"

The competitive dimensions of speed, dependability, quality and flexibility have been examined in section 2.5 to section 2.8. Literature below describes long supply chains in the South African aerospace industry. This provides background to understand how long supply chains compete on the dimensions of speed, dependability, quality and flexibility.

2.9 South African Aerospace Long Supply chains

2.9.1 Background

Bales *et al* (2004, p. 253) explains that the global aerospace market is increasingly influenced by offset and technology transfer issues, with OEM's looking to low cost places like China to exploit these opportunities. South Africa can be seen as positioned in this global aerospace market for the manufacture of OEM aerospace components. Whilst the South African industry is providing services that are cost effective on an international scale, they are becoming expensive compared to India, China and the Eastern block (Haupt, 2005, p. 15). With aerospace component manufacture outsourced to South Africa from northern hemisphere countries, shipping costs are high and delivery times are long. These cost and time barriers involved in the importing of material and the exporting of finished products erode South Africa's competitive advantage when competing in global aerospace markets. Previous research into South African composite manufacturers practices (Snaddon and Reid, 2007) which included aerospace firms, identified supply chain management as an area needing further research to improve firm competitiveness.

2.9.2 Classification of firms

To establish a context of how long supply chains in the South African aerospace industry compete, the classification of firms with these long supply chains is required. Firms, including aerospace firms, can be manufacturing based firms or service based firms, or both. For the purposes of this research, a manufacturing based firm mainly involves a transformation process that converts physical inputs into physical outputs. Examples of manufacturing include aerospace interior and exterior component manufacture, chemical manufacture, and assembly operations. For the purposes of this research, a service based firm involves mainly intangible processes (Chase *et al*, 2006, p. 12). Examples of services include transportation and distribution of aerospace goods, and the maintenance and repair of aerospace products. Firms that include both manufacturing and service are not classified as such in this research.

Manufacturing firms can be further classified according to the process choice employed to manufacture products. Hill (1994, p.

94) highlights the five generic types of manufacturing process as *project, jobbing, batch, line* and *continuous processing*. The main decision in manufacturing process choice is what volume of product is to be made (p. 99). Chase *et al* (2006, p. 266-267) describes service firms according to *customer contact, creation of the service,* and *extent of contact*. Customer contact refers to the physical presence of the customer in the service; creation of the service refers to the work process involved in providing the service itself; and extent of contact may be roughly defined as the percentage of time the customer must be in the system relative to the total time it takes to perform the customer service.

This research will classify a firm according to whether it is a manufacturing based or service based firm.

2.9.3 Supply chain structure

The structure of a supply chain may differ according to product and/or industry. Hau Lee (2002) provides a classification of supply chain structure according to supply and demand uncertainty:

- *Efficient supply chain:* A supply chain aimed at achieving the greatest cost efficiency e.g. Food at a supermarket

- *Responsive supply chain:* A supply chain that is responsive and flexible to the needs of its customers e.g. Computers

- *Risk-hedging supply chain:* A supply chain that uses multiple sources of supply, possibly with other firms, so as to share possible risks in supply disruptions e.g. Multiple sources of electricity supply

- *Agile supply chain:* A supply chain that is responsive and flexible to the needs of its customers, whilst using multiple sources or pooling inventory and capacity to share possible risks in supply disruptions. This combines the properties of the *responsive* and the *risk-hedging* supply chain e.g. High-end computers

Whilst Hau Lee's classification is not used in this research, it illustrates that supply chains may differ by product and/or industry. Explanations are provided below for the supply chain

structure of the automotive and aerospace industry for comparison. Even though output volume of the motor industry is greater than that of aerospace, both are manufacturing industries that operate on a global scale. This may allow for some comparison.

Automotive industry supply chain structure

Moodley's (2002, p. 659) research into internet enabled supply chain integration in the South African automotive industry describes relationships within and between automotive supply chains in the past tending to be fixed, linear and clearly demarcated. Rich and Hines (1997, p. 216) say that collaboration in the Japanese lean networking model, such as that employed at Toyota in the automotive industry, has resulted in a highly structured and tiered supply chain. The focal purchasing organisation of the supply chain e.g. Toyota, is supplied by a comparatively small number of direct suppliers who provide entire sub-assemblies rather than component parts. The traditional parts suppliers, who no longer service the material requirements of the focal organisation, instead provide parts to the direct suppliers. The ability to integrate suppliers at all levels is aided by the small and medium-sized enterprises operating at the lower tiers of supply. These companies are flexible, responsive, often lack a formalized management structure and are keen to integrate with resources of larger customers. Figure 3 illustrates the tiered approach used in an automotive supply chain like Toyota.

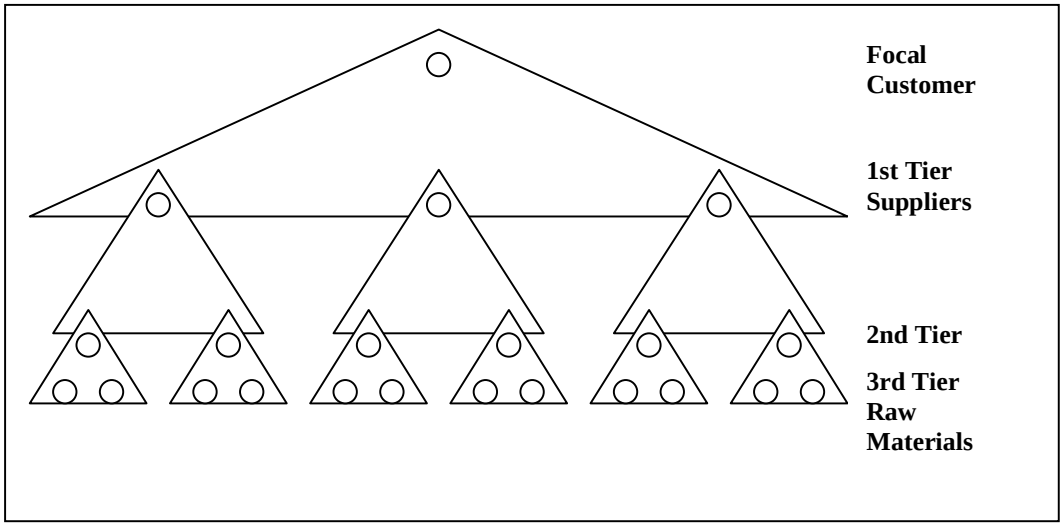

Figure 3: Tiered approach used in an automotive supply chain (Rich and Hines, 1997, p. 216)

Aerospace industry supply chain structure

Rose-Anderssen *et al* (2009, p. 252) explain that globalisation is leading to the integration of aerospace firms into just a few large groups, with local western suppliers being replaced to some extent by low cost country suppliers in the global market place. Bales *et al* (2004, p. 252) say that the outsourcing of periphery activities by large aerospace firms has altered the shape of the supply chain. As a result, the overall number of supply chain aerospace firms has decreased, but the subcontract base now carries out a greater volume of manufacturing work and of an increasingly complex nature.

The global aerospace industry can be broken down into five (product-type) tiers, which perform well-defined functions (Haupt, 2005, p. 8). Whilst these tiers are well-defined from a product-type perspective, they are less so from a firm operational perspective. Williams *et al's* (2002, p. 704) research into where strategic capabilities should lie within global aerospace supply chains found that firms nearly always operate in more than one tier of the supply chain. Williams *et al* (2002) uses the term supply *web* rather than supply *chain* to highlight the complexity of the global aerospace industry.

Table 6 illustrates these five tiers of the global aerospace industry as described by Haupt (2005). Both international and South African and firms operate to various degrees in all five tiers.

Table 6: Industry tiers illustrating global aerospace supply chain structure (Haupt, 2005, p. 9-10)

Tier	Description	Descriptors
One (Complete system)	An entire aircraft with all the required sub systems already fully integrated. This tier could also include logistics support, upgrade and maintenance of the system for a specified period	• Highest value added products • System/ business integrator level • Low volumes • High level human resources • Very little manufacturing • Mostly assembly
Two (Major sub-system)	Sub-systems that are made up out of a significant number of minor sub-systems e.g. Complete avionics system. This would still involve a level of system integration not dissimilar from the first tier	• High value added products • System integrator • Low volumes • High level human resources • Little manufacturing • Assembly
Three (Minor sub system)	A defined assembly of components indivisible into other systems e.g. Gearboxes	• Medium value added products • Sub-contractor • Medium volumes • Medium level human resources - production skills • Manufacturing • Assembly intensive

Table 6: Industry tiers illustrating global aerospace supply chain structure (continued)

Tier	Description	Descriptors
Four (Component)	A device with a clear function that is of no use unless integrated into a tier 3 system e.g. Electrical circuit boards	• Medium value added products • Sub-contractor • High volumes • Medium level human resources-production skills • Predominantly manufacturing • Assembly intensive
Five (Part)	A unit that can be defined as a single monolithic part. In some cases the part has not had any value added to it through for instance assembly or machining processes e.g. Un-machined castings	• Low value added products • Sub-contractor • Highest volumes • Medium level human resources • No integration • Solely manufacturing • No assembly

From the literature, a major difference between automotive and aerospace supply chain structure appears to be that:

- the automotive supply chain is fixed, linear and clearly demarcated, resulting in a tiered supply chain addressing a focal organisation; whereas

- the aerospace supply chain may have firms operating in more than one tier of the supply chain, addressing multiple organisations needs. This leads to greater supply chain complexity.

As a result of this complexity, case study firms in this research are not chosen according to a defined supply chain structure such as that given in table 6. This is not deemed problematic, due to the exploratory nature of this study.

2.10 Framework for research

The literature review above provides a strategic overview of a supply chain and long supply chain; an explanation of supply chain management and its control of material and information flows within and between supply chain members; an overview of the competitive dimensions of speed, dependability, quality and flexibility; and the background and classification of South African aerospace firms and supply chains. To focus this dissertation, a framework containing elements from the literature is constructed. *The framework uses three levels of qualitative measurement when classifying data, these being: First-order measurement*; *Second-order measurement; and Third-order measurement.* The competitive dimensions of speed, dependability, quality and flexibility from literature provide the first-order measurements. Second-order and third order measurements flow from these first-order competitive dimension measurements.

Even though the management of a network of businesses is seen as the new arena of corporate competition (Jain and Benyoucef, 2008, p. 484; Harland, 1996), the most important links in the supply network are the dyadic relationships that the firm has with their immediate suppliers and customers (Slack, 1991, p. 168). Research by Heide and John (1990) investigates how a purchasing firm manages its relationship with its direct suppliers (supplier-firm relationship), whilst Anderson and Narus (1990) explore the

relationship between a manufacturer and its distributors (customer-firm relationship). Frohlich and Westbrook (2001) investigate upstream and downstream integration strategies with direct supplier and customer (supplier-firm relationship and customer-firm relationship), and note that there is more emphasis on research on the supplier-firm side. *The units of analysis in this study focus on both the direct supplier-firm relationship, and the direct customer-firm relationship.* This is done as this research is exploratory in nature, and aims to identify issues on both the supplier side and customer side for further research. Whilst activities between the supplier, firm and customer such as warehousing, distribution and transportation do exist, they are indirectly addressed within the supplier-firm and customer-firm units of analysis. Aspects of bi-directional material and information flows between supplier, firm and customer are examined using the competitive dimensions.

The *speed* competitive dimension uses Stalk and Hout's (1990) three main ideas to convert to a time based supply chain as second-order measurements:

- The first idea is to provide each firm with better and timelier information about product orders and needs. This examines communication between supply chain members, and the use of IT as an enabler of information flow as third-order measurements.
- The second idea is to shorten the lead times between firms by removing the obstacles to time compression. This discusses the time barriers that exist between members in the supply chain, with the aim of identifying areas for time compression.
- The third idea is to synchronise lead times and capacities among the levels or tiers of the supply chain so that more work can flow up and down the chain in a coordinated manner. This investigates the third-order measurement of how material order volumes and order frequencies are determined in the long supply chain; and the third-order measurement of reasons for capacity constraints in the long supply chain.

The *dependability* competitive dimension investigates, as a second-order measurement, what processes and procedures are in place between supply chain members to ensure on-time reliable delivery of goods.

With *quality* having a number of dimensions to it (internal, external, aesthetic etc.) the meaning of quality specific to that firm is first investigated. The quality competitive dimension is examined using Juran's (1999) quality trilogy, classifying quality into the second-order measurements of quality planning, quality control, and quality improvement. Because quality is a large topic, the quality trilogy second-order measurements help focus the overall quality competitive dimension:

- Quality planning examines the third-order measurement of the quality planning process with suppliers and customers, and the third-order measurement of trust to achieve the planned quality.
- Quality control investigates the third-order measurement of the quality control process, and the third-order measurement of performance measures that the firm uses to prevent poor incoming material quality to the firm, and poor outgoing material quality to the customer in the long supply chain.
- Quality improvement addresses improvement activities that the firm undergoes with its long supply chain suppliers and customers.

The competitive dimension of *flexibility* is not a simple single aspect of performance (Slack, 1991, p. 81). This research initially investigates what flexibility means to the case study firms, followed by how the firms achieve flexibility in the long supply chain as second-order measurements.

An additional competitive dimension called *other* investigates interviewee perceptions of what other than that examined in the *speed, dependability, quality* and *flexibility* dimensions may improve long supply chain competitiveness for supplier, firm and customer. These criteria may be either inside or outside the control of the firm e.g. legislation, political influence etc.

The long supply chain literature framework that will be used for this dissertation is outlined in figure 4.

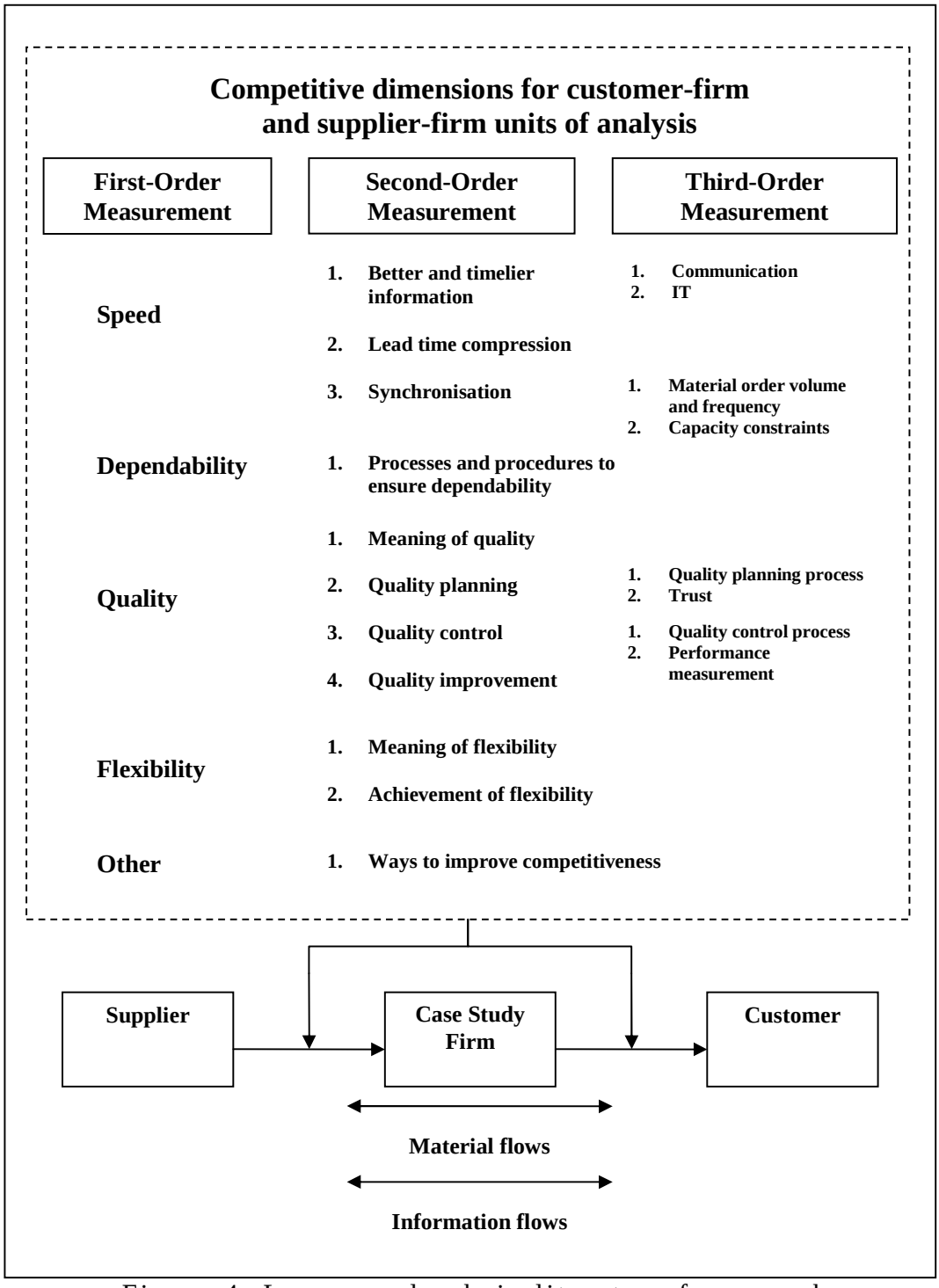

Figure 4: Long supply chain literature framework

3. RESEARCH METHODOLOGY

The research methodology includes inputs from the pilot study and the main study where applicable.

3.1 Empirical research

Empirical research is used here to describe field-based research which uses data gathered from naturally occurring situations or experiments (Flynn *et al,* 1990, p. 251). Empirical research is required in complex systems involving people and equipment, and it tries to explain the situation or experiment in its environment (Snaddon and Reid, 2007, p. 20). This is in contrast to laboratory or simulation studies, where researchers can isolate the situation or experiment from extraneous effects, thereby giving more control over the events being studied (Flynn *et al,* 1990). Supply chains are complex and dynamic in nature (Choi *et al*, 2001), and require an understanding of people and equipment in the operating environment. Therefore empirical research is applicable in this context. Flynn *et al* (1990, p. 257) outlines a number of approaches in empirical research, in the form of *field experiments, panel studies, focus groups, surveys* and *case studies*. Each approach is briefly explained below.

- *Field experiments* involve the manipulation of some aspect of the natural environment and then the systematic observation of the resulting changes.

- *Panel studies* obtain the consensus of experts in defining terms and making predictions on a subject matter. Experts respond in writing to a series of questions, which are anonymously distributed to all members of the panel, who can change their responses. This is performed until consensus is reached.

- *Focus groups* are similar to panel studies, but the group is physically assembled and the response is given to the entire group verbally rather than in written form. Discussion occurs with the goal of reaching consensus.

- The *survey approach* relies on self-reports of factual data, as well as personal opinion. A survey may be administered to a group which is homogenous with respect to at least one

characteristic, with the aim of determining whether the characteristic occurs or not.

- The *case study approach* is an in-depth examination of a contemporary phenomenon, where the investigator has little control over events (Yin, 2003, p. 9). The case study approach can be seen as a either a single case study or a multiple case study. The aim of the case study is to develop an understanding of "real world" events (McCutcheon and Meredith, 1993, p. 240). The case study is exploratory in nature, as it attempts to determine "how" or "why" events occur (Yin, 2003, p. 6).

The empirical case study approach is used for this research dissertation. The literature review did not find any literature specifically examining long supply chains in the South African aerospace industry, and how they compete. Therefore this research can be seen as exploratory in nature, as it is to determine *how* long supply chains in the South African aerospace industry compete. In addition, the aim of this research is to develop an understanding of the "real world" of long supply chains, where the investigator has little control. Leedy and Ormrod (2005, p. 144) say that the purpose of the case study is "To understand one person or situation (or perhaps a very small number) in great depth." This makes the case study approach the most viable of the empirical methods.

3.2 Case study approach

The single case study approach examines a particular situation which is unlikely to occur again. Multiple case studies examine several related situations, where links between the situations may highlight similar aspects. As the goal of this research is to determine how long supply chains compete, the use of several South African aerospace firms provides a better idea of operating practices than a single firm. This research therefore uses the multiple case study approach.

Multiple case studies follow replication logic, where the original findings in the first case study are replicated in subsequent case studies. This replication logic requires a rich theoretical framework for generalising to new cases, where the conditions under which a particular phenomenon is likely to be found (literal replication), as well as the conditions when it is not

likely to be found (theoretical replication), are stated (Yin, 2003, p. 47).

The replication approach used in designing multiple case studies is seen in figure 5. The initial step consists of theory development, followed by case selection and the definition of specific measures in the design of the data collection protocol. Each individual case study requires evidence to indicate whether the research questions are demonstrated or not, as well as its conclusions. Each of the individual case study conclusions provides the information needing replication by other individual cases. Cross case conclusions indicate the extent of the replication logic, and whether the predictions from theory produce the required results. The dotted feedback loop in figure 5 represents an instance where an individual case study does not suit the original design, requiring the redesign of the propositions from theory, or a change in the data collection protocol. This is necessary as adhering to the original research design when a discovery is made means that the data reporting process only suits the original theoretical propositions, ignoring or distorting the discovery.

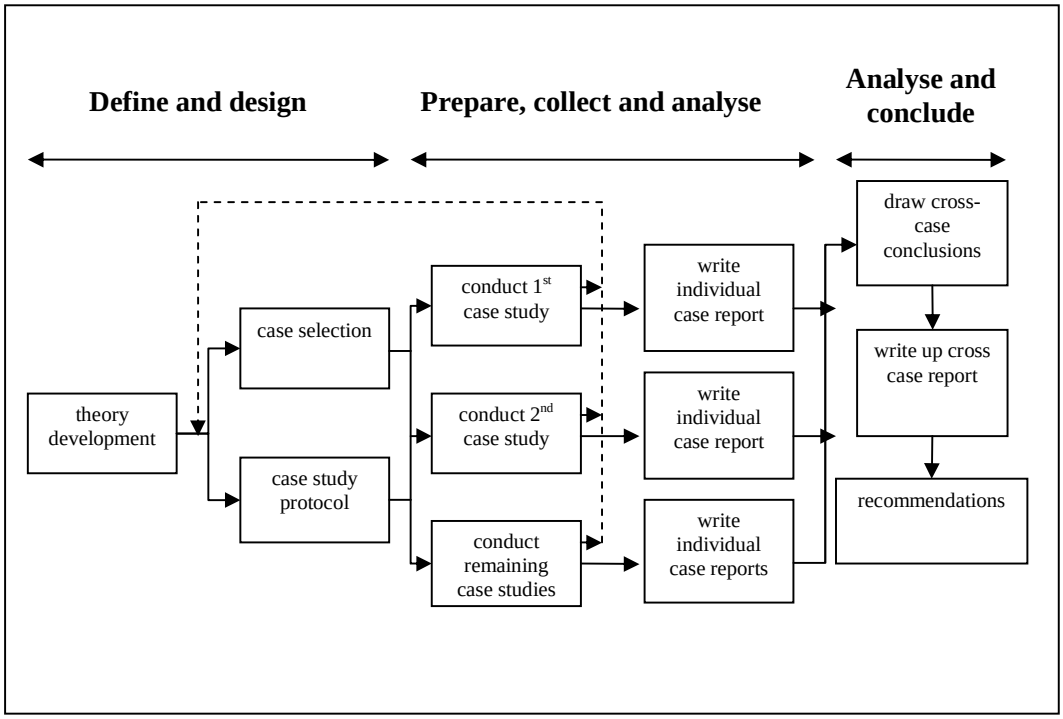

Figure 5: Multiple case study method (Yin, 2003, p. 50)

Theory development is performed in section 2 of this report. Theory development prior to the collection of case study data is an essential step in doing case studies. Theory development aids in defining the appropriate research design and data collection, but also becomes the main vehicle for generalising the results of the case study (Yin, 2003, p. 33).

3.3 Case selection

Cases chosen for multiple case studies do not follow a statistical sampling logic, where cases from a chosen population are randomly sampled to obtain accurate statistical evidence on the distribution of variables within the population (Eisenhardt, 1989, p. 537). Multiple case studies are chosen to follow replication logic, where the individual cases either predict similar results, or contrasting results but for predictable reasons (Yin, 2003, p. 47). The samples for multiple case study research can be chosen to represent an industry or theoretical category to allow for replication logic (Eisenhardt, 1989, p. 537). This research is concerned with a sample within the South African aerospace industry, with the criteria that the chosen firms should have a long supply chain. Replication logic across this sample looks at how these firms with long supply chains compete on the dimensions of speed, dependability, quality and flexibility.

The sample size for this multiple case study can be determined a number of ways. Glaser and Strauss (1967, cited from Eisenhardt, 1989) recommend that no cases should be added when the theoretical saturation point is reached. The theoretical saturation point is the point where phenomena observed have been seen in previous cases, and incremental learning is minimal. Due to the limited number of South African aerospace firms, as well as time and money constraints, theoretical saturation may be difficult to achieve. Eisenhardt (1989, p. 545) recommends using between four and ten cases when building theory from case study research. Fewer than four cases make it difficult to generate theory with much complexity, whilst more than ten cases make it difficult to cope with the complexity and volume of the data. Whilst this case study research is exploratory in nature and does not attempt to build theory, these recommendations appear reasonable and are followed.

An initial case selection for this study was done through:

- An examination of the South African Defence Industry Directory (www.sadid.co.za) to obtain descriptions and contact details of South African aerospace firms. Firms with involvement in the aerospace industry and who may potentially have a long supply chain were selected. Both manufacturing and service related firms were included.

- Discussion of the relevance of these selected firms with project sponsors and relevant personnel. Project sponsors required specific aerospace firms to be included in this study. Additional firms for this research that were not selected from the South African Defence Industry Directory or required in this study were suggested by project sponsors. As project sponsors of this research and relevant personnel have been involved in the South African aerospace industry for a number of years, they have knowledge of firms who fulfil long supply chain criteria, as well as firms who would be most willing to participate in the research.

Nine firms in total were approached to participate in this research. Eight firms agreed to participate. The firm who did not wish to participate (after initially agreeing to participate) cited that being an aerospace project-driven firm with a complex supply chain would make for difficult research. Further, two of the eight firms have not been included in the study as:

- Information gathered from the interviewee in the first firm was inadequate due to a lack of participation during the interview process.

- The second firm, which has an aerospace division within it, put forward another non-aerospace division within the firm for participation in this research. Whilst this non-aerospace division does fulfil the long supply chain criteria, it does fulfil the critical aerospace industry criteria.

From the nine firms, six firms, Firm A to Firm F, are included in this study.

3.4 Case study protocol

The case study protocol increases the reliability of case study research, and it is intended to guide the investigator in carrying out the data collection (Yin, 2003, p. 67).

3.4.1 Focus of study

The main problem investigated in this study is how long supply chains compete. The research subproblems of how long supply chains compete on the competitive dimensions of speed, dependability, quality, and flexibility contribute to the investigation of the main problem. To focus the study and help in the investigation of these subproblems, a classification scheme is used to identify the case study firm's suppliers and customers.

3.4.1.1 Supplier classification

The initial supplier classification scheme in the pilot study was performed using the Kraljic matrix. The Kraljic matrix (Kraljic, 1983) provides a framework on how to manage supply relationships. Purchased materials in the Kraljic matrix are classified by supply risk and profit impact. Supply risk is assessed by material availability, competitive demand or material substitution. Profit impact is determined by volume of materials purchased or percentage of the total purchase cost. The Kraljic matrix can be seen in figure 6 below.

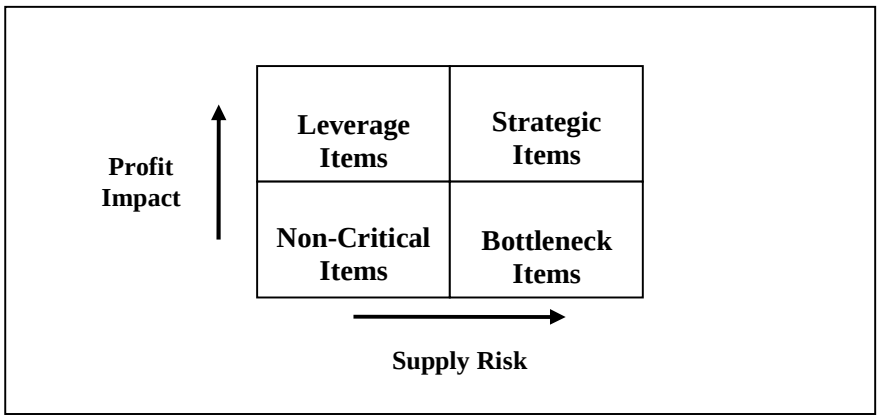

Figure 6: Kraljic matrix (1983, p. 112)

From the four quadrants of the Kraljic matrix in figure 6:

- Non-critical items call for standard product purchasing, efficient processing of orders, inventory optimization and order volume monitoring, possibly through spot purchasing in the market.
- Leverage items let the purchasing firm exploit its full purchasing power through negotiations, target pricing and product substitutions.
- Bottleneck items need to be secured through volume contracts even if a cost premium is attached to the contract, vendor control, backup plans and security of inventories.
- Strategic items call for the development of supply chain partnerships through the use of long term supply contracts, and may require the firm to consider make or buy decisions.

A full explanation of the Kraljic matrix can be found in Appendix A. The pilot study is discussed in section 3.4.4 below, and the full pilot study can be found in Appendix B.

Difficulties were found when using the Kraljic matrix for supplier classification in the pilot study. Discussions with the interviewee revealed that items with low supply risk and low profit impact would generally be sourced locally. As the purpose of this research is to look at the long supply chain problem, this makes the non-critical item quadrant of the Kraljic matrix redundant. Another difficulty arose in attempting to fit items into the required quadrants. Day (1986) asked what exactly is meant by supply risk and profit impact, and how could or should we measure these dimensions in practice. This issue was verified in the pilot case study, as the interviewee could not easily fit the items into the quadrants. This could affect the reliability of the research, as another interviewer who uses the Kraljic matrix may find that the interviewee has different measurements for supply risk and profit impact. These difficulties resulted in the abandonment of the Kraljic matrix for classification of the supplier-firm unit of analysis.

A number of other criteria are instead used to classify the final supplier-firm unit of analysis:

- The suppliers should generally be geographically distant (i.e. on another continent) from the case study firm, to fulfil the long supply chain criteria. If it proves impossible

to obtain a geographically distant supplier, a South African supplier is used. The South African or short supply chain results are not generalised with the long supply results, and similarities and differences are discussed.

- The supplier must provide a part with strategic importance to the firm. It was thought that supply chain management personnel in the firm, with an in-depth understanding of their supply chain, could identify parts with strategic importance to the firm. It is up to the supply chain management personnel to decide what criteria classifies a strategic part. Reasons to why the part is considered strategic in nature must be determined from the interviewee.

- The number of suppliers to the firm that fulfil these criteria will be chosen within reason. This means that if a large number of suppliers with strategic parts exist, the supply chain management personnel will be asked to limit the number to the most strategically important suppliers, ideally a maximum of 3 suppliers.

3.4.1.2 Customer classification

The final customer-firm unit of analysis is classified on similar criteria to the final supplier-firm unit of analysis:

- The customer should generally be geographically distant (i.e. on another continent) from the case study firm, to fulfil the long supply chain criteria. If it proves impossible to obtain a geographically distant customer, a South African customer is used. The South African or short supply chain results are not generalised with the long supply results, and similarities and differences are discussed.

- The customer must receive a finished assembly of strategic importance from the firm. It was thought that supply chain management personnel in the firm, with an in-depth understanding of their supply chain, could identify assemblies with strategic importance. It is up to the supply chain management personnel to decide what criteria classifies a strategic assembly. Reasons to why the part is

considered strategic in nature must be determined from the interviewee.

- The number of customers that fulfil these criteria will be chosen within reason. This means that if a large number of customers that are supplied with strategic assemblies exist, the supply chain management personnel will be asked to limit the number to the most strategically important customers, ideally a maximum of 3 customers.

3.4.2 Data Collection Procedures

Flynn *et al* (1990, p. 256) outline sources of evidence in empirical research as *historical archive analysis, participant observation, outside observation, questionnaires and interviews*:

- *Historical archive analysis* deals with the latent meaning of history, where primary and secondary sources of data are used to try and reconstruct the original event (Leedy, 1989, p. 125).

- *Participant observation* involves the researcher becoming part of the process being observed, in order to record what the participant's experience. Participant observation may be used as a component of action research, where a person within an organisation collects and analyses data regarding an ongoing change (Dubin, 1976, cited from Flynn *et al*, 1990, p. 258).

- *Outside observation* uses an unbiased observer to collect data, employing methods such as Industrial Engineering techniques to collect data systematically.

- The *questionnaire* is a commonplace instrument for observing data beyond the physical reach of the observer (Leedy, 1989, p. 142), and requires great thought in creating the line of questioning to fulfill reliability and validity criteria.

- *Interviews* can be in the form of ethnographic interviews, structured interviews and semi-structured interviews. An *ethnographic* interview facilitates the discovery of the meaning of specific concepts. A general question is asked, followed by further questions based on the respondents'

> answers to previous questions. A *structured* interview involves the use of a script specifying questions to be asked. Other questions may be asked based on the direction of the conversation, but all the questions specified by the script must be asked. In this way, the structured interview will appear to be a guided conversation rather than a structured query (Yin, 2003, p. 89). A *semi-structured* interview follows the standard set of questions with one or more individually tailored questions to get clarification or probe a persons reasoning (Leedy and Ormrod, 2005, p. 184).

The primary source of evidence for this case study research is obtained from *semi-structured interviews* with relevant personnel. With this case study research into long supply chains being exploratory in nature, the semi-structured interview approach allows for the exploration of the questions set by the script, as well as additional lines of questioning that may develop. This can provide a rich understanding of the long supply chain process, its environment, and the relative importance of some factors. The interviews in this case study research may be supplemented by documentation, observations and questionnaires (McCutcheon and Meredith, 1993, p. 242). Interviews are conducted with personnel in procurement and supply chain activities who are involved on a strategic level in supply chain activities. Interviews are conducted face-to-face with personnel who reside in South Africa, and telephonically or via email with personnel who reside overseas. These are discussed below:

- As case study firm personnel reside within South Africa, face-to-face interviews are possible. According to Leedy and Ormrod's (2005, p. 185), face-to-face interviews allow the researcher to gain the interviewees cooperation, and thus also yield the highest response rates in qualitative research. But the time and expense involved may be prohibitive if the needed interviewees reside in a variety of states or countries.

- Due to geographic distances between the case study firm and its suppliers and customers (i.e. a long supply chain), face to face interviews with suppliers and customers is not possible. The use of either a telephone interview or an email questionnaire to obtain supplier and customer perceptions was considered. Leedy and Ormrod's (2005, p.

185) descriptions of these two methods of obtaining qualitative data were taken into account:

> Telephone interviews are less time consuming and less expensive than face-to-face interviews, and the researcher has access to geographically distant interviewees who have a telephone. Whilst the researcher cannot establish the same cooperation as in a face-to-face interview, it does allow for the researcher to clarify ambiguous answers and seek follow up information. Even though response rate is not as high as in face to face interviews, it is higher than that of a mailed questionnaire. Because interviews take time, they are not practical when large sample sizes are important.
>
> Questionnaires, administered by post or email, can be sent to a large number of people, including geographically distant people, making them far cheaper to administer than face-to-face interviews and telephone interviews. But questionnaires also experience a low return rate, and questions can be misinterpreted, possibly distorting information. Specifying all questions in advance can also eliminate the possibility of exploring issues around the topic, reducing the depth of the picture.

Because little is documented on long supply chains in the South African aerospace industry, a broad understanding of the area is required. The questionnaire allows for specific questions to be addressed relating to competitiveness in long supply chains, but prevents the exploration of other possible areas of importance. Because the purpose of this exploratory case study research is to create initial understanding, the questionnaire approach is not appropriate. The telephonic interview approach is used, as it allows for geographically distant customers and suppliers to be reached, and topics around the interview questions can be explored if required.

The initial sample size of suppliers and customers for the telephonic interviews for seven case studies was calculated to be a maximum of 42 suppliers and customers. This is because with seven case studies and the maximum of three suppliers and three customers to be telephonically interviewed for each case study, 42 supplier and customer interviews is possible (3 suppliers in each firm + 3 customers in each firm) x (7 firms). Because of the time and cost constraints that exist in phoning 42 overseas

suppliers and customers, this is not viable. Instead, only one overseas supplier and customer in each firm is telephonically interviewed. This will give a maximum of 14 telephonic interviews, from (1 supplier in each firm + 1 customer in each firm) x (7 firms). Whilst this will bias results to lean towards one specific supplier and one specific customer in the case study analysis, here it is sufficient as this research is exploratory in nature.

To ensure logic and quality of the research design is kept, a number of criteria exist. These criteria are *construct validity; internal validity; external validity;* and *reliability* (Yin, 2003, p. 34):

- Construct validity is to establish correct operational measures for the concepts being studied. Construct validity in this research is guided by the found literature.

- Internal validity is to establish a causal relationship, whereby certain conditions are shown to lead to other conditions, as distinguished from spurious relationships. Internal validity will not be discussed here, as it is applicable to explanatory or causal studies, not in exploratory studies as in this research.

- External validity is to establish the domain to which the studies findings can be generalised.

- Reliability is to demonstrate that the operations of a study-such as data collection procedures-can be repeated, with the same results.

These criteria are discussed individually below.

3.4.2.1 Construct Validity

The use of multiple sources of evidence, known as data triangulation, can help obtain the most accurate picture of events and ensure construct validity (McCutcheon and Meredith, 1993, p. 244). In-firm data triangulation is performed in this study by addressing different interviewees in the firm with the same questions from the interview tool. Ideally, three interviewees per firm are used to ensure data triangulation, but this is dependent on firm size. To help reduce variation and volume of data created

in the case studies, multiple interviewees within the same firm are required to use the same suppliers and customers in the classification process. This means that the supplier and customer classifications that the first interviewee in the firm uses are required to be used by the next interviewee in the firm. This ensures that a maximum of 3 suppliers and 3 customers are involved in data analysis for each case, thereby focusing the study.

Suppliers and customers used in the supplier-firm and customer-firm units of analysis are directed with the same relevant line of questioning to that used for the face-to-face firm interview. This helps develop convergent lines of inquiry through the use of different sources of information, resulting in more convincing case study findings and conclusions (Yin, 2003, p. 98).

A chain of evidence, similar to that used in forensic investigations, needs to be maintained to ensure construct validity. The principle is to follow the derivation of any evidence, ranging from initial research questions to ultimate case study conclusions. The following steps are used in this research to ensure the chain of evidence is maintained (Yin, 2003, p. 105):

- The report should make sufficient citations to the relevant portions of the case study database.
- The database should reveal the actual evidence and indicate the circumstances of collection e.g. time and place of an interview.
- These circumstances should be consistent with procedures and questions in the case study protocol, to show the protocol was followed.
- A reading of the protocol should indicate the link between the contents of the protocol and the initial study questions.

3.4.2.2 External validity

With the focus on selected cases in the South African aerospace industry, there is no certainty that the findings are valid for other populations beyond those chosen. Even though theory may be used to provide a base for comparison and verification to maintain external validity in selected single case studies (Yin,

2003, p. 34), this proves difficult for this research. This is because long supply chain literature is limited. This highlights the fact that this study is exploratory in nature.

External validity in the multiple case studies can be achieved through replication, where the results of the individual case studies are comparable to one another (McCutcheon and Merideth, 1993, p. 244). But because selected cases include both long and short supply chains, with emphasis on long supply chains, the results could be biased towards long supply chains.

3.4.2.3 Reliability

Reliability of the case study is enhanced through the use of a case study database. A case study database is a way of organising and documenting the data collected for case studies. The database allows other investigators to review the evidence directly and not be limited to the written case study reports, allowing them to make their own conclusions (Yin, 2003, p. 102). The database consists of four components (Yin, 2003, p. 102):

- *Case study notes*: The notes consist of interviews, observations and document analysis, and may be handwritten, typed or in audio form. The notes in this case study consist of transcribed interviewee audio recordings, and are classified according to the measurements of speed, dependability, quality and flexibility for the supplier-firm and customer-firm in each case study.

- *Case study documents*: No documents are collected in this research. Semi-structured interviews provide the sole source of information.

- *Tabular materials*: No tabular materials are collected from case study sites in this research. Tables will however be used in single and multiple case analysis for data reduction.

- *Narratives*: Narratives consist of open ended answers to the questions in the interview instrument. Relevant evidence from interviews, documents and observations needs to be cited in composing an adequate answer. These questions and answers can then serve as a basis for composing the individual case studies, as well as the cross

case analysis. Whilst narratives are used to an extent in this research, they are not included in this database, as the case study notes are deemed sufficient.

3.4.3 Interview guidelines

A standard protocol is followed when setting up face-to-face interviews with case study firms and telephonic interviews with the firm's suppliers and customers. The procedure for contacting local firms for face-to-face interviews generally starts with an initial phone call to make contact with the firm. If the relevant person in the firm agrees to participate in the research, an email describing the research, method and times required is sent to them. In certain cases, the relevant personnel could not be reached telephonically at that point and the author was asked to send an email explaining the research to them. If they did not reply to the email, a follow up email and a telephone call were made to ask if they wanted to participate in the research. If there was no reply after attempting to contact the relevant person three to four times (within reason), it was taken that they did not want to participate in the research. International supplier and customer details for the telephonic interviews are generally obtained from the face-to-face firm interviews. These international customers and suppliers are initially contacted via email. This email was either sent by someone in the local firm that knows who to contact in the international firm, or by the author. The author cited the local firm contact when contacting international suppliers and customers. Generally, two emails and a phone call were made when asking international suppliers and customers to participate in the research. Again, if there was no reply after attempting to contact the relevant person, it was taken that they did not want to participate in the research.

Guidelines to conducting interviews in a qualitative study by Leedy and Ormrod (2005, p. 147-149) is used to develop a structure for the interview process for this research:

1. *Identify some questions in advance*: All questions are identified in advance, guided by the literature and the pilot study. Alternative topics based around how long supply chains compete will however be discussed if they arise in the interview. The exact wording of the questions may not be the same in each of the interviews, depending on what information is covered in the conversation. Choi and Hong

(2002, p. 474) say that the interview conversation should be allowed to proceed at its own pace, with the requirement that all of the questions in the interview tool are answered. Repeat visits may be necessary to finish the interviews or to interview additional people.

2. *Make sure the interviewees are representative of the group*: People should be chosen that you expect will give you typical perceptions and perspectives. People in the aerospace firms with titles such as supply chain manager, procurement manager, purchasing manager etc. will be interviewed for this study. These personnel will ideally be in middle to upper management positions, as they can provide a strategic, tactical and operational overview of their supply chain. A competitive dimension like quality may require input from somebody in the quality department of a firm.

3. *Find a suitable location*: Face-to-face interviews will be conducted on-site at the aerospace firm, ideally in a quiet location without distractions or interruptions. Face-to-face interviews based at the aerospace firm may also allow for a plant tour, which will better place the case study operating environment in context. Telephonic interviews will be conducted off-site in a suitably quiet location.

4. *Get (written) permission:* The nature of the study and the plans for using the results need to be explained to each participant. The study will be described to the participant as an investigation into how long supply chains compete in the South African aerospace industry. Any information that is deemed confidential will be kept so. An abstract of the research report will be offered to the participant once the study has been completed.

5. *Establish and maintain rapport:* The conversation between researcher and participant should begin with small talk that can break the ice. The researcher will be courteous and respectful at all times, and genuine interest will be shown in what the participant has to say. Evans *et al* (2004) say that minimal encouragements should be used in interviews to indicate to others that you are interested in what they are saying. A minimal encouragement (p. 54) “is a prompt that indicates that you’re listening to what the client is saying and that you want him or her to continue.” This may be

something like “uhm-hmm” or “right” that indicates that you want the participant to continue.

6. *Focus on the actual rather than the abstract or hypothetical:* Revealing information will more likely be obtained if the participant is asked what they do or would do in a specific situation. This can be seen in a direct question like “how are performance measures used in controlling or preventing poor quality with suppliers?” instead of phrasing the question as “what is the role of performance measures in controlling or preventing poor quality with suppliers?”

7. *Don’t put words in people’s mouths:* People must choose their own way of expressing their thoughts. The researcher needs to listen and let people say what they want to say in the way they want to say it.

8. *Record responses verbatim:* Where possible, the face-to-face conversation will be recorded to provide a more accurate rendition of the interview. Recording allows the quality of the interview to be raised significantly if the researcher does not have to take meticulous notes (Flynn *et al*, 1990, p. 259). If the participant does not want to be recorded, the interviewer will need to rely on hand written notes and memory. The telephonic interviews with suppliers and customers will not be recorded due to equipment constraints, and will therefore rely on hand written notes and memory.

9. *Do not show your reactions:* The researcher should try to not show surprise or disapproval of what the participant says to increase the likelihood of getting accurate information.

10. *Remember that you are not getting the facts:* Participants responses should always be treated as perceptions rather than facts.

11. *The results of focus groups should take group dynamics into account:* When two or more individuals are involved in a single interview, the individuals will rarely act as true equals. This research will always try and interview participants on a one to one basis to omit group dynamics.

3.4.4 Pilot study

The purpose of the pilot case study is to help refine data collection plans with respect to both the content of the data and the procedures to be followed (Yin, 2003, p. 79). According to Leedy and Ormrod (2005, p. 188), the pilot study allows for the fine-tuning of clear and concise questions that will save time over the long run before data collection begins. The pilot case study has been tested in a firm not included in the final study. The firm used for the pilot study is involved in the manufacture of carbon fibre products, a material used in the aerospace industry, and has a long supply chain on both incoming material and outgoing products. An initial and final pilot study was conducted within the same firm. The full pilot study can be found in Appendix B. Appendix B contains:

- The initial pilot study research framework (p. 195);
- The initial pilot study interview tool (p. 200);
- The initial pilot study interview transcription (p. 203);
- Initial pilot study analysis and resulting changes made to the initial research framework (p. 211);

- The final pilot study research framework (p. 222);
- The final pilot study interview tool (p. 224);
- The final pilot study interview transcription (p. 227);
- Final pilot study analysis and resulting changes made to create the research framework found in the main report (p. 237).

All literature and research methodology content in the main report contains the relevant input from the pilot studies. Some important changes to the research methodology as a result of the pilot studies are discussed within the relevant sections of this main report. Some changes to the main research framework (section 2.10) as a result of the pilot studies include:

- The use of Stalk and Hout's (1990) three ways to convert to a time based supply chain is used as second-order measurement categories for the speed competitive dimension. The pilot study questions were loosely coupled around Stalk and Hout's ideas, but also included inputs from other sources. The use of Stalk and Hout's three ideas helps to focus the speed competitive dimension, and

explore the other inputs within the quality dimension (Appendix B, p. 214, p. 217).

- Dependability examines the general processes and procedures that are in place to ensure on time reliable delivery of goods from suppliers and to customers. This will provide a broad overview by the interviewees on what aids in dependable delivery, instead of limiting the interviewee as done in the pilot study (Appendix B, p. 216).

- The use of the Juran trilogy of quality planning, quality control and quality improvement as second-order measurements for classifying quality. Quality was initially classified by second-order measurements in the literature perceived to be important. The addition of an initial question asking what quality means to the interviewee will help establish context for quality, not done in the pilot study (Appendix B, p. 215).

- The pilot study uses second-order measurements culled from literature to try and understand flexibility. But with numerous flexibility second-order measurements, this constrained the exploration of other possible definitions of flexibility. The use of the interviewee's definition of flexibility to understand what flexibility means for the firm, its suppliers and customers is used for the main study (Appendix B, p. 218).

Other changes made are discussed within Appendix B. While the pilot studies interviews are fully transcribed, only parts of the interviews perceived to be important for the main study are included in the appendices. This is done as this research is primarily looking for theme, not content. The standard of the writing of pilot studies is not to the same level as that in the main report. This is not deemed an issue, as the purpose of the pilot study is to establish the framework, not for data analysis.

3.4.5 Final interview tool

The heart of the case study is a set of substantive questions that reflect the actual line of inquiry (Yin, 2003, p. 73). Evans *et al's* (2005, pp. 43-60) guidelines to effective questioning in interviews has been used in formulating questions for the interview tool. Effective questioning requires the use of both

open-ended questions and close-ended questions to facilitate communication. Open-ended questions that are on topic should be used to stimulate detailed responses, allow the interviewee to tell their story in the own way, and let the interviewee introduce relevant topics. Open-ended questions frequently begin with the words “could”, “could you” and “how”. Closed questions, whilst preventing the interviewee from exploring or clarifying his or her concerns, are useful when focus on a specific point is required. The exploration of one topic per question at a time is done to prevent the interviewee from becoming confused. In addition to Evans *et al’s* guidelines to effective questioning, a number of changes to the interview tool as a result of the initial and final pilot study have been made. Some of these changes include:

- A separation of the supplier-firm and the customer-firm units of analysis in the final interview tool (Appendix C, p. 248-253). Initially, the line of questioning (Appendix B, p. 200-202) would examine the supplier and customer units of analysis directly after one another, as seen in “How much information does the firm share with its suppliers?”, and directly afterwards “How much information does the firm share with its customers?” It was found that this leads to an overlap between the supplier-firm and customer-firm units of analysis, as the interviewee would sometimes switch between talking about the supplier and customer in the same sentence. This is likely because supplier and customer units are not completely separated in questioning. This makes it more difficult to analyse independent units of analysis. To rectify this, the complete set of questions relevant to the supplier-firm unit of analysis is first investigated, followed by the complete set of questions relevant to the customer-firm unit of analysis.

  Once the supplier-firm and customer firm units of analysis were separated, it was found during the interview process that greater discussion on the supplier firm unit of analysis was undertaken, whereas the answers to the customer firm unit of analysis were shorter in length. This may be a result of the interviewee becoming tired towards the end of the interview when the customer-firm questions were being asked. To try and fix this, the questions on the customer-firm and supplier-firm units of analysis are alternately asked at the beginning of the interview. This is done with multiple interviewees (when available) within the same firm.

- A change in the order of questioning in the interview tool. It was found in the pilot study that some competitive dimensions could encompass content relevant to other competitive dimensions. This is especially evident in the quality competitive dimension (e.g. Garvin's (1988) eight dimensions of quality), which can also cover elements of speed and dependability. To try and keep the competitive dimensions as independent from one another as possible, quality will be examined after speed and dependability. In this way, the speed and dependability content will have already been discussed, and is less likely to appear within the quality dimension. Flexibility appears from the pilot study to be relatively independent from the speed, dependability and quality, and is asked last.

- A change in the tone of the interview questions, from an "adversarial" tone to a more "collaborative" tone. An example of an adversarial type tone used is "How does the firm control or prevent poor *incoming* quality *from its* suppliers?" (Appendix B, p. 225). This in the final interview tool has changed to "How is poor quality controlled or prevented *with* suppliers? (Appendix C, p. 250). The first question squarely puts the blame on the supplier for poor quality, whereas the second question recognises that poor quality may occur, but does not directly blame the supplier. A sense of vagueness is added, which may help identify where the source of poor quality originates (e.g. incorrect customer specifications, or supplier manufacturing processes).

- An addition of an "other" question in the interview tool that examines issues that have not been contained in the competitive dimensions of quality, dependability, speed and flexibility. With this case study research being exploratory in nature, this will help identify areas for future research into improving long supply chain competitiveness that do not fit into the developed framework.

The initial and final pilot study interview tools can be found in Appendix B. The final interview tool used in the main study for this research can be found in Appendix C. The final interview tool will first ask general questions to provide an overview of the case study firm. Suppliers are classified and the supplier-firm

unit is examined on how it competes on the dimensions of speed, dependability, quality and flexibility. This is followed by customer classification and how the customer-firm unit competes on the dimensions of speed, dependability, quality and flexibility. A standard list of definitions for the final interview tool is compiled to explain what a definition in a question means if the interviewee is unsure. This will help enhance validity between the case studies, and provide focus to the questions. Only areas where uncertainties are thought to arise have been provided with standard definitions. The standard list of definitions can be found in Appendix C (p. 254-255).

3.4.6 Data analysis

According to Yin (2003, p. 109), "data analysis consists of examining, categorising, tabulating, testing, or otherwise recombining both qualitative and quantitative evidence to address the initial propositions of a study." With the initial propositions in Yin's explanation replaced by initial problem statements in this exploratory case study research, data analysis will be guided by the main problem statement that led to this research in the first place. The main problem is to investigate how long supply chains compete. The sub-problems are to examine how long supply chains compete on the dimensions of speed, dependability, quality and flexibility.

Yin's (2003) technique of cross case synthesis for data analysis in multiple case studies is used. Yin (p. 133, 2003) says that the technique is relevant if a case study consists of a minimum of two cases. With the investigation of six case studies, the technique is applicable to this research. Initially, individual case studies use McCutcheon and Merideth's (1993) logical approach in analysing data, where logical connections among the events are sought, relying on prior knowledge obtained from the literature survey. Multiple case studies will then use the outcomes from the single case studies to draw cross-case conclusions. Yin (2003, p. 134) suggests the use of word tables that display the data from the individual case studies according to some uniform framework when drawing cross-case conclusions. McCutcheon and Merideth (1993, p. 244) say that tabular displays can help sort out patterns and important information from the masses of material that a case study can generate. With this in mind, tables will be used for data analysis in cross case synthesis for this research. Tabular construction has

been aided using Miles and Huberman's (1994) work on qualitative data analysis techniques, together with inputs from Gerwin and Tarondeau's (1983) and Choi and Hong's (2002) case study tabular construction. The table will use the speed, dependability, quality, flexibility and "other" dimensions to provide a framework to summarize and reduce the data in cross case synthesis. Tables will be constructed for both the supplier-firm and customer-firm units of analysis. A sample of the table for cross-case analysis can be found in Appendix D (p. 257).

Data analysis in this research is done by *theme* as opposed to *content*. Case study *thematic* research, such as that by Choi and Hong (2002) and Gerwin and Tarondeau (1982), attempts to classify data into thematic measurement categories from the created framework. The data put into these measurement categories needs to fit the theme, the wording itself is not necessarily relevant. *Content* research, such as that by Williams *et al* (2002), identifies specific characteristics of a body of material e.g. words, and may involve coding of the material in terms of predetermined and precisely defined characteristics (Leedy and Ormrod, 2005, p. 144). This may be aided by a qualitative software package that allows for coding of the data. *Thematic* data analysis is used in this research as it better suits the exploratory nature of the study.

Miles and Huberman's (1984, p. 215) technique of *counting* is used to identify the "most likely" results within each thematic measurement category for cross-case analysis. The number of similar interviewee responses within each measurement category is counted, and a percentage is assigned based on the total number of responses for that measurement category. This allows for identification of important themes within competitive dimensions for further research.

3.4.7 Reporting case studies

The format of this report will initially present the single case studies using speed, dependability, quality, flexibility and "other" dimensions as sub-sections within the case study. Cross case analysis will use the results of the single case studies. Again, the sub-sections of speed, dependability, quality, flexibility and "other" will be used in cross case analysis, together with tabular materials for data reduction and

comparison. The names of the case study firm, suppliers and customers will be kept anonymous in this research.

Only the parts of the interviews that the author believes as relevant to the research questions have been transcribed. A standard format is used when transcribing interview data:

- Words in normal font not in quotation marks represent a paraphrasing of the interviewee's words. This is done if the interviewee's words can be written in a simpler format to that written verbatim. This is also done if interviewee's words are not recorded.

- Words in *italic* font that are not in quotation marks are used when the author is making a general comment, or when asking the interviewee an additional question that is not a specific interview tool question.

- "": Words in normal font that are in quotation marks are used when the interviewee is quoted verbatim. This is done either when the interview has been recorded and transcribed, or from writing down the interviewee's exact words on paper during the interview process. Whilst every effort has been made to transcribe the interviewee verbatim when it is put in quotation marks, a number of negligible errors may still be present due to the nature of the transcription process.

- ...: Represents either a long pause in the conversation; or the exclusion of some of the interviewee's conversation which does not contain any perceived relevant information to the research framework.

- ( ): Words that are put in brackets are used to place a portion of the conversation in context. Context may be required when some of the interviewee's verbatim conversation is excluded when it is perceived to not contain any relevant information to the research framework, or it can be written in a simpler form. Brackets may also be used to substitute names or words that may give away the identity of a supplier, firm or customer.

4. SINGLE CASE ANALYSIS

4.1 Sources of evidence

Single case studies are written up using the speed, dependability, quality, flexibility and "other" dimensions as a framework. Both supplier-firm and customer-firm units of analysis are discussed within these competitive dimensions. All information obtained from interviews and written up in these case studies is based on interviewee perceptions. Multiple sources of evidence enhance the construct validity of the case study. Case A to case F contains inputs from the supplier, customer and firm participants. Within each case, suppliers, firm and customers are individually referenced as named in the units of analysis. Participants in case A through to case F are listed as participant 1 through to participant 19 in Appendix E through to Appendix J. Sources of evidence for each case study are given in table 7.

Table 7: Sources of evidence for single case studies

	Case A		**Case B**	
	Reference	**Interviewee**	**Reference**	**Interviewee**
Firm	Firm A	Director (Participant 1)	Firm B	Managing director (Participant 2)
Supplier	Supplier A1	-	Supplier B1	-
	Supplier A2	-	Supplier B2	-
Customer	Customer A1	-	Customer B1	-
	Customer A2	-	Customer B2	-
			Customer B3	-

Table continues on next page

Table 7 (continued): Sources of evidence for single case studies

	Case C		Case D	
	Reference	**Interviewee**	**Reference**	**Interviewee**
Firm	Firm C	Director (Participant 3) Director (Participant 4)	Firm D	Senior purchasing manager (Participant 7) Supply chain manager (Participant 8) Inventory management and dispatch (Participant 9) Quality assurance supply chain (Participant 10)
Supplier	Supplier C1 Supplier C2 Supplier C3	Order processing (Participant 5) - -	Supplier D1 Supplier D2 Supplier D3 Supplier D4 Supplier D5	Product manager (Participant 11) - - - -
Customer	Customer C1	Purchasing officer (Participant 6)	Customer D1 Customer D2 Customer D3	Procurement agent (Participant 12) - -

Table continues on next page

Table 7 (continued): Sources of evidence for single case studies

	Case E		Case F	
	Reference	**Interviewee**	**Reference**	**Interviewee**
Firm	Firm E	Mechanical engineer (Participant 13)	Firm F	Procurement (Participant 16) Supply chain manager (Participant 17)
Supplier	Supplier E1	Internal technical support (Participant 14)	Supplier F1 Supplier F2 Supplier F3	- - Relationship manager-commercial directorate (Participant 18) Chief operating officer (Participant 19)
Customer	Customer E1 Customer E2	- Engineer (Participant 15)	Customer F1	-

The main body of this study only includes the complete Case B write-up, found in section 4.3. This is to provide an overview of how the single case study is written up. The other five complete case studies, Case A, Case C, Case D, Case E, and Case F can be found in Appendix K. A summary of the key results found within Case A to F is however included after the complete Case B write-up. Case B is chosen for the main report as it fits the typical customer and supplier classification criteria as outlined in sections 3.4.1.1 and 3.4.1.2. Tabular materials used in Case A, Case C, Case D, Case E, and Case F has been included in Appendix L. This is because the tabular materials are lengthy and make the main report difficult to read. Tables for Case B

however have been included in the main report for illustration. Tables for both the supplier-firm and customer-firm units have been constructed.

The structure of the case study supply chains for this research, following the chosen supplier and classification criteria, is explained below.

4.2 Case study supply chain structure

It has proven difficult to obtain case studies for this research that fit the part of the typical supplier and customer classification criteria, this being an international supplier and international customer to the local firm. As a result, a number of differences to the typical classification criterion exist. These differences for the supplier-firm and customer-firm dyadic relationships can be seen in figure 7. Case A, Case D and Case F have both international and local suppliers and/or customers because the classification criteria allows for a maximum of three strategic suppliers and customers for discussion. Case B and Case C follow the ideal supplier and customer classification criteria.

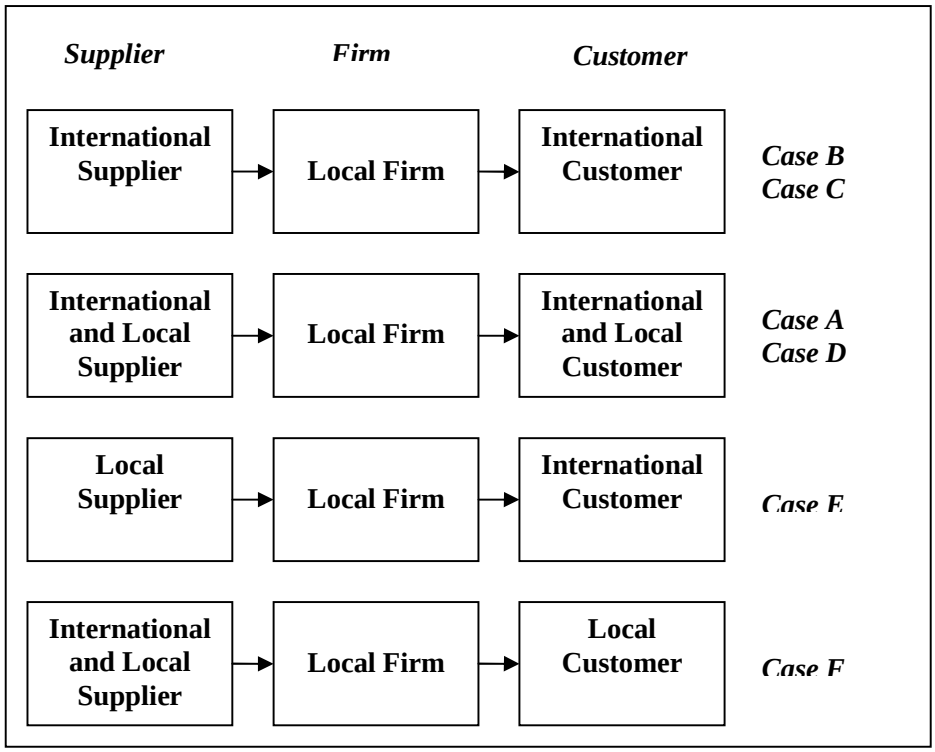

Figure 7: Case study supply chain structure

Whilst the focus of this research is on the dyadic supplier-firm and customer-firm relationship, it should be noted that complexity increases beyond the dyadic relationship in the supply chain. Figure 8 gives an example of how certain suppliers, firms and customers chosen for this study relate to one another in the extended supply chain structure:

- An international supplier, the name of which was not disclosed to the author, manufactures raw material for local supplier E1.
- Local supplier E1, a distributor, provides this material to local firm E.
- Local firm E manufactures a part or component from this raw material.
- This part or component is sent to local firm D, which is assembled together with other parts and components into a system.
- This system is sent to international customer D1 to be assembled into an aircraft together with other systems.

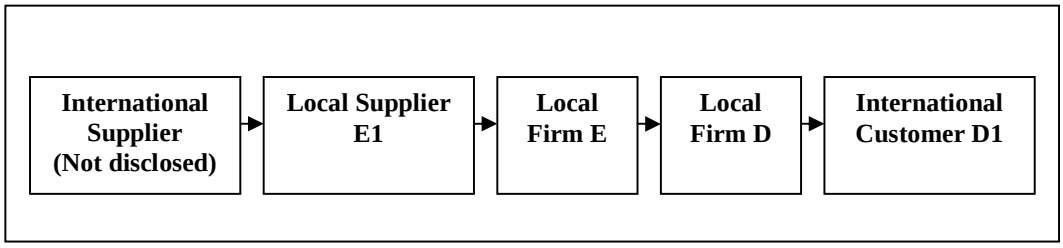

Figure 8: Extended case study supply chain structure

This makes the management of information and material flows between multiple members difficult. This extended case study supply chain structure is beyond the scope of this research.

4.3 Single case study: Case B

The transcribed audio interviews for Case B can be found in Appendix F.

General

Firm B is a producer of tooling systems for the aerospace industry. Suppliers and customers discussed within this case study, the product supplied and its strategic importance are given in table 8 and table 9 below.

Table 8: Suppliers identified by Firm B for analysis

Supplier name	Strategic part supplied to firm. Why?	Location
Supplier B1	Special clamps and cylinders that are used on machining fixtures. Participant 2 says "(t)here's probably only six of these suppliers in the world... without their supply we wouldn't be able to support the marketplace with machines."	Germany
Supplier B2	Tooling aids Participant 2 says "...the aerospace industry for instance has a tendency to specify (products)...they come from companies like Supplier B2..."	USA

Table 9: Customers identified by Firm B for analysis

Customer name	Strategic part sent to customer. Why?	Location
Customer B1	Ground support equipment (service tooling) for a local aircraft. Strategic for financial reasons.	Sweden
Customer B2	Ground support equipment (service tooling). Strategic for financial reasons.	Sweden
Customer B3	Ground support equipment (service tooling). Strategic for financial reasons.	UK

Speed

Better and timelier information

Communication

The purchase of products from suppliers B1 and B2 is "purely" done using comprehensive catalogues of items. These catalogues contain "graphic information" that Firm B can import into the product designs. Participant 2 says that "it's very rare that we ever speak to them (suppliers)." Information sharing between Firm B and its customers is "totally transparent." The tooling systems that Firm B manufactures are of "strategic importance" to the customer. This is because tooling systems are initially required for the manufacture of the customer's end product. Participant 2 says that Firm B is therefore "required to give them ongoing timing information and disclose to them any quality issues and technical issues that we would have."

IT

Procurement of goods from suppliers is done through their online internet purchasing facilities. Product catalogues, credit card facilities and goods tracking exist as online services. Information Technology use in communicating with customers includes "elementary stuff like email, to predetermined crafted reports..."

to the future use of an online portal for information exchange. Participant 2 explains that IT systems have their downsides as well, where "...your systems got to work for you, if you're not careful, you can overcomplicate it, and before you realise, the guys who are in there running it have lost sight of what you do, and they believe that the job is the system."

Lead time compression

Lead time compression between placing an order with Suppliers B1 and B2 and delivery to Firm B is not required according to participant 2, saying "I think they've actually got a pretty slick system..." This is achieved through "standardised" tooling aids and the fact they "supply it for the worldwide market." A barrier to lead time compression with customers exists because firms often follow the "European approach to manufacture." This means that manufacture of the physical product often begins before getting all "upfront information right." Participant 2 says that "...that is the area that we need to focus on, getting our act together at the front end..."

Synchronisation

Material order volume and frequency

Participant 2 says material order volumes from supplier B1 "could run into the millions," but are made "every two to three months." Material orders volumes from supplier B2 "of not large amounts of money" are made "on an ongoing basis," generally every month. Products from Firm B are ordered by customers "(w)hen they've reviewed our quotation and have decided that they want to deal with it..." Material volumes ordered by the customer are dependent on the customer's requirements.

Capacity constraints

Delays in the receiving of materials due to supplier capacity problems are rare, with participant 2 saying that "(t)he only time we ever get a problem is with our own department of customs..." Delays in sending materials to customers as a result of capacity problems in Firm B include "labour issues", "absenteeism" and scheduling delays as a result of doing "one-off engineering" projects.

Dependability

Processes and procedures to ensure dependability

The automation of the order process from suppliers to Firm B ensures "full visibility", where goods are tracked online, from placing the order through to the landing of the goods. Participant 2 explains that "if you become transparent, and you allow a customer to see where you are, you have to make it happen." Participant 2 goes on to say that the culture in South Africa is one of not letting the customer know an order may be late, as it may jeopardise the next order. Instead, the firm should "rather let that customer know you're late and what you're doing about it to fix the problem so you're not late the next time, so he's got confidence that you're prepared to deal with the issue..." Participant 2 says dependable delivery from Firm B to its customers is achieved by "(c)ontinuous monitoring, daily production meetings, follow ups...we're monitoring statistically our performance all the time..."

Quality

Meaning of Quality

Participant 2 says quality between Firm B and it's suppliers means "...protecting the bottom line..." where not only "...quality of product..." is important, but "...quality of every single system you've got in the company..." Quality for Firm B and its customers again means "...protecting the bottom line...", but participant 2 also says that quality, according to Firm B's mission statement, is to "...give our customers exactly what they want, not more, not less." Participant 2 explains "...that quality is about the delivery as much as it is about the product..." with customers.

Quality planning

Quality planning process

Participant 2 explains planning for quality with suppliers involves defining a "...specification for the product that we want or the material that we want delivered, plus the delivery criteria" Planning quality requirements with customers is to "...give the customer what they want."

Trust

A “(g)ood” relationship exists between Firm B and its suppliers. Firm B “monitors” their suppliers on the vendor list with regards to quality and delivery performance. If a problem with a supplier arises, participant 2 says Firm B “...will try to work out the problem...” If the problem cannot be corrected, the supplier is taken off the vendor list. Trust between firm B and its supplier’s means “integrity of supply...supplying a product at the right specifications at the right time...” Participant 2 explains that trust is shown when “...one of our suppliers comes back to us before the due date and tells us he’s got an issue.” A “relatively good” relationship exists between Firm B and its customers. The customer trusts Firm B to deliver the required quality, and participant 2 says that this is because “we’ve got a strong reputation of always getting it right.”

Quality control

Quality control process

Supplier quality is evaluated through product inspection. If issues occur Firm B returns the faulty product to the supplier. Participant 2 says that they “...haven’t had many quality problems with our suppliers, we’ve got a pretty good...supply chain and suppliers.” Quality control is achieved with customers through ”continuous monitoring”, with 100 % internal quality control and some customers monitoring incoming product quality from Firm B. Firm B also goes through a customer approval process beforehand, so customers “...wouldn’t give us the work if they thought we couldn’t do it.”

Performance measurement

Supplier delivery performance and quality standards are monitored statistically for quality control. Performance measures are “embedded” into the steps of Firm B’s manufacturing processes, with a 100% product quality check performed before goods are shipped to customers. Only the quality control department at Firm B can authorise the dispatch of finished goods to customers.

Quality improvement

Quality improvements are not generally made with suppliers. Participant 2 explains that because Firm B's suppliers are not involved in "bespoke manufacturing," they have "...generally...perfected their processes in the first instance." Quality improvements with customers are made by first picking up any non-conformances that occur internally or externally by the customer. Participant 2 says "(w)e then analyse it, determine what the remedial action is, what was the cause, what are we going to do to prevent it happening, we actually put a cost to it, and we actually statistically capture it, so we're monitoring whether we've had this sort of problem before." Participant 2 says it's "...very important to track quality...back to rands and cents..." to quantify quality improvement efforts.

Flexibility

Meaning of flexibility

Flexibility between Firm B and its suppliers means suppliers are "upfront" and relaying information "timeously" to Firm B. Flexibility between Firm B and its customers means Firm B does a "good job" of anticipating customer order intake before orders are placed, and Firm B and its customers are "attuned" to one another's processes.

Achievement of flexibility

Flexibility is achieved by transmission of early information from suppliers to Firm B. Early information from suppliers allows Firm B to be "flexible to a degree", and to "...accommodate that situation within our own material planning." Firm B may need to reach out to the supplier before a delay and obtain the necessary information, a "time consuming" process. Flexibility is achieved with customers through "relationships", which participant 2 says is the "...most difficult part..."

Other

Ways to improve competitiveness

The cost dimension is important in improving the competitiveness of Firm B and its suppliers. "Payment" issues

result from interest rate levels in South Africa, which puts Firm B "...seriously under pressure from a cash flow point of view..." (Participant 2) Improving the competitiveness of Firm B and its customers is dependent on the "professional project manager", who has "people skills" and the ability to develop relationships and monitor the project.

4.4 Tabular material for Case B

Table 10 presents the tabular materials used in Case B analysis for the supplier-firm and customer-firm units.

Table 10: Summary of Case B data

Competitive dimension	Second-Order Measurement	Third-Order Measurement	Case B (supplier-firm unit)
Speed	Better and timelier information	Communication	Standard online catalogues provide full product information. Participant 2 says that "(i)t's very rare that we ever speak to them (suppliers)."
		IT	Internet purchasing facilities enable automated online information exchange.
	Lead time compression	-	Lead time compression not required. Current short supplier lead times achieved from product "standardisation" (Participant 2) for the world market.
	Synchronisation	Material order volume and frequency	Material orders volumes from supplier B2 "of not large amounts of money" are made "on an ongoing basis," generally every month. Material order volumes from supplier B1 "could run into the millions," but are made "every two to three months" (Participant 2).
		Capacity constraints	Delays in the receiving of materials due to supplier capacity problems are rare.
Dependability	Processes and procedures	-	Automation of the order process from suppliers to Firm B ensures "full visibility" (Participant 2).

Table 10: Summary of Case B data (continued)

Competitive dimension	Second-Order Measurement	Third-Order Measurement	Case B (supplier-firm unit)
Quality	Meaning of quality	-	"…protecting the bottom line…" where not only "…quality of product…" is important, but "…quality of every single system you've got in the company…" (Participant 2).
	Quality planning	Quality planning process	Set the "…specification for the product that we want or the material that we want delivered, plus the delivery criteria" (Participant 2).
		Trust	A "(g)ood" relationship (Participant 2). Firm B "monitors" their suppliers on the vendor list with regards to quality and delivery performance. Trust between firm B and its supplier's means "integrity of supply...supplying a product at the right specifications at the right time…" Trust is shown when "…one of our suppliers comes back to us before the due date and tells us he's got an issue" (Participant 2).
	Quality control	Quality control process	Supplier quality evaluated through product inspection. Products returned to supplier if problems occur.
		Performance measurement	Supplier delivery performance and quality standards monitored statistically.

Table 10: Summary of Case B data (continued)

Competitive dimension	Second-Order Measurement	Third-Order Measurement	Case B (supplier-firm unit)
Quality	Quality improvement	-	Quality improvements not generally made with suppliers. Because Firm B's suppliers are not involved in "bespoke manufacturing," they have "…generally…perfected their processes in the first instance" (Participant 2).
Flexibility	Meaning of flexibility	-	Suppliers are "upfront" and relaying information "timeously" to Firm B (Participant 2).
	Achievement of flexibility	-	Early information from suppliers allows Firm B to be "flexible to a degree", and to "…accommodate that situation within our own material planning." (Participant 2).
Other	Ways to improve competitiveness	-	Improvement of "payment" and "cash flow" issues (Participant 2).

Table 10: Summary of Case B data (continued)

Competitive dimension	Second-Order Measurement	Third-Order Measurement	Case B (customer-firm unit)
Speed	Better and timelier information	Communication	"Totally transparent" information exchange (Participant 2).
		IT	Information Technology use in communicating with customers includes "elementary stuff like email, to predetermined crafted reports…" to the future use of an online portal for information exchange (Participant 2). IT systems have problems as well, you can "overcomplicate it" (Participant 2).
	Lead time compression	-	Compression of lead times possible by getting all "upfront information right" (Participant 2) before physical product manufacture begins.
	Synchronisation	Material order volume and frequency	Products are ordered by customers "(w)hen they've reviewed our quotation and have decided that they want to deal with it…" (Participant 2) Material volumes are dependent on the customer's requirements.
		Capacity constraints	Internal firm capacity problems like "labour issues", "absenteeism" and scheduling delays from "one-off engineering" projects (Participant 2)

Table 10: Summary of Case B data (continued)

Competitive dimension	Second-Order Measurement	Third-Order Measurement	Case B (customer-firm unit)
Dependability	Processes and procedures	-	South African firms need to be "transparent" with late customer orders and in fixing problems (Participant 2). Continuous statistical monitoring, daily production meetings, follow ups.
Quality	Meaning of quality	-	"…protecting the bottom line…" (Participant 2) "…give our customers exactly what they want, not more, not less" (Participant 2). "…quality is about the delivery as much as it is about the product…"
	Quality planning	Quality planning process	"…give our customers exactly what they want, not more, not less" (Participant 2).
		Trust	A "relatively good" relationship. (Participant 2) The customer trusts Firm B to deliver the required quality because "we've got a strong reputation of always getting it right" (Participant 2).

Table 10: Summary of Case B data (continued)

Competitive dimension	Second-Order Measurement	Third-Order Measurement	Case B (customer-firm unit)
Quality	Quality control	Quality control process	"Continuous monitoring" at Firm B through internal quality control (Participant 2). Certain customers monitor incoming product quality. Firm B undergoes a customer approval process before supplying goods.
		Performance measurement	Performance measures "embedded" into the steps of Firm B's manufacturing processes, with a 100% finished product quality check.
	Quality improvement	-	Quality improvements result if a non-conformance is found, with Participant 2 saying that "(w)e then analyse it, determine…the remedial action…the cause, what are we going to do to prevent it happening…put a cost to it…statistically capture it…"

Table 10: Summary of Case B data (continued)

Competitive dimension	Second-Order Measurement	Third-Order Measurement	Case B (customer-firm unit)
Flexibility	Meaning of flexibility	-	Firm B does a "good job" of anticipating customer order intake before orders are placed (Participant 2). Firm B and its customers are "attuned" to one another's processes (Participant 2).
	Achievement of flexibility	-	Achievement of flexibility with customers through "relationships", which is the "…most difficult part…" (Participant 2).
Other	Ways to improve competitiveness	-	Depends on the "professional project manager" who can monitor the project and develop relationships with customers (Participant 2).

Some key findings from Case A through to Case F are presented below. These are not necessarily findings that are replicated across cases for speed, dependability, quality and flexibility dimensions. Instead, they appear on face value as key findings within a competitive dimension. Cross case analysis determines whether some of these key findings are replicated across supplier-firm and customer-firm units, and provides a comparison to literature.

Case A

Speed

- Firms cannot completely rely on systems for information exchange with suppliers; face-to-face communication is still essential.

Dependability

- Delivery of documentation from the supplier is as equally important as the delivery of the physical product.

Quality

- Trust in the supplier-firm relationship is established over time.

- Active quality improvements are not made between firm and customer. The quality target initially set by the customer remains the same.

Case B

Speed

- Lead time compression is not required in the supplier-firm relationship. The short lead times that are achieved by the supplier in delivery to the firm are through product standardisation for the world market.

- Lead time compression with customers is difficult to achieve as a result of internal firm capacity problems such as labour issues, absenteeism and scheduling delays from one-off engineering projects.

Dependability

- South African firms need to be more transparent with customers when dealing with late orders and fixing problems.

Case C

Flexibility

- Suppliers that place stock on consignment with the firm would allow for efficient delivery of product to the customer.

Other

- The development of a local supplier base and support base would provide long term benefit for firms in the South African aerospace industry.

Case D

Speed

- Lead time compression with suppliers is possible if suppliers keep material stock for the firm.

Quality

- The checking of approved suppliers and materials is done in receiving when goods arrive from suppliers into South Africa, whereas it should be checked with procurement beforehand.

Case E

Quality

- Trust is shown between a firm and customer if they keep on coming back to the firm for repeat business.

Flexibility

- Firm and supplier may work together to find alternative materials and fit designs if specific materials are not available.

Case F

Speed

- E-procurement between supplier and firm is difficult in military applications in the aerospace industry due to the sensitivity around data transfers. Whilst complete integration is not possible, another level of IT above what is currently in place is needed.

Quality

- Quality problems from suppliers are only picked up on the shopfloor, as goods receiving are not technically orientated to do quality control as such. As a result, quality control relies heavily on the Certificate of Conformance (CFC) that comes with the product.

Flexibility

- Flexibility with customers is time based, as customers may need to be flexible with product delivery from the firm if suppliers deliver late.

5. MULTIPLE CASE ANALYSIS

This chapter contains general results and multiple case study results. The general results classify firm, supplier and customer criteria. Firms are classified according to whether they are manufacturing or service based firms; and the size of the firm based on number of employees. Suppliers are classified according to whether they are manufacturing or service based firms; location of the supplier; and strategic importance of the supplier to the case study firm based on competitive dimension criteria. Customers are classified according to whether they are manufacturing or service based firms; location of the customer; and strategic importance of the customer to the case study firm based on competitive dimension criteria. The multiple case study results are divided into the first-order measurements of speed, dependability, quality, flexibility and "other". The measurements explore both the supplier-firm and customer-firm units of analysis. A general summary of key findings in the cross case analysis is provided.

5.1. General results

5.1.1 Firm size

Firm size is classified according to number of employees in each firm, seen in table 11.

Table 11: Classification of firm size

Firm	Less than 50 people	50 to 100 people	100 to 500 people	500 to 1000 people
Firm A				X[2]
Firm B		X		
Firm C	X			
Firm D				X
Firm E	X			
Firm F				X

Firm sizes in this study vary.

[2] Aerospace product manufacture cannot be separated from automotive product manufacture in Firm A as the same plant is used for manufacture of both aerospace and automotive product. As such, the number of employees given is the total number of employees in the plant.

5.1.2 Firm Classification

Case study firms are classified as either manufacturing or service firms, seen in table 12.

Table 12: Classification of firms

Firm	Manufacturing or service
Firm A	Manufacturing
Firm B	Manufacturing
Firm C	Service
Firm D	Manufacturing
Firm E	Manufacturing
Firm F	Service

Four out of six of the firms in this study, or 67 percent, are manufacturing firms. Two out of six of the firms in this study, or 33 percent, are service firms.

5.1.3 Supplier Classification

Suppliers are classified according to whether they manufacture a product for the case study firm, or provide a service to the case study firm. Supplier location is given. Supplier classification is seen in table 13.

Table 13: Classification of suppliers

Supplier	Manufacturing or service	Location
Supplier A1	Manufacturing	Local and international[3]
Supplier A2	Manufacturing	Local and international[3]
Supplier B1	Manufacturing	Germany
Supplier B2	Manufacturing	USA
Supplier C1	Manufacturing	Germany
Supplier C2	Manufacturing	USA
Supplier C3	Manufacturing	France
Supplier D1[4]	Manufacturing	USA
Supplier D2	Manufacturing	UK
Supplier D3	Manufacturing	France
Supplier D4	Manufacturing	UK, with administration in Germany
Supplier D5	Manufacturing	France
Supplier E1	Services	South Africa[5]
Supplier F1	Manufacturing	USA
Supplier F2	Manufacturing	UK
Supplier F3	Services	South Africa[5]

Fourteen out of sixteen suppliers in this case study, or 88 percent are manufacturing based suppliers. Two out of sixteen of the suppliers in this study, or 12 percent, are service based suppliers.

Twelve out of sixteen suppliers in this case study, or 75 percent have long supply chains. Two out of sixteen suppliers in this case study, or 12, 5 percent have short supply chains, as they are located within South Africa. Two out of sixteen suppliers in this

[3] Participant 1 puts forward an alternative explanation for a long supply chain, where "…for me a long supply chain is also a complex product or raw material that needs to go into my product…for example…(my product involves) a very timeous process…which makes it a complex supply chain, or a long supply chain."

[4] Participant 7 and participant 8 put forward different suppliers that they believed to be strategic to Firm D. Five suppliers were therefore discussed in Case study D. This is not in line with the research methodology of a maximum of three suppliers for analysis.

[5] Participant 13 from Firm E puts forward Supplier E1 with a short supply chain for discussion. This is because Firm E has no strategically important suppliers with long supply chains. Participant 16 and participant 17 from Firm F put forward Supplier F3 with a short supply chain for discussion. Participant 17 says that Supplier F3 is strategically important because they contribute about "40 % of supply by cost", the largest of all suppliers.

case study, or 12, 5 percent may have either long or short supply chains, based on Participant 1's explanation (Footnote 3).

Suppliers chosen by case study firm participants are also classified by their strategic importance to the firm in table 14. The author of this dissertation has attempted to classify strategic importance of suppliers in terms of competitive dimensions in the table below. Reasons for competitive dimension classification are given.

Table 14: Strategic importance of suppliers to case study firms

Supplier	**Strategic importance to case study firm**	**Competitive dimension**	**Reason for choice of competitive dimension**
Supplier A1	Main material needed for product manufacture from Supplier A1 (Participant 1)	Dependability	On time reliable delivery of main material required for product manufacture at Firm A
Supplier A2	"Scarce" material needed for product manufacture, as a result of infrequent production runs by Supplier A2 (Participant 1)	Dependability	On time reliable delivery of a scarce material required
Supplier B1	Participant 2 says "There's probably only six of these suppliers in the world… without their supply we wouldn't be able to support the marketplace with machines."	Dependability	On time reliable delivery of product from few supply sources required
Supplier B2	Participant 2 says "…the aerospace industry for instance has a tendency to specify (products)…they come from companies like Supplier B2…"	Quality	Supplier product must meet aerospace industry specifications

Table 14: Strategic importance of suppliers to case study firms (continued)

Supplier	Strategic importance to case study firm	Competitive dimension	Reason for choice of competitive dimension
Supplier C1	Participant 3 says that Supplier C1 product "…represents about 20% of our annual turnover at the moment…"	Cost[6]	Cost as per a percentage of a firms annual turnover
Supplier C2	Participant 3 says that Supplier C2's product is "…strategic because it's a very common replacement item during aircraft maintenance"	Dependability	On time reliable delivery of a commonly used part from supplier to ensure that product is always available for the customer
Supplier C3	Participant 3 says that Supplier C3's windscreen product is needed as it is "…an item that an aircraft could get grounded if a bird strikes it, so the urgency and access to stock is probably quite imperative to an airline"	Flexibility	Response to an environmental uncertainty
Supplier D1	Supplier D1's materials "provide half of our total expenditure" (Participant 7)	Cost	Cost from expenditure on supplier
Supplier D2	Supplier D2 is strategic "in terms of money expended" (Participant 7)	Cost	Cost from expenditure on supplier
Supplier D3	Supplier D3 is strategic "in terms of money expended" (Participant 7)	Cost	Cost from expenditure on supplier

[6] Whilst cost has been examined in this research within the speed, dependability, quality and flexibility competitive dimensions, classification of the strategic importance of supplier to some firms evidently falls into a distinct cost competitive dimension

Table 14: Strategic importance of suppliers to case study firms (continued)

Supplier	Strategic importance to case study firm	Competitive dimension	Reason for choice of competitive dimension
Supplier D4	Supplier D4 is a stockist for Firm D, with a Service Level Agreement (SLA) in place that has reduced lead time for delivery of goods. (Participant 8)	Speed	Lead time reduction between firm and supplier
Supplier D5	Supplier D5 product is supplied to Firm D based on Customer D3's negotiated amounts and prices (Participant 8)	Cost	Lower cost of product from supplier
Supplier E1	Participant 13 says that Supplier E1 supplies "All my aerospace materials…"	Dependability	On time reliable delivery of all materials required from supplier
Supplier F1	Participant 16 says Supplier F1 provides "Anything we need" for a specific aircraft	Dependability	On time reliable delivery of all materials required from supplier
Supplier F2	Participant 16 says Supplier F2 provides "Anything we need" for a specific aircraft	Dependability	On time reliable delivery of all materials required from supplier
Supplier F3	Supplier F3 makes up about 40% of supply by cost (Participant 17)	Cost	Cost from expenditure on supplier

The strategic importance of suppliers in terms of competitive dimensions is classified as:

- Seven out of sixteen, or 44 percent of suppliers are strategically important from a dependability competitive dimension perspective;
- Six out of sixteen, or 38 percent of suppliers are strategically important from a *distinct* cost competitive dimension perspective;
- One out of sixteen, or 6 percent of suppliers are strategically important from a quality competitive dimension perspective;
- One out of sixteen, or 6 percent of suppliers are strategically important from a speed competitive dimension perspective;
- One out of sixteen, or 6 percent of suppliers are strategically important from a flexibility competitive dimension perspective.

The two South African suppliers, Supplier E1 and Supplier F3, both services, compete on dependability and cost respectively.

5.1.4 Customer Classification

Customers are classified according to whether they are a manufacturing or service based firm. Customer location is given.

Table 15: Classification of customers

Customer	Manufacturing or service	Location
Customer A1	Manufacturing	Local and international[7]
Customer A2	Manufacturing	Local and international[7]
Customer B1	Manufacturing	Sweden
Customer B2	Manufacturing	Sweden
Customer B3	Manufacturing	UK
Customer C1	Service	Mauritius
Customer D1	Manufacturing	USA
Customer D2	Manufacturing	France
Customer D3	Manufacturing	UK
Customer E1	Service[8]	Saudi Arabia
Customer E2	Service[8]	USA
Customer F1	Service	South Africa

Eight out of twelve customers in this case study, or 67 percent are manufacturing based customers. Four out of twelve of the customers in this study, or 33 percent, are service based customers.

Nine out of twelve customers in this case study, or 75 percent have long supply chains. One out of twelve customers in this case study or 8 percent have short supply chains, as they are located within South Africa. Two out of twelve customers in this case study, or 17 percent may have either long or short supply chains, again based on Participant 1's explanation (Footnote 7).

Customers chosen by case study firm participants are also classified by their strategic importance to the firm. The author of this dissertation has attempted to classify strategic importance of customers in terms of competitive dimensions in the table 16. Reasons for competitive dimension classifications are given.

[7] Participant 1 puts forward an alternative explanation for a long supply chain, where "…for me a long supply chain is also a complex product or raw material that needs to go into my product…for example…(my product involves) a very timeous process…which makes it a complex supply chain, or a long supply chain."

[8] Customer E1 is classified as service as it receives a fully assembled product for use from Firm E. Customer E2 is also classified as service as it is primarily a R&D firm.

Table 16: Strategic importance of customers to case study firms

Supplier	Strategic importance to case study firm	Competitive dimension	Reason for choice of competitive dimension
Customer A1	Participant 1 says that Customer A1 receives a "Safety component" from Firm A, which holds an important function in aviation.	Quality	Quality from a safety perspective
Customer A2	Participant 1 says that Firm A product supplied to Customer A2 is a "Unique interior product" for aesthetic reasons.	Quality	Quality from an aesthetics perspective
Customer B1	Product supplied to customer is strategic for financial reasons	Cost[9]	Money from customer

[9] Again, whilst cost has been examined in this research within the speed, dependability, quality and flexibility competitive dimensions, classification of the strategic importance of supplier to some firms evidently falls into a distinct cost competitive dimension

Table 16: Strategic importance of customers to case study firms (continued)

Supplier	Strategic importance to case study firm	Competitive dimension	Reason for choice of competitive dimension
Customer B2	Product supplied to customer is strategic for financial reasons	Cost	Money from customer
Customer B3	Product supplied to customer is strategic for financial reasons	Cost	Money from customer
Customer C1	Product supplied to customer is strategic for financial reasons	Cost	Money from customer
Customer D1	Product supplied to customer is strategic for cost reasons	Cost	Money from customer
Customer D2	Product supplied to customer is strategic for cost reasons	Cost	Money from customer
Customer D3	Product supplied to customer is strategic for cost reasons	Cost	Money from customer
Customer E1	Participant 13 says that the product supplied to the customer allows the exploration of other markets besides South Africa	Cost	Exploration of other markets leads to more money from customer
Customer E2	Product supplied to customer is strategic for cost reasons	Cost	Money from customer
Customer F1	Participant 16 says that "Basically we've got one customer, that's Customer F1"	Cost	Dependent on one customer for money

The strategic importance of customers in terms of the competitive dimensions is classified as:

- Ten out of twelve, or 83 percent of customers are strategically important from a *distinct* cost competitive dimension perspective;

- Two out of twelve, or 17 percent of customers are strategically important from a quality competitive dimension perspective;

The one South African customer, Customer F1, a service, competes on cost.

5.2. Multiple case results

The multiple case results are divided into the first-order measurements of speed, dependability, quality, flexibility, and "other". Within each measurement, recurring results (if found) from case study A to case study F are presented in tables. The first table in each measurement displays the frequency of found recurring results from each case study. The first table summarises the results according to their recurrence in the multiple case study analysis the following way:

- An *X* means that the result is present in that case.
- A blank space means that the result is not present in that case.
- A – in the table means that there was no data in that case for the measurement.
- The percentage of recurrence of the result for each measurement is calculated by taking an average of the available case data. So if all six cases have available data, and three of the six cases have a recurring result, then the result occurs in fifty percent of cases. If only five cases have available data, and three of the five cases have a recurring result, then the result occurs in sixty percent of cases. The percentages in this study should not be taken as statistically significant, but rather for illustrative purposes.

The content of the first table for each measurement is then explained. A second table for each measurement provides an illustrative example from the single case study results to further clarify the multiple case study results. Each measurement presents the results for both the supplier-firm and customer-firm units of analysis.

5.2.1 Speed

Supplier-firm unit of analysis

Table 17 summarises the speed results according to their recurrence in the multiple case study analysis for the supplier-firm unit:

Table 17: Speed competitive dimension results for supplier firm unit

Second-Order Measurement	Third-Order Measurement	Multiple case result	Present in Case?						%
			A	B	C	D	E	F	
Better and timelier information	Communication	Information sharing is critical to supplier-firm relationships	X	X[10]	X	X	X	X	100
	IT	Use of customised or advanced IT	X	X	X	X		X	83
		Other factors in IT	X			X		X	50
Lead time compression	-	Inventory	X			X			33
		Transhipment mode	X		X	X		X	67
		Improve planning			X	X	X	X	67
Synchronisation	Material order volume and frequency	Irregular material order volume and frequency	X	X	X	X		X	83
	Capacity constraints	External capacity problems	X			X	X	X	67

Recurring results found in case studies A to F as per the measurements taken from literature are:

1. Communication third-order measurement:

- Information sharing is critical to supplier-firm relationships: This means that the firm and its suppliers

[10] Whilst Case B generally obtains its information from static online product catalogues from suppliers (instead of more dynamic means like telephonic, email, face-to-face etc. as in other firms), these catalogues, to this author, constitute information sharing between firm and supplier.

recognise the importance of sharing information in the relationship to achieve competitive advantage.

2. IT third-order measurement:

- Use of customised or advanced IT solutions: This means that IT technologies like MRP, C2C, advanced internet applications and customised software solutions are used for sharing information between firm and suppliers.

- Other factors in IT: Whilst IT is recognised as an enabler of information sharing, other factors like people, cost and security issues must be understood in IT.

3. Lead time compression second-order measurement:

- Inventory: Inventory as a time buffer can be used to achieve lead time compression.

- Transhipment mode: Air freight instead of ship freight can be used to reduce transhipment lead times, considering costs and product characteristics.

- Improve planning: Improved upfront planning can lead to a reduction in overall lead time.

4. Material order volume and frequency third-order measurement:

- Irregular material order volume and frequency: Order volume and frequency generally varies with suppliers.

5. Capacity constraints third-order measurement:

- External capacity problems: Capacity problems external to the firm related to the supply of goods from the supplier.

Table 18 gives examples from the multiple case study results to illustrate their meaning.

Table 18: Example quotes from multiple case analysis of speed competitive dimension for the supplier firm unit

Second-Order Measurement	**Third-Order Measurement**	**Multiple case result**	**Example**
Better and timelier information	Communication	Information sharing is critical to supplier-firm relationships	Information sharing with suppliers is a "…open two way channel" and a "lot of information" is shared (Participant 3, Case C).
	IT	Use of customised or advanced IT	"…C2C, or system to system…" (Participant 7, Case D)
		IT problems	IT "has lost that personal touch" (Participant 1, Case A)
Lead time compression	-	Inventory	"Stock carried is obviously of vital importance, everybody wants to carry as little stock as possible." (Participant 1, Case A)
		Transhipment mode	Lead time reduction using air instead of ship freight, but costs must be considered (Case A).
		Improve planning	"…comprehensive and effective planning…" (Participant 17, Case F)
Synchronisation	Material order volume and frequency	Irregular material order volume and frequency	For known projects, material order frequency is done on a "regular basis" (Participant 5, Case C). But if an AOG, material is air freighted within 48 hours to Firm C. The volume of material ordered by Firm C is "fluid", as the aerospace "market (is) not so regular." (Participant 5, Case C)
	Capacity constraints	External capacity problems	Bevel gear production from suppliers is constrained as a result of "…production difficulties…and an unexpected increase in demand…" (Participant 19, Case F)

Customer-firm unit of analysis

Table 19 summarises the speed results according to their recurrence in the multiple case study analysis for the customer-firm unit:

Table 19: Speed competitive dimension results for customer firm unit

Second-Order Measurement	Third-Order Measurement	Multiple case result	Present in Case?						%
			A	B	C	D	E	F	
Better and timelier information	Communication	Information sharing is critical to customer-firm relationships		X	X	X	X		67
		Information sharing from a sales or marketing perspective	X		X				33
	IT	Use of customised or advanced IT	X	X	X	X			67
		Other factors in IT	X	X		X			50
Lead time compression	-	Inventory			X	X			33
		Transhipment mode	X			X			33
		Use of IT for lead time compression			X			X	33
Synchronisation	Material order volume and frequency	Irregular material order volume and frequency	X	X	X		X	X	83
	Capacity constraints	External capacity problems	X		X			-	40
		Internal capacity problems	X	X		X		-	60

Recurring results found in case studies A to F as per the measurements taken from literature are:

1. Communication third-order measurement:

- Information sharing is critical to customer-firm relationships: This means that the firm and its customers recognise the importance of sharing information in the relationship to achieve competitive advantage.

- Information sharing from a marketing or sales perspective: This means the firm gives the customer the type of information that ensures they will remain satisfied with the firm.

2. IT third-order measurement:

- Use of customised or advanced IT solutions: This means that IT technologies like MRP, C2C, EDI, advanced internet applications and customised software solutions are used for sharing information between firm and customers.

- Other factors in IT: Whilst IT is recognised as an enabler of information sharing, other factors like people, costs and security issues must be understood in IT.

3. Lead time compression second-order measurement:

- Inventory: Inventory as a time buffer can be used to achieve lead time compression.

- Transhipment mode: Air freight instead of ship freight can be used to reduce transhipment lead times, considering costs and product characteristics.

- Use of IT for lead time compression: Technology applications to automate processes to enable lead time compression.

4. Material order volume and frequency third-order measurement:

- Irregular material order volume and frequency: Order volume and frequency generally varies with customers.

5. Capacity constraints third-order measurement:

- Internal capacity problems: Capacity problems within the firm that result in late delivery to the customer.

- External capacity problems: Capacity problems external to the firm (e.g. transhipment) related to the delivery of goods to the customer.

Table 20 gives examples from the multiple case study results to illustrate their meaning.

Table 20: Example quotes from multiple case analysis of speed competitive dimension for the customer firm unit

Second-Order Measurement	**Third-Order Measurement**	**Multiple case result**	**Example**
Better and timelier information	Communication	Information sharing is critical to customer-firm relationships	"Almost everything…" Customers "…look at our business right from the front end right to the back, they know probably as much about us as we know about ourselves." (Participant 7, Case D)
		Information sharing from a sales or marketing perspective	"To try and tell the customer that you are obviously the best…you would try to convince and maintain to your customer that the customer is first…by giving him the best price, the best quality, and delivery when he wants it." (Participant 1, Case A)
	IT	Use of customised or advanced IT	"…highly technical, and formalised", with "…a variety of electronic interfaces." (Participant 7, Case D)
		IT problems	IT systems have problems as well, you can "overcomplicate it" (Participant 2, Case B)
Lead time compression	-	Inventory	Firm C keeps on hand safety stock for Customer C1 for fast moving stock (Case C).
		Transhipment mode	Choice of transhipment modes, considering costs, product characteristics and cash flow (Case D).
		Use of IT for lead time compression	Lead time reduction may be possible if computer systems "…could be talking to one another…" (Participant 16, Case F)

Table 20: Example quotes from multiple case analysis of speed competitive dimension for the customer-firm unit (continued)

Second-Order Measurement	**Third-Order Measurement**	**Multiple case result**	**Example**
Synchronisation	Material order volume and frequency	Irregular material order volume and frequency	Development work between Firm E and Customer E1 resulted in "…three or four…" orders with Firm E. The order placed by Customer E2 was a "once off product", and as such there is not really any form of scheduling in place (Participant 13, Case E).
	Capacity constraints	Internal capacity problems	Internal firm capacity problems like "labour issues", "absenteeism" and scheduling delays from "one-off engineering" projects (Participant 2, Case B).
		External capacity problems	External capacity delays because of flight availability to clients (Case C).

5.2.2 Dependability

Supplier-firm unit of analysis

Table 21 summarises the dependability results according to their recurrence in the multiple case study analysis for the supplier-firm unit:

Table 21: Dependability competitive dimension results for supplier firm unit

Second-Order Measurement	Third-Order Measurement	Multiple case result	Present in Case?						%
			A	B	C	D	E	F	
Processes and procedures to ensure dependability	-	Electronic systems		X	X	X			50
		Face-to-face meetings					X	X	33
		Performance monitoring and feedback				X		X	33
		Understanding of supplier requirements	X		X				33

Recurring results found in case studies A to F as per the measurements taken from literature are:

1. Processes and procedures second-order measurement:

- Electronic systems: Automation of order processes to ensure on time reliable delivery of goods from supplier to firm.

- Face-to-face meetings: Face-to-face discussion between firm and supplier to review orders and problems.

- Performance monitoring and feedback: The firm monitors and gives feedback to the supplier on performance related to on-time delivery, quality etc.

- Understanding of supplier requirements: Supplier requirements must be understood to better aid in on time reliable delivery of goods.

Table 22: Example quotes from multiple case analysis of dependability competitive dimension for the supplier firm unit

Second-Order Measurement	**Third-Order Measurement**	**Multiple case result**	**Example**
Processes and procedures to ensure dependability	-	Electronic systems	Automation of the order process from suppliers to Firm B ensures "full visibility" (Participant 2, Case B)
		Face-to-face meetings	Supplier E1 meets with Firm E to discuss current projects, participant 14 (Case E) says that "…it's almost as if I work in the company…"
		Performance monitoring and feedback	Firm F monitors the "typical errors" (Participant 17, Case F) that its suppliers may make
		Understanding of supplier requirements	Supplier "standard lead times" and product regulatory requirements must be understood (Participant 3, Case C)

Customer-firm unit of analysis

Table 23 summarises the dependability results according to their recurrence in the multiple case study analysis for the customer-firm unit:

Table 23: Dependability competitive dimension results for customer firm unit

Second-Order Measurement	Third-Order Measurement	Multiple case result	Present in Case?						%
			A	B	C	D	E	F	
Processes and procedures to ensure dependability	-	No similarities	X	X	X	X	X	-	100

Recurring results found in case studies A to F as per the measurements taken from literature are:

1. Processes and procedures second-order measurement:

- No similarities: No similarities within the processes and procedures second-order measurement were found across cases for the customer-firm unit of analysis

Table 24 gives examples from the multiple case study results to illustrate their meaning.

Table 24: Example quotes from multiple case analysis of dependability competitive dimension for the customer firm unit

Second-Order Measurement	Third-Order Measurement	Multiple case result	Example
Processes and procedures to ensure dependability	-	No similarities	Firm E sends a "…spreadsheet or project plan…" to Customer E1 to aid on time reliable delivery of goods (Participant 13, Case E) South African firms need to be "transparent" with late customer orders and in fixing problems (Participant 2, Case B)

5.2.3 Quality

Supplier-firm unit of analysis

Table 25 summarises the quality results according to their recurrence in the multiple case study analysis for the supplier-firm unit:

Table 25: Quality competitive dimension results for supplier firm unit

Second-Order Measurement	Third-Order Measurement	Multiple case result	Present in Case?						%
			A	B	C	D	E	F	
Meaning of quality	-	External dimension	X	X	X	X	X	X	100
		Internal dimension	X	X	X	X	X	X	100
		Documentation			X	X	X	X	67
Quality planning	Quality planning process	Supplier requirements flow from customer requirements	X	X	X	X	X		83
		Documentation				X	X	X	50
	Trust	Amicable relationships	X	X	X	X	X	X	100
		Trust requires evidence			X	X		X	50
		Demonstration of trust	X	X			X	X	67
Quality control	Quality control process	Incoming quality control	X	X	X	X	X	X	100
		Traceability			X	X	X		50
		Delayed quality control				X		X	33
	Performance measures	Performance measures used	X	X	X	X		X	83
Quality improvement	-	Quality improvements made with suppliers	X		X	X	X		67

Recurring results found in case studies A to F as per the measurements taken from literature are:

1. Meaning of quality second-order measurement:

- External dimension: External dimensions are concerned with whether the features of the products meet the customer needs and provide customer satisfaction. External dimensions take a strategic view of product quality, following a longer term orientation (Slack, 1991, p. 37). The customer in this case is the firm in the supplier-firm unit of analysis to whom the supplier supplies.

- Internal dimension: Internal dimensions are concerned with the product being free from deficiencies, thereby preventing reworks, customer claims, field failures etc. (Juran, 1999, p. 2.1).

- Documentation: Certificates of Conformance (CFC's) and other documentation that provides evidence that the material meets the requirements.

2. Quality planning process third-order measurement:

- Supplier requirements flow from customer requirements: Quality requirements that the firm requires from the supplier are based on the quality requirements of the final customer in the supply chain.

- Documentation: A Certificate of Conformance is required from the supplier to provide evidence that the quality requirements have been achieved.

3. Trust third-order measurement:

- Amicable relationships: The relationship between firm and supplier is generally positive in nature.

- Trust requires evidence: Trust between firm and supplier is based on evidence like CFC's, service level agreements, technical level agreements and supplier qualification systems.

- Demonstration of trust: Trust between firm and supplier is demonstrated by behaviours and actions over an extended period of time (Donovan and Maresca, 1999, p. 21.23).

4. Quality control process third-order measurement:

- Incoming quality control: A set of procedures is in place to address poor incoming quality from suppliers.

- Traceability: Full traceability of incoming product from suppliers is required. Documentation like a CFC must accompany the product.

- Delayed quality control: Supplier quality problems are picked up at the firm later than they should.

5. Performance measurement third-order measurement:

- Performance measures used: Measures are used by the firm to track supplier performance.

6. Quality improvement second-order measurement:

- Quality improvements made with suppliers: Quality improvements are made with suppliers through the form of feedback, reports, audits and interactions. There is no formalised quality improvement process in place with suppliers, such as through a supplier association.

Table 26 gives examples from the multiple case study results to illustrate their meaning.

Table 26: Example quotes from multiple case analysis of quality competitive dimension for the supplier firm unit

Second-Order Measurement	**Third-Order Measurement**	**Multiple case result**	**Example**
Meaning of quality	-	External dimension	Quality is a combination of "…material quality, to my product quality, to my service quality to the customer…" (Participant 13, Case E)
		Internal dimension	"product control" of incoming material from suppliers (Participant 3, Case C)
		Documentation	Suppliers "…deliver on time…they deliver the right stuff to the right quality, and…accompanied by test reports or certificates of conformance…" (Participant 7, Case D)
Quality planning	Quality planning process	Supplier requirements flow from customer requirements	Planning for quality with suppliers generally controlled by prescribed product specifications, product standards or defined part product numbers as per the OEM, airline or maintenance firm (Case C)
		Documentation	Quality requirements set with suppliers require a Certificate of Conformance (CFC) to be sent with all components. Participant 17 says that this is to ensure the sent component "…is correct in every detail, for the intended use." (Case F)
	Trust	Amicable relationships	A "…good working relationship…" exists between Firm E and Supplier E1 (Participant 13, Case E)

Table 26: Example quotes from multiple case analysis of quality competitive dimension for the supplier-firm unit (continued)

Second-Order Measurement	Third-Order Measurement	Multiple case result	Example
Quality planning	Trust	Trust requires evidence	"…there's no such thing as trust when you get to the aircraft industry, guys have got to perform to a certain standard…you want documentation…" (Participant 7, Case D)
		Demonstration of trust	Trust in the relationship is established "over time" (Participant 1, Case A)
Quality control	Quality control process	Incoming quality control	Firm A does "random sampling testing" and "inspection" with suppliers Consistent quality problems result in stepped up quality inspections, "additional audits in process", and supplier on-site inspections (Participant 1, Case A)
		Traceability	Full traceability is "…an extremely important factor" (Participant 4, Case C)
		Delayed quality control	Checking of approved suppliers and materials is done in receiving, whereas "…that should actually be a check with procurement…" before goods arrive at Firm D (Participant 9, Case D)
	Performance measures	Performance measures used	"…a whole series…" of "very simple" performance measures are used with suppliers (Participant 17, Case E)
Quality improvement	-	Quality improvements made with suppliers	Firm C gives "specific feedback" on performance and product quality to its distributorships or main suppliers on a monthly and annualised basis. Firm C gives "widespread feedback" to its non-distributorships or ad-hoc suppliers (Participant 3, Case C)

Customer-firm unit of analysis

Table 27 summarises the quality results according to their recurrence in the multiple case study analysis for the customer-firm unit:

Table 27: Quality competitive dimension results for customer firm unit

Second-Order Measurement	Third-Order Measurement	Multiple case result	Present in Case?						%
			A	B	C	D	E	F	
Meaning of quality	-	External dimension	X	X	X	X		-	80
Quality planning	Quality planning process	Identification of customers needs	X	X	X	X	X	X	100
	Trust	Amicable relationships	X	X	X	X	X		83
		Demonstration of trust		X		X	X		50
Quality control	Quality control process	Internal quality control	X	X	X	X			67
		Customer quality control		X		X			33
	Performance measures	Performance measures used	X	X	X	X		-	80
Quality improvement	-	Quality improvements made with customer		X	X	X		-	60

Recurring results found in case studies A to F as per the measurements taken from literature are:

1. Meaning of quality second-order measurement:

- External dimension: External dimensions are concerned with whether the features of the products meet the customer needs and provide customer satisfaction. External dimensions take a strategic view of product quality, following a longer term orientation (Slack, 1991, p. 37).

2. Quality planning process third-order measurement:

- Identification of customers needs: Quality planning requires the identification and understanding of the customers various needs.

3. Trust third-order measurement:

- Amicable relationships: The relationship between firm and customer is generally positive in nature.

- Demonstration of trust: Trust between firm and the customer is demonstrated by behaviours and actions over an extended period of time.

4. Quality control process third-order measurement:

- Internal quality control: Product that is sent to the customer undergoes some form of active quality control at the firm. This includes quality control systems, quality inspections etc.

- Customer quality control: Customers monitor quality of incoming product from the firm.

5. Performance measurement third-order measurement:

- Performance measures used: Measures are used internally by the firm in measuring performance with customers.

6. Quality improvement second-order measurement:

- Quality improvements made with customers: Quality improvements are made with customers through the form of feedback, reports, audits and interactions. No formalised quality improvement process, such as a supplier association, is in place.

Table 28 gives examples from the multiple case study results to illustrate their meaning.

Table 28: Example quotes from multiple case analysis of quality competitive dimension for the customer firm unit

Second-Order Measurement	**Third-Order Measurement**	**Multiple case result**	**Example**
Meaning of quality	-	External dimension	"Maybe in a nutshell, if you exceed your customer's expectations, then you've achieved quality" (Participant 1, Case A)
Quality planning	Quality planning process	Identification of customers needs	"…give our customers exactly what they want, not more, not less." (Participant 2, Case B)
	Trust	Amicable relationships	The relationship with Customer E1 is "In general, very good." (Participant 13, Case E)
		Demonstration of trust	Trust between Firm D and customers "is earned", based on Firm D's historical performance (Participant 7, Case D)
Quality control	Quality control process	Internal quality control	"Continuous monitoring" at Firm B through internal quality control (Participant 2, Case B)
		Customer quality control	Customer D1 monitors Firm D's incoming quality and documents quality trends (Case D)
	Performance measures	Performance measures used	Performance measures in place at Firm C with customers. Customer satisfaction questionnaires supply "very simple" responses (Participant 3, Case C)
Quality improvement	-	Quality improvements made with customers	Quality improvements "basically come…from the OEM" (Participant 7, Case D)

5.2.4 Flexibility

Supplier-firm unit of analysis

Table 29 summarises the flexibility results according to their recurrence in the multiple case study analysis for the supplier-firm unit:

Table 29: Flexibility competitive dimension results for supplier firm unit

Second-Order Measurement	Third-Order Measurement	Multiple case result	Present in Case?						%
			A	B	C	D	E	F	
Meaning of flexibility	-	Adaptive response to environmental uncertainty	X			X	X	X	67
Achievement of flexibility	-	Communication		X		X			33
		Relationships	X				X		33
		Cost			X			X	33

Recurring results found in case studies A to F as per the measurements taken from literature are:

1. Meaning of flexibility second-order measurement:

- Adaptive response to environmental uncertainty: Suppliers react to the firm's changing demands.

2. Achievement of flexibility second-order measurement:

- Communication: Information sharing between firm and its suppliers can help achieve flexibility.

- Relationships: The firm and its suppliers must have established some form of positive relationship between them to achieve flexibility.

- Cost: More money in the supplier firm relationship can help achieve flexibility.

Table 30 gives examples from the multiple case study results to illustrate their meaning.

Table 30: Example quotes from multiple case analysis of flexibility competitive dimension for the supplier firm unit

Second-Order Measurement	**Third-Order Measurement**	**Multiple case result**	**Example**
Meaning of flexibility	-	Adaptive response to environmental uncertainty	Ability of Firm E to change orders from the original forecast sent to Supplier E1 (Case E)
Achievement of flexibility	-	Communication	Early information from suppliers allows Firm B to be "flexible to a degree", and to "…accommodate that situation within our own material planning." (Participant 2, Case B)
		Relationships	Flexibility between Firm E and Supplier E1 is achieved by having "…a very good relationship…" It is necessary to make the relationship "...work for both sides, looking for win-win kind of scenarios…" (Participant 14, Case E)
		Cost	An increase in "payment terms", where you "…sell the product before you actually have to pay for it…" (Participant 3, Case C)

Customer-firm unit of analysis

Table 31 summarises the flexibility results according to their recurrence in the multiple case study analysis for the customer-firm unit:

Table 31: Flexibility competitive dimension results for customer firm unit

Second-Order Measurement	Third-Order Measurement	Multiple case result	Present in Case?						%
			A	B	C	D	E	F	
Meaning of flexibility	-	Adaptive response to environmental uncertainty				X	X	X	50
Achievement of flexibility	-	Cost	X		X		-	-	50

Recurring results found in case studies A to F as per the measurements taken from literature are:

1. Meaning of flexibility second-order measurement:

- Adaptive response to environmental uncertainty: The firm is required to react to the customers changing demands.

2. Achievement of flexibility second-order measurement:

- Cost: More money in the customer firm relationship can help achieve flexibility.

Table 32 gives examples from the multiple case study results to illustrate their meaning.

Table 32: Example quotes from multiple case analysis of flexibility competitive dimension for the customer firm unit

Second-Order Measurement	**Third-Order Measurement**	**Multiple case result**	**Example**
Meaning of flexibility	-	Adaptive response to environmental uncertainty	Firm E must be flexible because Customer E1 is "…constantly changing requirements…" (Participant 13, Case E)
Achievement of flexibility	-	Cost	Flexibility of "payment terms" with customers, with a "win-win" payment situation for both parties involved (Participant 3, Case C).

5.2.5 Other

Supplier-firm unit of analysis

Table 33 summarises the other results according to their recurrence in the multiple case study analysis for the supplier-firm unit:

Table 33: Other competitive dimension results for supplier firm unit

Second-Order Measurement	Third-Order Measurement	Multiple case result	Present in Case?						%
			A	B	C	D	E	F	
Ways to improve competitiveness	-	Cost	X	X	X		X	X	83

Recurring results found in case studies A to F as per the measurements taken from literature are:

1. Ways to improve competitiveness second-order measurement:

- Cost: More money in the supplier firm relationship may help improve competitiveness.

Table 34 gives an example from the multiple case study results to illustrate the meaning.

Table 34: Example quotes from multiple case analysis of other competitive dimension for the supplier firm unit

Second-Order Measurement	Third-Order Measurement	Multiple case result	Example
Ways to improve competitiveness	-	Cost	Having longer payment terms with suppliers leads to an improved cash flow, which "leads to regularly getting in more funds…" (Participant 1, Case A)

Customer-firm unit of analysis

Table 35 summarises the other results according to their recurrence in the multiple case study analysis for the customer-firm unit:

Table 35: Other competitive dimension results for customer firm unit

Second-Order Measurement	Third-Order Measurement	Multiple case result	Present in Case?						%
			A	B	C	D	E	F	
Ways to improve competitiveness	-	No similarities	X	X	X	X	X	-	100

Recurring results found in case studies A to F as per the measurements taken from literature are:

1. Ways to improve competitiveness second-order measurement:

- No similarities: No similarities were found in achieving competitiveness in the customer-firm relationship.

Table 36 gives examples from the multiple case study results to illustrate the meaning.

Table 36: Example quotes from multiple case analysis of other competitive dimension for the customer firm unit

Second-Order Measurement	Third-Order Measurement	Multiple case result	Example
Ways to improve competitiveness	-	No similarities	Depends on the "professional project manager" who can monitor the project and develop relationships with customers (Participant 2, Case B) The development of a local supplier base and a support base "…where in the long term everyone would benefit…" (Participant 3, Case C)

Some key findings from cross case analysis are presented below. These findings are replicated across the supplier-firm and customer-firm units for speed, dependability, quality and flexibility dimensions. Findings are regarded as important if recurring results are found between cases.

Speed

Supplier firm unit

- All cases describe information sharing as critical to supplier firm relationships.

- The majority of cases use some form of customised or advanced IT to ensure better and timelier information in the supplier firm relationships.

- The majority of cases experience irregular material order volume and frequency between supplier and firm.

Customer firm unit

- The majority of cases experience irregular material order volume and frequency between customer and firm.

Dependability

Supplier firm unit

- Half of the supplier-firm relationships have electronic systems in place to ensure dependability.

Customer firm unit

- No similarities are found in cases for processes and procedures to ensure dependability between customer and firm.

Quality

Supplier firm unit

- All cases describe quality as having both an internal and an external dimension in the supplier firm relationship.
- Supplier requirements flow from customer requirements in the majority of supplier firm relationships.
- All cases describe the supplier firm relationship as amicable in nature.
- All of the firms have some form of incoming quality control for goods from suppliers.
- The majority of cases have performance measures in place in the supplier firm relationship.

Customer firm unit

- The majority of cases describe quality as having an external dimension in the customer firm relationship.
- All cases require the quality planning process to identify customer's needs.
- The majority of cases describe the customer firm relationship as amicable in nature.
- The majority of cases have performance measures in place in the customer firm relationship.

Flexibility

Supplier firm unit

- Over two thirds of cases take flexibility to mean an adaptive response to environmental uncertainty in the supplier firm relationship.

Customer firm unit

- Over half of cases take flexibility to mean an adaptive response to environmental uncertainty in the customer firm relationship.

- Over half of cases take cost as a requirement to achieve flexibility in the customer firm relationship.

Other

Supplier firm unit

- The majority of cases take cost factors as a way to improve competitiveness in the supplier firm relationship.

Customer firm unit

- No similarities were found in how to improve competitiveness in the customer firm relationship.

6. DISCUSSION OF RESULTS

This chapter discusses the *general results*; the *research problem and sub problems*; and the *research process* undertaken. The *general results* containing the firm, supplier and customer classification results are discussed. The *research problem and sub problems* present qualitative evidence to support how long supply chains in the South African aerospace industry compete on the dimensions of speed, dependability, quality and flexibility. Evidence is also presented on aspects from the "other" measurement in the research on how long supply chains compete. A summary of the supplier-firm and customer-firm results is given. The *research process* will discuss general aspects of the research process, weaknesses, the interview tool and validity of results.

6.1 General results

The South African aerospace industry is heterogeneous with regards to firm size. From Table 11, it can be seen that firm size ranges from 50 to 1000 people. This research has made no attempt to take into account firm size with regards to the multiple case results obtained. This is because firm size was not addressed within the original research framework and problems and subproblems.

With 67 percent, the majority of South African aerospace firms are manufacturing type firms (Table 12). On the long supply chain, 88 percent of suppliers (Table 13) and 67 percent of customers (Table 15) are of the manufacturing type. But on the short supply chain, the remaining 12 percent of suppliers and 8 percent of customers are of the service type. This means that all suppliers and customers located on a short supply chain in South Africa are of the service type. But these South African *service* suppliers and customers supply and receive to and from South African *manufacturing* firms. Whilst only two South African suppliers and customers have only been included in this study due to lack of long supply chain data, this further suggests the heterogeneous nature of the South African aerospace industry.

There does not appear to be any difference in the classification of strategically important South African suppliers and customers to that of long supply chain suppliers and customers.

For the most part, firms do not classify suppliers and customers by the *quality* competitive dimension, a highly important dimension in the aerospace industry. A possible reason for this is that quality may be a prerequisite condition for the firm to do business with a supplier, or for a customer to approach the firm for business.

Forty four percent of suppliers are strategically important to the case study firms from a *dependability* perspective (Table 14). Aerospace component manufacture must meet stringent requirements, generally imposed by regulatory bodies and OEM customers (Participant 3, pg. 294). As such, there are few suppliers in the world who have the ability to meet these requirements. So firms are *dependent* on few suppliers for components (Participant 2, pg. 274). Few suppliers to-many firms introduces a dynamic where power relationships and bargaining may come into play. Williamson's (1981) transaction cost economics framework or Kraljic's (1983) matrix may help in structuring these relationships. Thirty eight percent of suppliers are strategically important to the case study firms from a *distinct cost* perspective (Table 14). Whilst cost is a competitive dimension that is examined within the other competitive dimensions in the research framework, it is cited numerous times in the multiple case results as an individual competitive dimension. This result is discussed within section 6.2.5. Participants classify suppliers by the amount of money that the firm spends on goods from the supplier (Participant 7, p. 318).

Eighty three percent of customers are strategically important to the case study firms from a *distinct cost* perspective (Table 16). As explained above, suppliers are strategically important to the firm from the amount of money the firm spends on goods from them. Customers though are strategically important to the firm from the amount of money the customer is willing to pay the firm for the product.

6.2 Research problem and sub problems

The main problem statement in this research is: "How do long supply chains compete?" The research subproblem results that contribute to the main research problem are discussed below, with reference to both the supplier-firm and customer-firm unit of analysis. The results from the multiple case analysis indicate

the extent of the replication logic, and whether predictions from theory produce the required results.

6.2.1 Speed (Subproblem 1)

Supplier-firm

Better and timelier information

All supplier-firm relationships in this case study recognise the importance of information sharing, which links strongly with literature. While results identify that information sharing is important, little insight into the *content* of this information has been gained. It is one thing for participants to say that sharing information is important; it's another thing to know whether that information is not *masked* or *distorted* by one or both parties in the relationship.

The majority of supplier-firm relationships have some form of customised or advanced IT in place. Whilst IT is recognised in literature as integral to managing supply chains, the diversity of IT available requires further investigation of each technologies drawbacks and benefits. The one supplier-firm relationship that did not have any form of customised or advanced IT in place consisted of a South African supplier and firm. Whilst another South African supplier-firm relationship did have some form of customised or advanced IT in place, the size difference between the firms vastly differs. This is similar to Hill and Scudder's (2002) findings that the adoption of an IT technology like EDI is correlated with firm size.

Half of the supplier-firm relationships recognise that other factors are important when using IT. These factors include: not all suppliers wanting to participate in electronic communications due to lack of perceived benefits (Participant 7, p. 319); and the impersonal nature of IT (Participant 1, p. 261). The first finding agrees with Childerhouse *et al* (2003a), who describe choosing supply chain members who largely contribute to the benefit of the supply chain when using IT; the second the use of "softer" issues when using IT (Bailey and Francis, 2008). No noticeable difference was found between South African and global supplier-firm relationships.

Lead time compression

A small number of global supplier-firm relationships *do* use inventory as a buffer to aid in lead time compression. As both South African supplier-firm relationships *do not* use inventory as a buffer, this suggests that inventory can serve as a guard against market and operational uncertainties in the long supply chain (Jammernegg and Reiner, 2007, Jain and Benyoucef 2008). Whilst inventory does provide a buffer to aid in lead time compression, a resulting expense is incurred through direct material and overhead storage costs of that buffer inventory. This does not strictly agree with Slack's (1991, p. 112) view of increasing speed to decrease direct and indirect costs associated with inventory. This may be because Slack's view does not take into account uncertainties and lead times in the global market, which may require stored inventory to respond quicker to customer demands. In the case of short supply chains, Slack's view may hold true.

Transhipment mode is cited as important in achieving lead time compression in over two thirds of supplier-firm relationships. This result, whilst being logical, does not appear to fit with the majority of presented literature. Lead time compression by choosing air freight over shipping freight as a transhipment mode is more applicable in the long supply chain rather than the short supply chain setting. The literature examined in this research is primarily concerned with lead time compression in the short supply chain. This is due to the lack of long supply chain literature. Interestingly, one of the South African supplier-firm relationships also cited transhipment mode as important in achieving lead time compression (Participant 16, p. 395). This is because an *indirect* long supply chain exists, with the locally based supplier having to receive materials from an overseas supplier to provide for the South African customer.

Improved planning is important to achieve lead time compression in over two thirds of supplier-firm relationships. This planning generally relates to the coordination of material flows. Evans *et al's* (1995) suggestions to achieve lead time compression in the supply chain may aid in improving the planning process. No discernable differences were seen between South African and global supplier-firm planning practices.

The majority of supplier-firm relationships display irregular material order volume and frequency characteristics. This does

not fit in with the Stalk and Hout (1990) literature of keeping regular order volumes and frequencies to achieve lead time compression. With uncertainty being an inherent characteristic of the aerospace industry (Bales *et al*, 2004), and the aerospace market irregular in nature (Participant 5, p.308), it appears that Stalk and Hout do not account for the inherent uncertainty in supply chain operations in their methods to achieve lead time compression.

External capacity problems occur in over two thirds of supplier-firm relationships, occurring equally for both global and local suppliers. The reason the word *external* is used is because firms attribute the capacity problem to the supplier, not *internally* within the firm itself. Whilst capacity problems are unsurprisingly acknowledged, there appears to be no recurring reason in the multiple case results for these capacity problems.

Customer-firm

Better and timelier information

Over two thirds of customer-firm relationships in this study recognise the importance of information sharing, again linking strongly with the literature. Interestingly though, the information that a number of firms share with their customers is from a sales and marketing perspective. This, to the author, may be where information is *masked* or *distorted*, the purpose being for the firm to obtain or keep a customer's business. Information sharing with suppliers is on a functional level; information sharing with customers may not always be. No noticeable differences were seen in information sharing between South African and global customer-firm relationships.

Some form of customised or advanced IT is in place in over two thirds of customer-firm relationships. As in the supplier-firm relationships, the diversity of IT available requires further investigation of each technologies drawbacks and benefits. Half of the customer-firm relationships also require other factors to be accounted for in IT: Participant 1 (p. 267) describes the "softer" issue of face-to-face communication as essential above IT communication; the firm may be obliged to use technologies prescribed by the customer (Participant 7, p. 326). The South African customer-firm relationship does not have any customised or advanced IT in place.

Lead time compression

Multiple case results for lead time compression are not concentrated in one particular area, with customer-firm relationships pointing to solutions such as inventory, transhipment mode and IT. These diverging results may be a result of interviewed participants having more knowledge of the supplier-firm unit rather than the customer firm-unit of analysis. This point is further discussed in the *general aspects* of the research process below. The South African customer-firm result does not lean towards any particular area.

The majority of customer-firm relationships display irregular material order volume and frequency characteristics, again not fitting in with the Stalk and Hout (1990) literature. Whilst the supplier-firm and customer-firm are two separate units of analysis in this research, the fact that irregular material order volume and frequency exists with both units should be highlighted. Because the supplier, firm and customer cannot survive independently of one another, irregular material order volume and frequency characteristics on the customer-firm side may cause irregular material order volume and frequency characteristics on the supplier-firm side. Another scenario could be that the internal firm may not be relaying *regular* customer-firm material order volume and frequency characteristics to the supplier on time, causing *irregular* material order volume and frequency characteristics on the supplier side.

External capacity problems occur in under half of the customer-firm relationships. This external capacity problem is found in the transhipment *link between* customer and firm, where things like flight and shipping capacity and availability must be taken into account. Stalk and Hout (1990) only describe balancing *internal capacity* at each member of the supply chain. From this result, both *internal capacity* as well as *external (transhipment) capacity* must be taken into account in long supply chains.

Over half of customer-firm relationships experience internal capacity problems. But whilst in the supplier-firm relationship the internal capacity problem existed with the *supplier*; in the customer-firm relationship the internal capacity problem exists with the *firm*. There appears to be no recurring reason in the multiple case results for the internal capacity problem.

6.2.2 Dependability (Subproblem 2)

Supplier-firm

A third of *local* supplier-firm relationships cite face-to-face meetings as a method to ensure dependability. Half of the *global* supplier-firm relationships have electronic systems in place, where processes and procedures are automated and embedded within software. To the author, these results taken together may identify a difference between coordination mechanisms in short and long supply chains: short supply chains rely on people to ensure dependability, whilst long supply chains have to rely on electronic systems to ensure dependability. This finding augments Jain and Benyoucef's (2008, p. 486) call for research into the role of IT in buyer supplier relationships in the long supply chain.

Performance monitoring and feedback is used to ensure dependability in a third of supplier-firm relationships. This result agrees with Slack (1991, p. 72), who says that delivery dependability should be *measured* to account for early or late delivery. This result is split between a global and a South African based supplier, so little can be said about its contribution to how long supply chains compete on dependability.

An understanding of supplier requirements is said to be necessary to achieve dependability in a third of all cases. This result is rather vague: whilst an understanding of supplier requirements is important, it tells very little about a process or procedure in place to achieve dependability.

The responses on processes and procedures to ensure dependability are varied, but all acknowledge the fact that dependability is important. Whilst dependability leads to lower cost manufacture according to Slack (1991, p. 112), a link between dependability and cost is not seen in these cases.

Customer-firm

It was found that all of the customer-firm relationships do not have any similar processes and procedures in place to ensure dependability. A reason for this may be that a question asking about processes and procedures covers a wide number of aspects, resulting in a wide range of results.

6.2.3 Quality (Subproblem 3)

Supplier-firm

Meaning of quality

All of the supplier-firm relationships approach quality as having both internal and external dimensions, in agreement with Juran (1999). Internal dimensions are concerned with the physical quality of the product sent to the firm by the supplier. External dimensions are also concerned with the physical quality of the product, but often include delivery criteria from suppliers. Over a third of firms believe that quality means documentation must accompany the delivered product. This can be linked in with Garvin's (1998) *conformance* dimension of quality and Crosby's (1996) quality definition of "*conformance to requirements*". This is because documentation provides proof that the product quality does conform to the stipulated requirements. No discernable differences are found between short supply chain and long supply chain results.

Quality planning

In the majority of supplier-firm relationships, supplier requirements flow from customer requirements in the quality planning process. This agrees with Godfrey (1999), with quality planning beginning with customers and their needs. With the supplier requirements flowing from customer requirements, this result also blurs the separate analysis of the supplier-firm and customer-firm units as taken for this research. Again, no discernable differences are found between short supply chain and long supply chain results.

Documentation from suppliers is an essential component to the quality planning process for half of the case study firms. Within these case study firms, a third consists of South African based suppliers. This result, to the author, could be interpreted as firms requiring documentary proof of product quality from their South African suppliers, more so than from their global suppliers. The reason for this may be trust based (discussed later), where the firm has more trust in the global than the local supplier; or it may be that documentation from global suppliers is the standard, whereas with local suppliers it is not.

All of the supplier-firm units of analysis present evidence that an *amicable* relationship exists between the supplier and firm. Whilst this result is positive, the results below on trust add to the complexity of fully understanding the components that contribute to this relationship.

Half of the supplier-firm relationships require evidence for *trust* to exist. This trust applies to product quality, with evidence provided by documentation that verifies product quality specifications. This result disagrees with Sako's (1991) definition of trust: If documentation is required for trust to exist, the firm may not be confident in the supplier always delivering to the decided product specifications. But whilst documentation can be interpreted as disagreeing with Sako's definition of trust, documentation in a highly regulated industry like aviation is required. This is because any form of opportunistic behaviour such as suppliers cutting costs by decreasing quality levels can endanger lives.

Over two thirds of firms believe that trust develops with suppliers through demonstration of behaviours and actions over an extended period of time. This result agrees with Donovan and Maresca's (1999) description of trust.

Quality control

All of the supplier-firm relationships have incoming quality control procedures in place. But whilst procedures do exist, the content of these procedures differs between firms, ranging from audits, incoming product inspections and reliance on quality systems to achieve quality control. In over half of these cases, traceability of product is cited as critical for quality control. Traceability can be seen as similar to the *documentation* result found earlier, and forms a thread between the meaning of quality, quality planning and quality control measurements. It was found in a third of these cases that quality control of incoming supplier product to the firm is often done later than required. This means that product quality specifications are only identified when the product is passed receiving or on the shop floor. Whilst this result is not extensive across multiple cases and is split between a South African and global supplier, it is important.

Performance measures are in place in the majority of supplier-firm relationships. These performance measures are general in nature. First, they do not align to a narrow focus on quality

assurance (Graham and Ahmed, 2000) as expected in aerospace. Second, differing to Neely *et al* (1994), the measurements are not orientated to the dependability and cost dimensions as found from the strategic importance of suppliers to the firm (Table 14). Whilst performance measures are in place, which are important, the results do little to explain the overall use of performance measurement *systems*. No noticeable difference was found between South African and global supplier-firm performance measures.

Quality improvement

Over two thirds of supplier-firm relationships implement quality improvements. The quality improvements made are generally in the form of feedback, reports and infrequent audits between the firm and supplier, as opposed to a set formal quality improvement process. From a long supply chain perspective, a set formal quality improvement process or supplier association proves difficult. This is because distances inhibit frequent audits and inspections of firm and supplier, as well as face to face communication. Locally however, the development of supplier associations for local supplier-firm relationships may be viable. No noticeable difference was found between South African and global supplier-firm results.

Customer-firm

Meaning of quality

The majority of customer-firm relationships approach quality from an external dimension. This result appears logical, as external dimensions are concerned with meeting customer needs and providing customer satisfaction. This does not mean that the internal dimension of quality is not important to customers. Most likely, the internal dimension is dealt with on the supplier-firm side, where product quality and documentation is addressed. No noticeable differences were found between South African and global customer-firm results.

Quality planning

In all of the customer-firm quality planning results, the identification of customer needs forms an output. Whilst this result agrees with Godfrey (1999) in that the quality planning process is followed, little else can be said about how quality

planning in the aerospace long supply chain occurs. The recommended sourcing strategy literature covered for this research did not appear in the results. This may be due to the line of questioning used in the interview tool.

Evidence exists that an *amicable* relationship is in place between customer and firm for the majority of results. One South African based customer and firm however does not present evidence to say that an amicable relationship exists (Participant 16, p. 401). This does not say that an amicable relationship does not exist. Evidence given by Participant 16 just does not describe the relationship in this way.

Half of the firms believe that trust develops with customers through a demonstration of the *firms* actions over an extended period of time. This is in line with Donovan and Maresca's (1999) idea of trust. Whilst not fitting in with Donovan and Maresca's idea of trust for the multiple case result, Participant 1 from Case A's (p.269) idea of trust fits in Kim and Prabhakar's (2004) idea of calculative trust. This is because trust between firm and customer in Case A's instance develops at *initial contact*, rather than *over time*. This result highlights the complexities that exist in supply chain relationships.

Quality control

Over two thirds of firms perform internal quality control before products are sent to the customer. The results do not point to any specific quality control processes that are used within the firms, but may include quality inspections, quality control systems and continuous monitoring of product quality. In addition to internal quality control, a third of customers monitor incoming product quality from the firm. The quality control process can therefore be said to extend from supplier to firm, internally within the firm and from the firm to the customer.

Internal performance measures are in place in the majority of customer-firm relationships. As with the supplier-firm unit of analysis, the results on performance measures are general in nature, do not appear to align to a narrow focus on quality, and do not orientate to the cost dimension as found from the strategic importance of customers to the firm (Table 16).

Quality Improvement

Over half of customer-firm relationships implement quality improvements. The customer implements the quality improvement with the firm, whereas the firm implements the quality improvement with the supplier in the units of analysis. Again, quality improvements made are generally in the form of feedback, reports and infrequent audits between the firm and customer. Participant 2 from Case B (p. 285) explains the need to quantify quality improvements through costs. This agrees with Juran's (1999) COQ and Crosby's (1996) PONC to justify quality improvement efforts. COQ and PONC can be used to support Slack's (1991, p.112) view that higher quality contributes to low cost manufacture. Costing of quality improvements may also augment Ferdows and De Meyer's (1990) sand cone model, where quality is the initial focus of improvement. By initially focusing on quality (the first layer of the sand cone) and being able to quantify improvements in cost terms, focusing on the last layer of the cone, costs themselves, requires the least amount of effort.

6.2.4 Flexibility (Subproblem 4)

Supplier-firm

Meaning of Flexibility

Over two thirds of supplier-firm relationships take flexibility to mean an adaptive response to environmental uncertainty. This result agrees with Gupta and Goyal (1989) and Gerwin's (1993) view of flexibility. These environmental uncertainties, often brought on by changing customer requirements, require the firm to change delivery schedules, delivery quantities, and materials with suppliers. These changes link strongly with delivery flexibility, volume flexibility, and product (mix) flexibility as found in table 5.

Whilst manufacturing flexibility and supply chain flexibility can be separated in the literature, the author believes that manufacturing flexibility can be considered a source of supply chain flexibility. Internal manufacturing flexibility of each supply chain member adds to the overall flexibility of the supply chain. Supply chain flexibility, in the form of logistics, transhipment and routing flexibility elements, form links between supply chain members. But these links themselves are dependent

on the internal manufacturing flexibility of the members (e.g. logistic services) who provide them.

Achievement of flexibility

The achievement of flexibility in the supplier-firm unit of analysis varies, with a third of cases citing communication, relationships and cost as important factors. These factors do not appear to correlate with the research literature on achieving *delivery*, *volume* and *product* (*mix*) flexibility, as found in the meaning of flexibility result above. A reason for this may be that the link between the interview question on the *meaning of flexibility* and the next question on the *achievement of flexibility* was not explicit. It may also be that flexibility is not as easy to grasp in a question as something like quality. As a result, participants deal with the semantics of something that is not completely tangible.

Customer-firm

Meaning of flexibility

Over half of customer-firm relationships again take flexibility to mean an adaptive response to environmental uncertainty. A third of the environmental uncertainties in these customer-firm relationships are time based. This result is most similar to the delivery flexibility dimension as found in table 5. This result is interesting, as it seems counter-intuitive for a long supply chain to compete on a time based flexibility dimension due to geographic distances involved.

Achievement of flexibility

Cost is an important factor in achieving flexibility in half of the customer-firm relationships. Cost can either be flexibility in payment terms with customers, or it can be money to aid in flexibility for inventory, transportation modes etc. If the meaning of flexibility result is taken as delivery flexibility, achieving delivery flexibility by having more money (cost) is possible by having a large buffer inventory, choosing air freight over shipping freight etc. Cost is not cited in most literature as a means to achieve flexibility. Slack (1991) however says that a competitive dimension such as flexibility contributes both directly and indirectly to low cost manufacture. This may explain

why cost is important in achieving flexibility in some supplier and customer firm relationships.

6.2.5 Other

Supplier-firm

The majority of supplier-firm relationships point to the broad dimension of cost as a way to improve competitiveness. The cost dimension refers to payment and cash flow issues with suppliers; bank charges and foreign currency payments; South African government funding to the correct areas within the aerospace industry; and little choice in minimising costs with suppliers due to obligations with OEM's.

Whilst cost is examined within the competitive dimensions of speed, dependability, quality and flexibility in this research framework, it also appears as an individual "other" competitive dimension. This may be because the link between contributions of speed, dependability, quality and flexibility to cost, as described by Slack (1991), is not necessarily explicit in nature. Supplier cost, or price of goods, may be individually evaluated by the firm in the same way that a required quality level or lead time for example is evaluated when obtaining goods. So whilst speed, dependability, quality and flexibility all contribute to the overall dimension of cost, some of these competitive dimensions may be also be individually evaluated alongside cost when it comes to judging supplier performance. The evaluation process of competitive dimension choice may be guided by sourcing strategies like the continuity-involvement matrix (Childerhouse *et al*, 2002, p. 498), the Kraljic matrix (Kraljic, 1983**)** and the transaction cost economic framework (Williamson, 1981).

Cost as the final effort in Ferdows and De Meyer's (1990) sand cone model for lasting manufacturing improvements is not found in the cost result in the "other" dimension. This result may be likely because the line of questioning in the interview tool did not address the application *order* or *hierarchy* of the competitive dimensions for sustainable improvement efforts. The interview tool instead addressed content based on literature within each competitive dimension. As this research is exploratory in nature, addressing content within each competitive dimension is sufficient.

Customer-firm

No similarities were found in the customer-firm relationship to improve competitiveness, so little can be discussed.

6.2.6 Summary of Results

Table 37 and table 38 present a summary of the research results for the supplier-firm and customer-firm units of analysis. The subproblems of how long supply chains compete on speed, dependability, quality and flexibility provide the guide to the summary table. The “other” category is also included. Only results that are relevant to how long supply chains compete are presented in the tables below. This means that not all discussed results are found in the tables below, as they do not fit the ‘competing’ part or the ‘long supply chain’ part of the subproblems. This does not mean excluded results are not important; they instead contribute to the research process and further work sections discussed below.

Table 37: Summary of research results for supplier firm unit of analysis

Dimensions	**How to compete**
Speed	Share information between firm and supplier Use of customised or advanced IT solutions between firm and supplier, but also acknowledge the softer issues Inventory, transhipment mode (air versus freight) and improved planning for lead time reduction
Dependability	Automated processes and procedures Performance monitoring and feedback between firm and suppliers Understand supplier requirements
Quality	Compete on internal and external dimensions of quality; conformance to requirements through documentation Quality planning begins with customers and their needs Amicable supplier-firm relationships Trust demonstrated by behaviours and actions over time, but trust also requires documentary proof Various incoming quality control procedures in place; product traceability through documentation important Performance measures in place Quality improvements through feedback, reports, infrequent audits
Flexibility	Delivery, volume and mix flexibility important Flexibility achieved through communication, relationships and contribution of cost factors
Other	Compete through distinct cost factors

Table 38: Summary of research results for customer firm unit of analysis

Dimensions	**How to compete**
Speed	Share information between firm and customer Use of customised or advanced IT solutions between firm and customer, but also acknowledge the softer issues Inventory, transhipment mode (air versus freight) and IT for lead time reduction
Dependability	No multiple case similarities in the results
Quality	Compete on external dimension of quality Quality planning begins with customers and their needs Amicable customer-firm relationships Trust demonstrated by behaviours and actions over time Internal quality control at firm and customer quality control procedures in place Performance measures in place Quality improvements through feedback, reports, infrequent audits
Flexibility	Delivery flexibility important Achievement of flexibility through cost factors
Other	No multiple case similarities in the results

Whilst the supplier-firm and customer-firm units of analysis are analysed separately in this research, some important similarities and differences between units can be identified:

- On the *speed* competitive dimension, the supplier-firm unit cites *improved planning* for lead time reduction. This is not mentioned as a result for the customer-firm unit. This may be because planning with suppliers is often dependent on the customer placing an order with the firm, which cannot always be planned for in advance.

- For the *dependability* competitive dimension, no similarities were found in the results for the customer-firm unit, whereas similarities were found for the supplier-firm unit. This may be because on time reliable delivery of goods to the customer is dependent on internal firm operations e.g. manufacturing time. The interviewees picked for this research may have had more insight into external firm rather than internal firm operations because of their job focus on the supply chain, so no similarities were found.

- For *quality*, the supplier-firm unit interprets quality from an *internal* and *external* dimension, whereas the customer-firm unit interprets quality from only an *external* dimension. A possible reason for the *external* dimension for both the supplier-firm and customer-firm unit is that customer requirements depend on both supplier and customer input. The *internal* dimension result may only exist for the supplier-firm unit because it is the focal case study firm requiring technical specifications such as quality documentation from its suppliers. This is different from the focal case study firm requiring technical specifications like quality documentation from its customers, which does not seem logical. This is a directional issue between supplier, firm and customer, discussed in section 6.3.1.

- *Flexibility* results between supplier-firm and customer-firm units vary. For the supplier-firm unit, *delivery*, *volume* and *mix* flexibility are important, but only *delivery* flexibility is important for the customer-firm unit. The author of this paper is unable to come up with a possible reason for this result. *Communication and relationships* are given as important to achieving flexibility in the supplier-firm unit, but not the customer-firm unit. This may be a result of the interviewees chosen for this research having more insight into the supplier-firm unit of the supply chain.

- For the *other* result, distinct *cost* factors are given as important for the supplier-firm unit but not for the customer-firm unit. This may be because costs are relatively fixed for the customer-firm unit, but could vary for the supplier-firm unit. Large customers may dictate pricing to the firm, who has little choice but to settle for

the given price to survive. But negotiation and bargaining around cost may occur with smaller suppliers, who have little choice but to take the price set for them by the firm to survive. Cost factors between supplier-firm and customer-firm units may form part of further work, discussed in Section 7.2.

6.3 The research process

6.3.1 General aspects

This research explores the *link* between the supplier and the firm; and the *link* between the customer and the firm. Material and information flows form the basis of the link, with the competitive dimensions loosely coupled around these flows. This was done to try and explore the dimensions of speed, dependability, quality, flexibility and 'other' within the link, instead of solely focusing on the firm, supplier, or customer. What this means though is that the direction of the link may be from supplier to firm or firm to supplier; or from customer to firm, or firm to customer. An example can be seen in Customer A1 receiving a "safety component" (Participant 1, p. 266) from Firm A, which holds an important function in aviation. This is saying that Customer A1 regards Firm A as strategic, not as Firm A regarding Customer A1 as strategic. This complicates analysis in some ways, as it means that directionality of the link must be accounted for. But it may also identify where power lies in the supplier-firm or customer-firm relationship, which may have implications for better structuring the long supply chain.

Even though the units of analysis in this research attempt to examine the *link* between the supplier, firm and customer, often the internal firm operations are indirectly examined in the process. This fits in with Bales et al's (2004) research findings of internal firm operations having an affect on intra-organisational supply chain issues. An example of an internal firm operation affecting the customer-firm link can be seen in Firm B doing "continuous monitoring" (Participant 2, p. 284) of outgoing product to the customer using internal firm quality control systems. The fact that internal firm operations do come out in the examination of the links between supplier and customer highlights the fact that members in a supply chain cannot work in isolation from one another.

The classification criteria of picking suppliers/customers who are geographically distant from the firm, and who provide/receive a part with strategic importance to/from the firm had, in some cases, conflicting goals. For example Firm E identified Customer E2 as strategic and receiving goods on a long supply chain (Participant 15, p. 389). But Customer E2 only had a once off order with Firm E, and was unsure when they would again reorder a project. This means that customers, and suppliers who have a long supply chain to the firm are not necessarily the most strategic to the firm. More strategic customers and suppliers may be found on a short supply chain within South Africa. This may be seen in Firm F identifying local Customer F1 as their most strategic customer (Participant 16, p. 399), even though a less strategic customer did exist on a long supply chain. Whilst the main problem statement is to investigate "How long supply chains compete", it may be better to investigate how supply chains compete in the South African aerospace industry based on strategic customer and supplier relationships. This means that the length of the supply chain is not a classification criterion; instead strategic relationships form this basis.

When writing up the single case studies, greater emphasis has been placed on certain interviewee opinions more so than others within a particular case study. This is because some interviewees appear to be more knowledgeable and credible than other interviewees. This means that data triangulation of the interview results in a case study does not necessarily take an equal weighting of all interviewee inputs.

It appears that there is a far greater focus on the supplier-firm unit of analysis than the customer-firm unit of analysis, especially in the larger firms (500 to 1000 people, Table 11). This is based on the fact that participants in these firms have shorter responses to the customer-firm questions than the supplier-firm questions, or do not have any response to the customer-firm questions. The author thinks that this may be because the personnel interviewed have titles such as 'supply chain manager' and 'procurement manager'. This means that they are for the most part focusing on the supplier-firm unit of analysis.

It may appear that greater emphasis has been given to competitive dimensions like quality and speed, in relation to dependability and flexibility. This is due to more questions in the interview tool and research framework having been dedicated to

the quality and speed dimensions. Some second-order measurements like relationships in the quality competitive dimension, and communication in the speed competitive dimension could just as well have been examined in the dependability competitive dimension. This is because improved communication and relationships could lead to on time reliable delivery. But the purpose of this research, at least initially, is not concerned with the placing of emphasis of one competitive dimension over another. Rather it should be regarded as a first iteration to identify which measurements in the competitive dimensions do apply in the long supply chain in a South African setting. Results indicate that supplier-firm units compete on measurements of speed, dependability, quality, flexibility and cost. Customer-firm units compete on measurements of speed, quality and flexibility.

Generally participants did not have any objections on having the audio interview recorded by the author. Only one participant voiced concerns about not wanting the recording to be distributed. It is unclear whether the interviewees did alter their responses to the questions due to the presence of a recording device. But interviewee behaviour did appear, to the author, to be the same before and after the recording device was turned on and off.

For the most part, evidence found during data triangulation corroborated participant responses for the single case studies. Often the responses built up a result using another angle to the question, rather than verifying another participant's answer. Participant answers in the single case studies, for the most part, did not contradict one another. One contradiction was found in Case D, where a participant describes the need for "partnership models" (Participant 11, p. 362) when setting quality requirements with suppliers. But another participant says relationships with suppliers are "...arm's distance..." (Participant 7, p. 322) due to distances involved.

It was found that the dependability competitive dimension results can often be encompassed within the quality competitive dimension results. This is because quality from an external dimension viewpoint needs to meet customer requirements through product quality and on time delivery. On time delivery is the focus of the dependability competitive dimension. Flexibility and speed appear to act independently within the chosen competitive dimensions.

Table 39 provides a summary of general aspects of the research process:

Table 39: General aspects of the research process

1. Directionality of the supplier-firm and customer firm link is important
2. Internal firm operations may emerge when examining the intra-organisational supplier-firm and customer-firm link
3. In some cases conflicting classification criteria of geographically distant supplier/customer and strategically important supplier/customer may occur
4. More interviewees in a case study provide a better 'fit' to aspects of the literature and research framework
5. Greater emphasis is placed on certain interviewee opinions
6. Greater focus on the supplier-firm unit of analysis
7. The initial research framework is not concerned with placing extra emphasis on any of the competitive dimensions
8. Recording of interviews did not appear to have an effect on interviewee behaviour
9. Evidence found during data triangulation corroborated participant responses
10. Dependability contained within the quality competitive dimension. Speed and flexibility appear independent of one another

6.3.2 Weaknesses in the research process

With the South African aerospace industry being heterogeneous in nature, it has proved difficult to obtain the number of case studies recommended by Eisenhardt (1989) of between four and ten that fulfil the long supply chain criteria. Because of this, Firm E and Firm F, which have components of short supply chains, have been included in the multiple case analysis.

When listening to the initial audio interviews, the author found that in some cases suggestions were given to the interviewee on what they were trying to say. This goes against Leedy and Ormrod's (2005) research guideline of allowing people to choose their own way of expressing their thoughts. To keep to this guideline, when suggestions were given to the interviewee by the

author, this part of the audio interview was excluded for analysis.

As per their request, the face-to-face interview with Participant 3 and Participant 4 in Case C was conducted at the same time. Whilst this is not seen as an ideal situation in terms of group dynamics (Leedy and Ormrod, 2005), the author did not perceive any of the questions answered by interviewees to be influenced by a group dynamic. This is because interviewee answers appeared to not contradict one other, and both interviewees are directors in Firm C, and therefore, on paper, on equal footing.

Participant 5 from Supplier C1 granted a telephonic interview with the author provided that the interview questions were emailed before the interview. This goes against the proposed research methodology, as in the other case studies interview questions were not sent out beforehand.

When telephonically interviewing suppliers and customers, it is possible that the answers given by the interviewees may be biased to what the interviewee thinks the firm would want to hear. This may be seen in questions like: “Would you say that the firm trusts the supplier to deliver the required quality”, or “Can you describe the type of relationship that exists with the firm?” A better understanding of whether a bias does exist would be in the future to use multiple interviewees and gauge their responses. It must also be understood that interviewee responses are based on perception, not fact.

Table 40 provides a summary of weaknesses in the research process:

Table 40: Weaknesses in the research process

1. It has proven difficult to obtain the recommended number of case studies
2. In cases the author made suggestions to the interviewee on what they may be trying to say
3. A face to face interview was conducted with two participants at the same time, possibly introducing group dynamics
4. Interview questions were sent to Supplier C1 before the telephonic interview
5. Telephonic interview responses may be biased towards what suppliers and customers think the firm wants to hear

6.3.3 Interview tool

It was found that results for the supplier-firm and customer-firm are often similar in nature. This may be due to the supplier-firm and customer-firm units of analysis being discussed directly after one another in the interview tool. A solution may be to only address the supplier-firm or customer firm unit of analysis with an interviewee. This may prove difficult if the firm has limited staff involved in supply chain operations. Another possibility is that supplier, firm and customer operations are strongly linked together. Therefore one cannot completely separate them for individual analysis.

Certain interviewee responses to questions in the interview tool inadvertently discuss other topics that are relevant to a later question. For example, in Case D a portion of Participant 7's answer of "In the aircraft industry the general rule is that everything on the aircraft should be traceable back to origin" (p.327) is mentioned in the question relating to lead time compression. This answer is more relevant to the quality competitive dimension, and so is moved into this section of the framework. This type of change is only done when it is obvious that the answer or part of the answer is relevant to another portion of the research framework.

It appeared that towards the end of some interviews examining both the supplier-firm and customer-firm units of analysis that the interviewee became agitated. This was indicated to the author by more abrupt responses to questions and general restlessness. This may be attributed to the length of the exploratory interview tool, which attempted to cover a broad range of topics. If future research is conducted using an interview type tool, content should be focused and guided by further work suggestions as outlined in section 7.2.

Table 41 provides a summary of issues with the interview tool:

Table 41: Issues with the interview tool

1. Supplier-firm and customer-firm results are often similar possibly due to structure of interview tool
2. Interviewee responses to questions in the interview tool do not always fit the examined competitive dimension
3. Length of interview tool proved problematic in some cases

6.3.4 Validity of results

Construct validity

Data triangulation proved difficult with the smaller case study firms having less than 100 people (Table 11). Within these firms, a few managers are in charge of multiple business functions like finance, marketing and supply chain operations. This means that smaller firms having staff with titles such as ‘procurement manager’ and ‘supply chain manager’ do not exist. Because of this, the smaller case study firms often only have one interviewee with a high level understanding of their firm’s supply chain, reducing the overall richness of these case studies.

Within this case study research, the more interviewees available for a case study means more data, and therefore the better the chances that the data will fit into the research framework and link up to the literature. Whilst every effort is made to not “force” the data into the framework, it appears that cases with more interviewees or longer interviews better fit aspects of the framework and literature. This does not mean that the case studies with fewer interviewees do not fit aspects of the framework and literature. It just means that the evidence from the case studies with fewer interviewees has not been given, as given evidence is based on interviewee perceptions.

Whilst this research calls for a maximum of three of the same suppliers and customers to be used by participants in the firm, this did not occur in Case D. This is because two of the participants disagreed with each others strategic choice of supplier. This is a result of the classification process in this research, where the first participant’s choice of suppliers and customers is used for all participants in the firm. To improve construct validity for future work, strategic suppliers and

customers should be chosen by an individual who is involved on the highest possible level in supply chain activities in the firm.

External validity

Whilst literature can allow for comparison and verification to maintain external validity, it has proven difficult for this study. This is because the literature survey addresses components of long and short supply chains, with limited available long supply chain literature. The case studies in this research also contain both long and short supply chains, so direct comparison of results to literature may sometimes prove difficult.

Direct comparison of individual case study results through replication could only be done for ‘like’ supply chains, where long supply chain results are compared with long supply chain results and short supply chain results are compared with short supply chain results. Because more cases contain long supply chains, the results are biased towards long supply chains.

Reliability

Due to the exploratory nature of this research, large sections of the audio interviews were transcribed, even when the author was unsure to whether it was relevant to the question. This was done to allow for all possible thematic areas within the interviews to be used in multiple case analysis.

Table 42 provides a summary of the validity of results:

Table 42: Summary of the validity of results

Construct validity
1. Data triangulation proved difficult with smaller case study firms
2. More interviewees for a case study provides a better fit to the research framework
3. Strategic classification of suppliers and customers to interviewees in the same firm may differ
External validity
1. Comparison and verification of results to literature can prove difficult
2. Replication of results biased towards long supply chains
Reliability
1. Large sections of audio interviews were transcribed to allow for capture of thematic areas

7. CONCLUSIONS AND FURTHER WORK

7.1 Importance of findings

This research indicates that the supplier-firm unit in the long supply chain competes on aspects of speed, dependability, quality, flexibility and cost. The customer-firm unit in the long supply chain competes on aspects of speed, quality and flexibility. These aspects can be used to guide future research focus on how long supply chains compete.

Suppliers are found to be strategically important to the firm from mainly a dependability and cost perspective. Customers are found to be strategically important to the firm from mainly a cost perspective. These results illustrate the structure of relationships in the South African aerospace industry.

This research agrees with Harland *et al* (1999), in that manufacturing competitive dimensions can also be applied in a supply chain setting.

This work contributes to further research on long supply chains, an area that is lacking in the literature (Jain and Benyoucef, 2008, p. 475; Shi and Gregory, 1998, p. 197). Specifically, it has added to competitive strategy research in the long supply chain field.

This work contributes to further research on the customer-firm relationship, which is often neglected when compared to research on the supplier-firm relationship in the supply chain (Frohlich and Westbrook, 2001).

This research process has identified the South African aerospace industry as *small* and *heterogeneous*. This is because it has proved difficult to obtain up to the 10 recommended case studies as set by Eisenhardt (1989, p. 545). It has also proved difficult to include only global suppliers and customers for this study. As a result, a small number of South African suppliers and customers were used. To complicate matters further, South African suppliers are on an *indirect* long supply chain, in that they are locally based, but receive materials from overseas suppliers for the locally based firms. Results should therefore not be generalised. This is due to the small sample size, data not being

random, and difficulty in fulfilling long supply chain criteria for all cases.

Manufacturing and service firms, suppliers and customers that have both long and short supply chains in the South African aerospace industry have been identified in this research. This may aid future research.

7.2 Further work

General

Conflict exists in the classification of suppliers and customers who fulfil the long supply chain criteria and send/receive a part with strategic importance to/from the firm. Whilst the long supply chain criteria is crucial, local suppliers and customers who are strategically more important than those overseas may be greater so. Further research may investigate the strategic importance of suppliers and customers to local aerospace firms, be it on either the short or long supply chain.

This multiple case study has made no attempt to take into account the effect of firm size; supplier and customer size; firm process choice as per Hill (1994); and the effect of manufacturing or service type on firm, supplier or customer with regards to the results obtained. Further work may involve investigating the effect of one or the entire list above, and their effect on how supplier-firm and customer-firm relationships compete in the aerospace supply chain. Due to the relatively small size of the South African aerospace industry in relation to other countries, caution should be taken in that such research does not become idiosyncratic.

The supplier-firm and customer-firm units of analysis may be further extended to include the supplier-supplier-firm, or the customer-customer firm. A supplier-customer unit of analysis may be created to examine the extent of information sharing in the supply chain.

This research has not directly addressed the role of warehousing, distribution and transportation activities that exist between supplier, firm and customer. Further work should examine the competitive advantage that could be gained from these activities.

Speed

Whilst supplier-firm and customer-firm units of analysis recognise the importance of information sharing, this research has shed little insight into the *content* of the information shared. Further work may investigate the content, direction and frequency of information flows between supplier, firm and customer.

Supplier-firm and customer-firm units of analysis have some form of customised or advanced IT in place. Further research should investigate the role of IT, as well as its associated 'softer' issues, in improving long supply chain competitiveness.

Stalk and Hout's (1990) framework for lead time compression does not fit the aerospace long supply chain with regards to material order volume and frequency characteristics. This may be a result of uncertainty being an inherent characteristic of the aerospace industry (Bales *et al*, 2004). Investigate material order volume and frequency characteristics in aerospace long supply chains. This investigation may include the effect of the found results of inventory, production planning and transhipment methods in lead time compression.

Dependability

The investigation of processes and procedures to ensure dependability in this research has been broadly addressed. This may be a reason to why no similarities were found for the customer-firm unit of analysis. Further research should focus on other dependability literature for analysis. This could look specifically at the strategic importance of suppliers to South African aerospace firms from the dependability competitive dimension.

Quality

Documentation and traceability appear to be necessary in planning and controlling for quality in the aerospace supply chain. Further research should investigate processes and procedures that are in place for traceability and management of quality documentation between supplier, firm and customer.

Further investigation into the role of performance measures in the aerospace supply chain should be undertaken. This would

look at the role of performance measures and systems, as well as the competitive performance measures that the aerospace supply chain aligns to. The foundation for this study may be provided by Neely *et al's* (1994) study into the realisation of UK manufacturing firm strategies through performance measurement systems.

This research has identified that amicable relationships appear to exist between suppliers, firms and customers in the aerospace supply chain. Results also show that trust is demonstrated by behaviours and actions over time. Further research should investigate relationships that exist in the aerospace supply chain in detail, including the role that contracts and trust can play. Research by Ghosh and Fedorowicz (2008) can provide a basis for this study.

Flexibility

Whilst results for flexibility have been found for the supplier-firm and customer-firm units of analysis, the author thinks that time spent on research into the semantics of flexibility could be better spent on the speed, dependability and quality competitive dimensions.

Other

Results broadly point to cost as an important factor in improving competitiveness in the supplier-firm relationship. Future research may investigate the role that cost as a distinct competitive dimension plays in the long supply chain in the South African aerospace industry. The link between the contributions of speed, dependability, quality and flexibility to cost, as described by Slack (1991) within the long supply chain may also be determined. The application of Ferdows and De Meyer's (1990) sand cone model may provide a further area of research, examining the order of application of competitive dimensions for lasting improvements in a long supply chain setting. Differences in how cost factors differ between supplier-firm and customer-firm units may also form part of further research.

7.3 Future literature focus

The literature covered in this research has for the most part provided a broad generic overview of competitive dimensions and

supply chain criteria. Whilst this has allowed for numerous topics to be examined, it has also detracted from in-depth examination of specific topics. But because this research is exploratory in nature and little literature exists on long supply chain topics, a broad generic overview is thought to be appropriate. To aid future research, competitive dimension literature covered in this study that appears relevant to the results is given below:

- For *speed*:
    - Stalk and Hout's (1990) first idea of *providing firms with better and timelier information* appears relevant from both a communication and IT perspective.
    - Stalk and Hout's second idea of *shortening lead times in time compression* is applicable, possibly due to the generic nature of the found literature.
    - Stalk and Hout's third idea of *synchronisation in time compression* does not fit results from an *order volumes and frequencies* perspective. The limited literature on *capacity constraints* appears to apply to the results.

- For *dependability*:
    - Literature focusing on *centralised* and *decentralised coordination mechanisms* to ensure dependability did not appear in the results, possibly as a result of the open ended type question in the interview tool.

- For *quality*:
    - Literature describing the various definitions of quality appears applicable to results.
    - Literature on a recommended sourcing strategy as a primary output of the *quality planning* process did not appear in results. This may be because this is a specific topic that the interview question did not directly address. Explanations of trust did relate to the results.
    - The *quality control* process and performance measurement literature linked with results.
    - The supplier association literature in *quality improvement* did not feature in the results.

- For *flexibility*:
    - The *meaning of flexibility* taken from literature appears to be applicable to results.
    - For the most part, results agree most strongly with Slack's (1991) definitions of *manufacturing* and *supply chain flexibility* in literature.

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Appendix A

Appendix A contains an explanation of the Kraljic Matrix, an approach to purchasing as a strategy in the firm. Issues relating to the implementation of the Kraljic matrix are also provided.

Kraljic Matrix

Kraljic (1983) looks at how purchasing should be regarded as a strategy in the firm. This strategy gives a four stage approach towards minimising supply risk and making the most of the firms bargaining power to improve its competitive position. According to Kraljic (1983, p. 112), the company first classifies its purchased materials by the supply risk involved and the impact on profit. The supply market is then analysed to see the bargaining power of the suppliers against the firm's strengths. The firm then determines its own strategic position, followed by the development of a material strategy plan.

The purchased materials classification matrix can be seen below. Kraljic (1983, p. 112) determines the profit impact in terms of the volume of materials purchased, percentage of the total purchase cost or the impact on product quality or business growth. Supply risk is assessed in terms of material availability, competitive demand, substitutions or whether to make or buy.

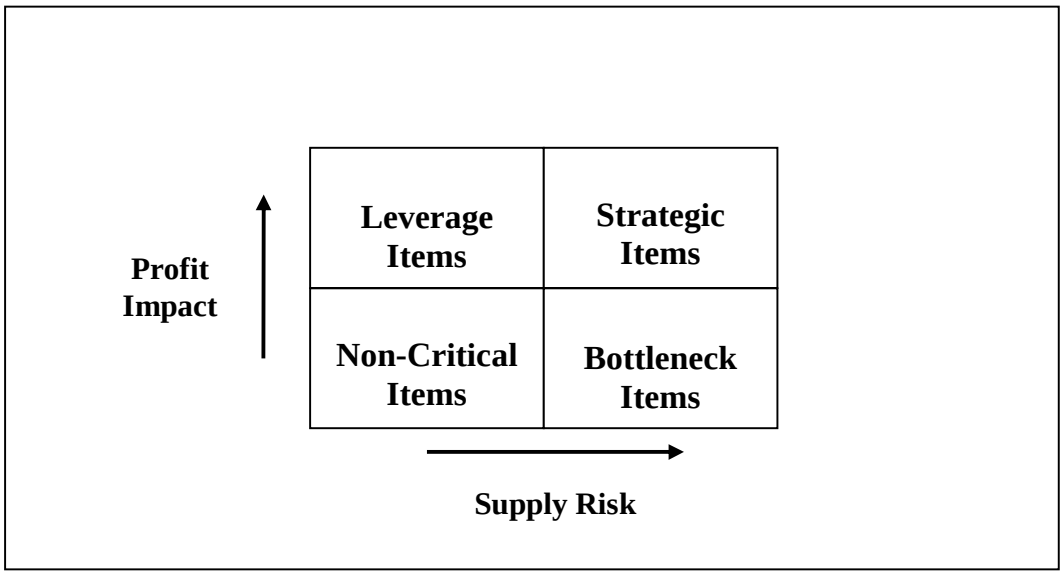

Figure A1: Kraljic Matrix

Non-critical items call for standard product purchasing, efficient processing of orders, inventory optimization and order volume monitoring, possibly through spot purchasing in the market. Leverage items let the purchasing firm exploit its full purchasing power through negotiations, target pricing and product

substitutions. Bottleneck items need to be secured through volume contracts even if a cost premium is attached to the contract, vendor control, backup plans and security of inventories.

Strategic items call for the development of supply chain partnerships through the use of long term supply contracts, and may require the firm to consider make or buy decisions. A supplier partnership is a mutual ongoing relationship that involves a high level of trust, commitment over time and long term contracts (Scannel *et al.*, 2000). The goal is to create and sustain a loyal buyer-supplier relationship that drives both the buyer and supplier to success (Yeung, 2008, p. 491). Strategic partnerships may include relationships with suppliers, IT providers and third party logistics (3PL) providers (Bhatnagar and Viswanathan, 2000).

Once the materials have been classified, the firm weighs up the bargaining power of its suppliers against its own strengths. Kraljic (1983, p.113) points out that the firm needs to assess the availability of strategic materials by quantity and quality, as well as the strengths of the supplier against its own. This allows the firm to gauge the supply terms that it wants based on its needs. Some areas that need to be examined are supplier capacity utilization, uniqueness of supplier's product, and potential costs in the event of non-delivery or quality problems.

Supplier capacity utilization is important as if supplier production capacity is exceedingly high, it may result in a supply bottleneck. Uniqueness of a supplier's product may mean that barriers to entry, possibly as a result of R&D costs or knowledge, are high. This means a monopoly type situation may occur (at least for a while) resulting in high prices and limited supply. Non-delivery and quality problems may result in additional safety stock, but if problems persist, it may be necessary to change suppliers. Changing suppliers results in pre and post contract costs, and may require changes to the firm's current production process to accommodate the new supplier's materials.

Once the firm's strengths have been weighed up against the supplier's strengths, the items identified as strategic in the Kraljic matrix need to undergo further analysis. This is done by plotting the firm's strengths against the supplier's strengths in the purchasing portfolio matrix below.

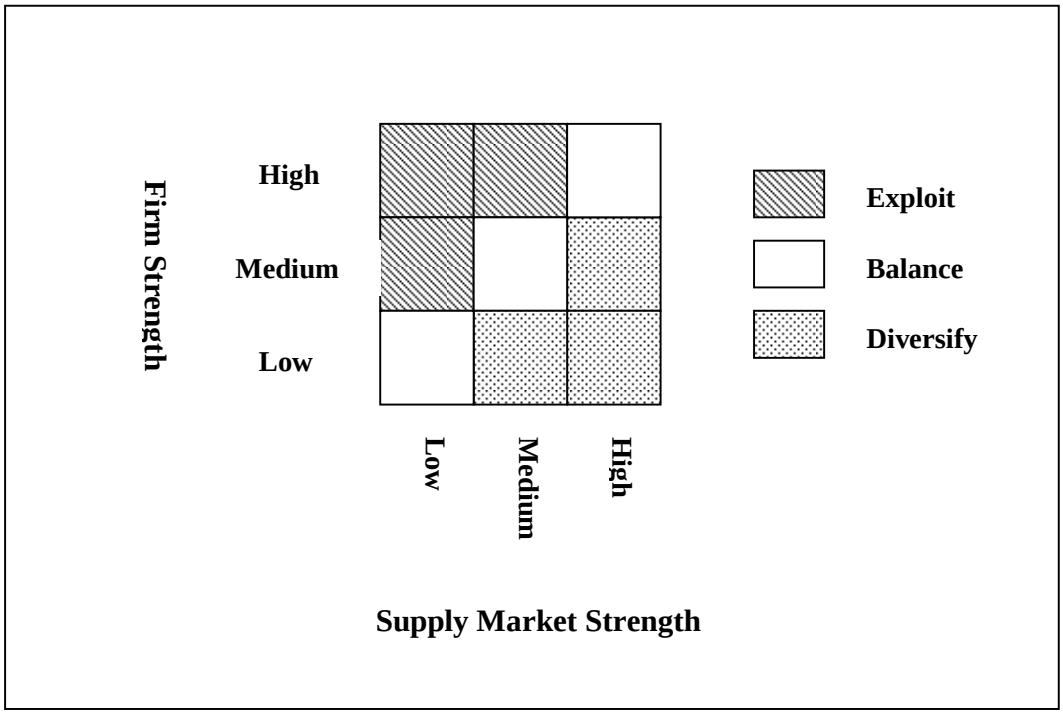

Figure A2: The Purchasing Portfolio Matrix
(Kraljic, 1983, p. 114)

When the firm plays a dominant market role and the supplier's strength is rated medium or low, the firm should use the strategy of "exploit". This is achieved through favourable pricing and contract agreements. It must be noted that the supplier should take care as not to exploit the advantage so aggressively that it jeopardizes long term relationships with suppliers (Kraljic, 1983, p 114).

The firm should use the strategy of "diversify" when the suppliers in the market are strong, and the firm's role in the supply market is weaker. This means that the firm may look at backward integration through investments in production facilities and R&D. It may also look for material substitutes for the same product, or possibly have more than one supplier. It may be necessary to increase efforts or expenditure on supplier relations in order to ensure supply.

The strategy of "balance" should be used when the firm and markets strengths are relatively equal to one another. This means

an intermediary strategy between “exploit” and “diversify” needs to be attained.

According to Kraljic (1983, p 114), when the firm “can bargain from a position of strength, it should press for preferential treatment. Bargaining from weakness, the company may have to offer inducements- long term contract obligations, for example, or higher prices- in order to achieve adequate supply.”

The final step in the Kraljic analysis is to develop a materials strategy plan for strategic items. In the short term, where diversify is identified, the firm should accept the supplier’s high prices and attempt to cover its necessary supply through volume contracts. In the long term, the firm should identify alternative suppliers, materials and possibly backward integrate to produce the material or product themselves. If the firm is stronger than the suppliers, it can exploit its price advantages and spot purchase some of the materials in the market.

Issues with the Kraljic matrix

According to Gelderman and Van Weele (2003, p. 207), the Kraljic matrix is still the dominant approach in the purchasing profession. This is despite some problems having been identified in the use of purchasing portfolio models such as the Kraljic matrix. Day (1986), taken from Gelderman and Van Weele (2003, p. 208) identified measurement as the “Achilles heel for all purchasing models”. Day (1986) expanded by asking what exactly is meant by supply risk and profit impact, and how could or should we measure these dimensions in practice. The Kraljic matrix does not take into account the supplier’s side or reaction to the firm’s strategy, as well as the action that the supplier takes (Kamann 2000, p. 1, from Gelderman and Van Weele 2003, p. 208). Cox (2001, p.13) points out that the Kraljic matrix does not provide guidelines on how to move within the matrix to improve the firms competitive position.

Despite these problems, Gelderman and Van Weele’s (2003, p. 207) case study research on the use of the Kraljic matrix in practice manages to provide solutions to the problems found in the literature. Their research indicates “that there is no simple, standardized blueprint for the application of the portfolio analysis. It requires reflecting on results, critical thinking and sophistication of purchasing management”

Appendix B

Appendix B contains the following items:

- The initial pilot study research framework;
- The initial pilot study interview tool;
- The initial pilot study interview transcription;
- The initial pilot study analysis and resulting changes made to the initial research framework;

- The final pilot study research framework;
- The final pilot study interview tool;
- The final pilot study interview transcription;
- The final pilot study analysis and resulting changes made to create the research framework found in the main report.

Initial pilot study research framework

The research framework for the pilot case study differs to the final framework outlined in the main body of the report. A brief explanation is provided:

The competitive criteria variables of *quality, dependability, speed* and *flexibility* and aspects of *information and material flows* are discussed to evaluate supplier-firm and customer-firm relationships. The basic supply chain framework is seen below:

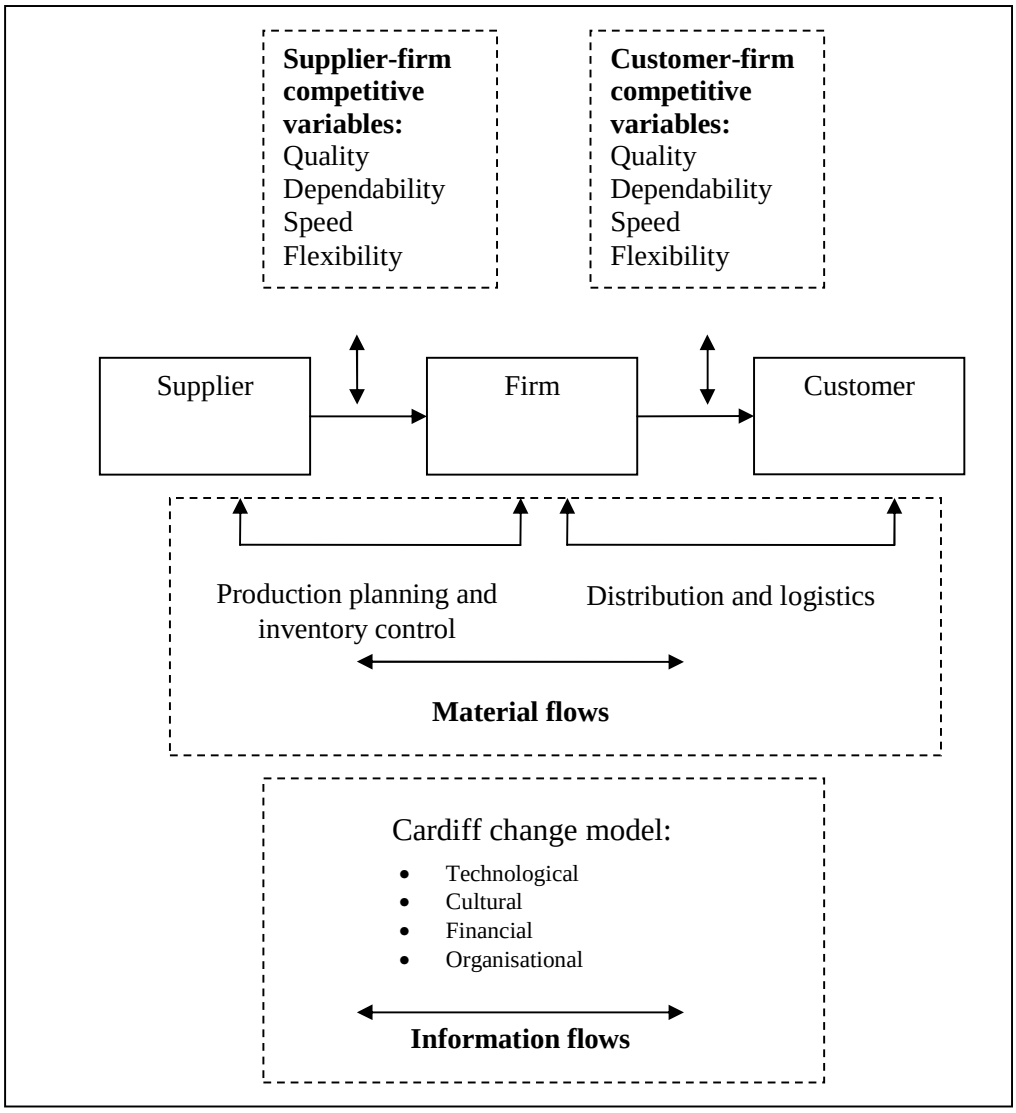

Figure B1: Research framework for initial pilot study

General

As seen in the framework above, there will be two units of analysis, the supplier-firm unit of analysis and the customer-firm unit of analysis. In order to help limit the size of the research study, only the suppliers that fit the following criteria are used:

- They must be geographically distant from the case study firm; and
- Only one supplier for each quadrant (i.e. max 4 suppliers for the study) of the Kraljic matrix (shown below).

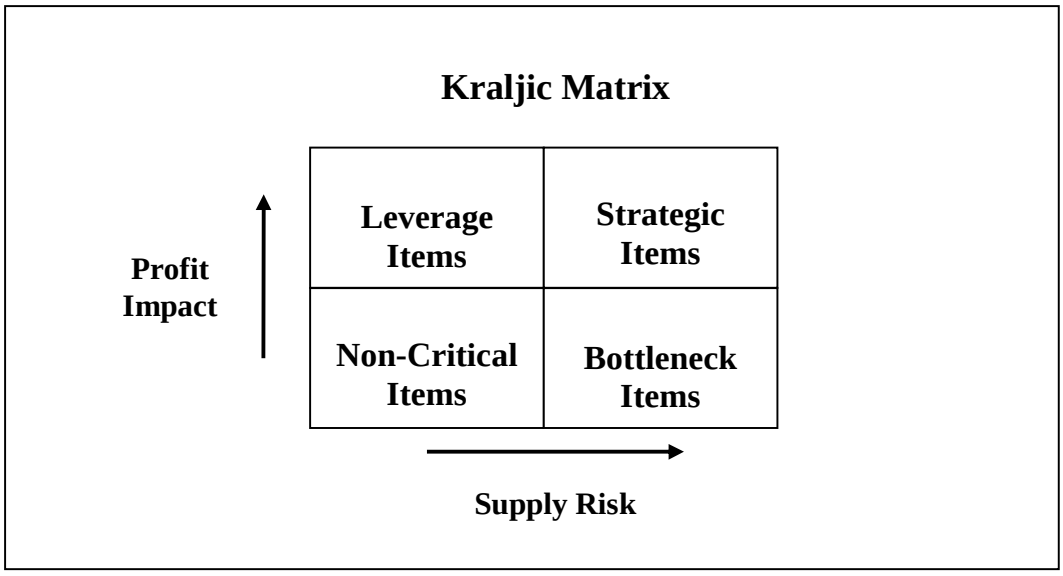

Figure B2: Kraljic matrix

Again, in order to limit the size of the research study, only the customers that fit the following criteria are used:

- They must be geographically distant from the case study firm; and
- The imported part must be of high value.

Material flow

Material flow between the suppliers, firm and customer can be dimensioned using the general constructs of:

- *Production planning and inventory control*, which describes the design and management of the entire manufacturing process, including policies and procedures for materials

- *Distribution and logistics process*, which determines how products are retrieved and transported from suppliers, to firm, to customer.

The purpose of the material management constructs is to provide a general overview of the materials management process from supplier, firm to customer.

Information flow

Information flows between suppliers, firm and customer will be dimensioned using the general constructs from the Cardiff business change model (Towill, 1991). The Cardiff business change model looks at information flows as an enabler in business process reengineering, and looks at cultural, technological, organisational and financial barriers to information flow:

- *Technological*: How IT systems are used to enable information flow.

- *Cultural*: What information the firm shares with suppliers and customers, the willingness to share information, and whether the information shared is “pure” and undistorted.

- *Financial:* Who in the supplier, firm, and customer relationship provides finance to enable information visibility.

- *Organisational*: What level of coordination exists between supplier, firm and customer, and where are decisions that affect members in the supply chain made.

The purpose of the information management constructs is to provide an overview of the information management process through identifying barriers to information flow.

Quality

The following constructs within the *quality* competitive strategy variable literature will be used to provide a framework for analysis:

- *Approach to quality*: Is there a clear consistent message of quality; is supplier incoming quality and customer outgoing quality achieved through preventative efforts, mass inspection, quality systems.

- *Measurement of quality*: How is supplier quality and customer quality measured (SPC, Cost of Quality).

- *Improvement of quality*: What type of improvement efforts occur between supplier-firm and the customer-firm.

Dependability

The following *dependability* competitive strategy variable constructs are to be used:

- *Dependability in uncertainty*: How does the firm manage delivery dependability with suppliers and customers in an uncertain and dynamic operating environment.

- *Measurement of dependability*: How is supplier and customer delivery dependability measured and how is this information used.

Speed

The *speed* competitive strategy variable constructs to be used:

- *Obstacles to lead time reduction*: What obstacles (duplicate inventories, storage time, delayed transmission of data, transportation network, consolidation of goods) exist in decreasing the lead time between the supplier, firm and customer.

- *Uncertainty in material and information flow*: How does uncertainty from unknown supplier capacity, lead times and batch sizes affect material and information speed from supplier, firm to customer.

Flexibility

The *flexibility* competitive strategy variable constructs to provide a framework for flexibility analysis:

- *Product flexibility*: How difficult non-standard orders and changing product variety affect supplier, firm and customer.

- *Volume flexibility*: Can production be increased or decreased quickly to meet customer demand.

- *Delivery flexibility*: Is the firm able to change planned or assumed delivery dates to meet customer requirements.

- *Logistics flexibility*: Can products be cost effectively delivered or received as sources of supply and customers change.

- *Supply flexibility*: Is a firm able to find another supplier for a specific component or raw material, and can a supplier provide similar product prices with varying order quantities and lead times.

Initial pilot study interview tool

The initial interview tool below differs from the final interview tool in the main body of the report. Reasons for the changes made will be discussed where relevant.

General

1. Total annual firm sales?
2. Number of employees?
3. Types of products manufactured?
4. Number of direct suppliers (local/global)?
5. Number of direct customers (local/global)?
6. Classify four global suppliers according to supply risk and profit impact and the parts supplied to the firm that contribute to a vital component.
7. Classify one customer that receives the component with the four supplier parts in it.
8. Classify an important logistics provider to the firm and the services provided.

1. Describe the current business environment that the firm operates in.
2. What type of relationship does the firm have with its suppliers and customers?

Material flows

1. How is production planning and inventory control from the supplier to the customer managed in the long supply chain operation?
2. Describe the distribution and logistics process from the supplier to the customer, including the role of the logistics provider.

Information flows

1. How do IT systems (e.g. EDI) enable information flow? Which suppliers and customers are these systems in place with? Who provides the financing for these systems?
2. What type of information (e.g. inventory and capacity levels, sales) is shared between the firm and its suppliers?

The firm and its customers? How willing are suppliers and customers to share information with the firm?
3. How do supply chain members work with one another in making decisions (e.g. production and inventory policies)? How do members coordinate their activities (e.g. distribution, knowledge transfer, shared R&D) with each other?

Quality

1. How does the firm approach supplier quality (e.g. preventative efforts, mass inspection, quality systems)? How does the customer approach firm quality?
2. How is supplier quality measured (e.g. SPC, cost of quality)? How do customers measure the quality of outgoing goods from the firm?
3. What is the firms approach to supplier quality improvement? How do customers approach firm quality improvement?

Dependability

1. How does the firm ensure on time delivery from suppliers with uncertainties in the supply chain (e.g. lead times, customs)? How does the firm ensure on time delivery to its customers with uncertainties?
2. How is supplier and customer delivery dependability measured? How is this information used?

Speed

1. What obstacles (e.g. excess storage times, consolidation of goods, and delayed transmission of data) exist in decreasing lead times from the supplier, to the firm and to the customer?
2. How do uncertainties (e.g. unknown supplier capacity, lead times, ordering of different batch sizes from suppliers) affect the speed of information and material flow from the supplier, to the firm and to the customer?

Flexibility

1. How do the firm and its suppliers deal with difficult non-standard customer orders and changing product variety?

2. How do the firm and its suppliers deal with increasing customer demand?
3. How do the firm and its suppliers deal with changing delivery dates to meet customer requirements? How flexible is the customer in changing delivery dates for the firm and its suppliers?
4. How does the logistics process adapt to changing sources of suppliers and customers? Include the role of the logistics service provider.
5. How easily can the firm find another supplier for a specific component or raw material? Can a supplier provide similar product prices with varying order quantities and lead times?

Initial pilot study interview

General

The interviewee will be herein be referred to as PilotParticipant1. The firm in the unit of analysis is herein referred to as PILOTFIRM1, suppliers as PilotSupplier1, PilotSupplier2, and PilotSupplier3, and customers as PilotCustomer1 when required.

The interview transcribed below did not use a recording device, and relies on the interviewer's notes and memory. Future transcriptions of the case studies for the main study will be recorded and written in active voice where relevant.

The interviewer initially explains that the purpose of this research is to investigate how long supply chains can be made more competitive in the South African aerospace industry. Whilst PILOTFIRM1 is not involved in the aerospace industry, it does have a long supply chain, and the composite materials it uses are similar to those used in aerospace manufacture. The purpose of the pilot case study with PILOTFIRM1 is to see whether the research framework is viable in practice, and that the line of questioning is not vague or irrelevant. The supply chain framework is explained, pointing out the supplier-firm and customer firm units of analysis; material and information flows between the supplier, firm and customer; and the competitive strategy variables of quality, dependability, speed and flexibility. The interviewee says that this framework seems acceptable, but that the interviewer should "sell" it better. The interviewee explains that the outcome of the research should be explained to the case study firms, and that the research will highlight the common practices and differences between the firms, as well as identifies areas for further research. This will make the firms more open to getting involved in the research.

The interviewer initially asks the interviewee general information about PILOTFIRM1. This looks at PILOTFIRM1's:

- Total annual firm sales
- Types of products manufactured
- Number of employees
- Number of direct suppliers (local/global)

- Number of direct customers (local/global)

The interviewee said that the general information about the firm and the line of questioning seems to be ok.

The interviewer asks the interviewee to classify four global suppliers using the Kraljic matrix. The interviewer explains the Kraljic matrix, where parts are classified according to supply risk and profit impact. The Kraljic matrix, seen below, is shown to the interviewee.

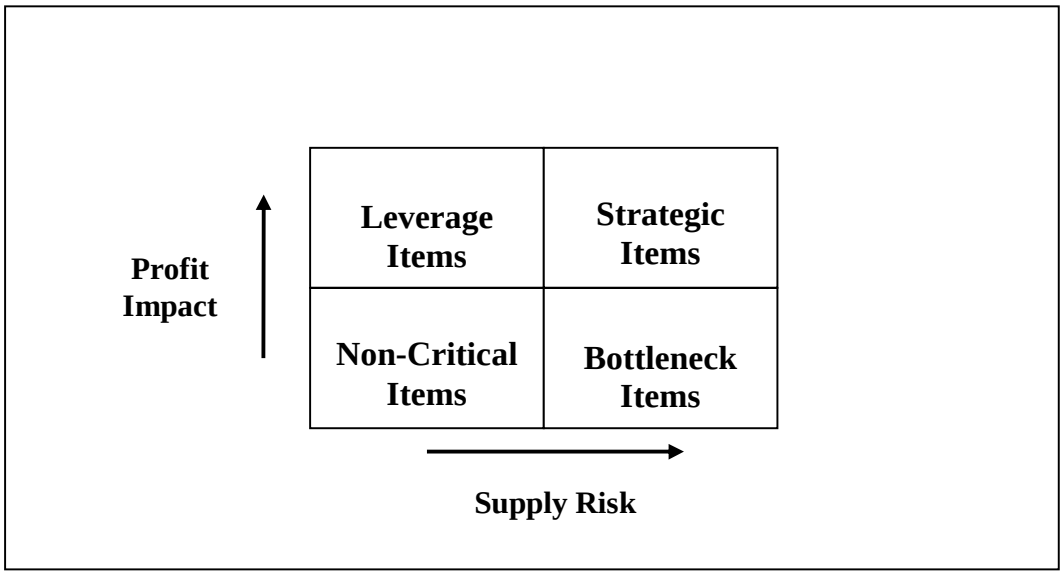

Figure B3: Kraljic Matrix

The interviewee finds it difficult to classify suppliers using the Kraljic matrix, and asks a number of times what supply risk and profit impact mean. After the interviewer attempts to clarify these meanings, the interviewee classifies items in the leverage items and strategic items quadrants. The interviewee classifies pre-preg carbon fibre from Taiwan as a leverage item, as it is readily available (low supply risk), and has a large impact on profit. The pre-preg carbon fibre from Germany is classified by the interviewee as a strategic item, as it requires forward planning to account for lead times (high supply risk), and has a large impact on profit. The interviewee cannot classify an item in the non-critical quadrant, and says that items with low supply risk and low profit impact would generally be sourced locally. The interviewee than, after some discussion on the meaning of

profit impact and supply risk, reluctantly classifies the logistics provider as a bottleneck item.

The interviewer than asks the interviewee to classify a global customer/s that receive a high value part from PILOTFIRM1. The interviewee identifies a firm in the USA called PilotCustomer1, which PILOTFIRM1 supplies to. The interviewee further explains that PILOTFIRM1 does orders for individual customers, especially in the USA.

The interviewer than asks the interviewee to describe the current business environment that the firm operates in. The interviewee explains that exchange rates are volatile, resulting in fluctuating material import costs. Electricity problems as a result of Eskom affect PILOTFIRM1's production. Generators are too costly and equipment such as the autoclave which uses large amounts of electricity could not run on generators anyway.

The interviewer asks what type of relationship PILOTFIRM1 has with its suppliers and customers. The interviewee explains that it has a good relationship with its customers, as this is a necessity to keep the business alive. Suppliers, the interviewer (half?) jokingly says, need to sometimes be screamed at in order to get things done.

Material flows

The interviewer says that this line of questioning looks at material flows, and asks how production planning and inventory control is managed with its suppliers. The interviewee says that the pre-preg carbon fibre supplier from Taiwan (leverage item), requires little notification from PILOTFIRM1 when ordering materials. The lead time required is that needed for transportation. In addition, this supplier will manufacture a larger batch for PILOTFIRM1 than required, and will store half the batch for PILOTFIRM1 until they need it for the next order. This is because this supplier says it is more economical to manufacture a larger batch, and they know that PILOTFIRM1 will use the material in the future. The pre preg carbon fibre supplier from Germany (strategic item) requires a great deal more notification from PILOTFIRM1 when they order materials. This means that PILOTFIRM1 must account for both supplier manufacturing time and transportation time in calculating lead times. The interviewer goes on to say that when ordering, the material batch sizes need to take overseas transport costs into

consideration, as you cannot order just when needed. The pre-preg carbon fibre has to be stored in a fridge with a set capacity at PILOTFIRM1, setting the limit for maximum carbon fibre inventory. The interviewer asks the interviewee to describe the distribution and logistics process from PILOTFIRM1 to its customers, including the role of the logistics provider. The interviewee says that the distribution and logistics process is not really an issue for them, as PILOTFIRM1 is a relatively small scale operation, with little complexity on the distribution side. A number of PILOTFIRM1's customers organise their own logistics providers, with PILOTFIRM1 notifying the customers when the goods are ready for collection. The goods wait in dispatch until the logistics providers pick it up. The interviewee says that the logistics provider does not play a large role in their business, and if another provider is needed, it is not too difficult to obtain if the money is right.

Information flows

The interviewer says that this line of questioning looks at information flows, and asks whether any IT systems are in place with its suppliers and customers. The interviewee responds by saying that no specific IT systems are in place, as PILOTFIRM1 is not a large enough company. The interviewee says that one of their customer's places orders with them using Google pages. The interviewer asks that if PILOTFIRM1 was a larger firm, would any of the customers or suppliers provide funding or some funding towards information systems to enable information visibility. The interviewee responds by saying this is highly unlikely, and that PILOTFIRM1 would most likely have to pay for these systems. The interviewer asks what type of information is shared between PILOTFIRM1 and its suppliers. The interviewee needs to be prompted on what types of information could be shared. The interviewer responds by saying information types such as inventory, capacity levels and sales. The interviewee says that only the basic information requirements are shared with its suppliers, such as amounts of inventory required from them, and when it is needed. There is no need to share any more information with suppliers. The interviewer asks what type of information is shared between PILOTFIRM1 and its customers. The interviewee responds by saying that more information is shared with its customers than its suppliers, as it is important to keep customers happy. The interviewer asks how supply chain members work together with one another in making decisions. The interviewee seems a bit unsure of this line of questioning.

The interviewer tries to explain by asking whether supply chain members work together in making production decisions or inventory policy decisions. The interviewee responds by saying their supply chain members don't really make decisions together. The interviewee further points out that this question is a bit vague and general in nature, and is similar to the question above on what information is shared between suppliers and customers. The interviewer than asks how members coordinate their activities with one another. Again, the interviewee seems a bit unsure of this line of questioning. The interviewer tries to explain that this question is trying to investigate whether supply chain members coordinate activities such as distribution, knowledge transfer and shared R&D. The interviewee responds by saying that knowledge transfer may be facilitated through an initiative like AMTS (Advanced Manufacturing Technology Strategy), but it would only be general type knowledge. Shared R&D is probably wishful thinking, as companies would not be willing to share information about their core competencies in business. The interviewee then says that they are doing some design work for a motorbike component, but that they keep all the design information to themselves. The interviewer nods, and asks the interviewee whether this question is again too vague and general in nature. The interviewee says yes.

Quality

The interviewer says that the line of questioning is now directed towards quality in the firm. The interviewer asks how PILOTFIRM1 approaches supplier quality. The interviewee thinks for a bit, and then says quality is such a broad subject that it is difficult to briefly explain how a firm approaches supplier quality. PILOTFIRM1 and the aerospace firms business is quality, so a single question such as that is will not really work. The interviewee than says that the quality management system in place at PILOTFIRM1 is ISO 9001: 2000, and that when quality issues arise they are documented and fed back into the system so that the problem doesn't happen again. This is done by the quality people at PILOTFIRM1, who walk around with checklists. The interviewee laughs, saying that the quality people enjoy that type of thing. The interviewer than asks how the customer approaches PILOTFIRM1 quality. The interviewee says that the customer sees the PILOTFIRM1 name on the box, and knows it is a quality product. PILOTFIRM1 is in the business of quality, and they get orders from around the world because people know it. The interviewer asks how supplier quality is measured. Again,

the interviewee says that this type of question is so broad, that there may be problems when asking it in the aerospace firms. The interviewee says that PILOTFIRM1 has four inspection points and a final inspection in manufacture. The interviewer then asks the final quality question, on how PILOTFIRM1 approaches supplier quality improvement. The interviewee says that continuous improvement in PILOTFIRM1 is done according to ISO 9000:2000, using CIP continuous improvement. The interviewee says again that the quality questions might pose a problem when using them in the aerospace firms. The interviewer says that quality is such a broad area, and this initial exploratory case study research has to have a relatively general framework, making the focusing of a specific quality topic difficult. The interviewee agrees, and says think about it.

Dependability

The interviewer then says that the line of questioning will move onto dependability, and asks how PILOTFIRM1 ensures on time delivery from suppliers with uncertainties in the supply chain. The interviewee laughs, and says that screaming at the suppliers generally works. The interviewee than says that dependability problems like late supplier shipping and goods getting stuck at customs affect dependability. A specific form for goods over R 50 000 has to be obtained and verified, adding to delays. Eskom's electricity problems add to production delays and nothing can be done about that. The interviewer than asks how PILOTFIRM1 ensures on time deliveries to its customers. The interviewee responds by saying that delays on the customer side due to logistics delivery is not their issue, as the customers organise this process. PILOTFIRM1 notifies the customers when their goods are ready for collection. Delays as a result of supplier late delivery and manufacturing problems are dealt with by contacting customers early on to signal that problems beyond PILOTFIRM1's control have happened, and trying to keep customers in the loop. The interviewee finally says that dependability is managed by sharing information and clarity. The interviewer than asks how supplier and customer delivery dependability is measured. The interviewee responds by saying that customer delivery dependability is measured through a questionnaire that is sent out at the end of the year to customers, in order to get performance feedback.

Speed

The interviewer then says that the line of questioning will move onto speed in the supply chain. The interviewee is a bit unsure of what speed in this context means, and then, after giving it some thought, seems to be happy that it means service delivery. The interviewer asks what obstacles exist in decreasing lead times on the supplier side. The interviewee seems unsure of this question, and the interviewer says physical obstacles such as excess storage times and consolidation of goods adding to lead times. The interviewee responds by saying that if there was greater cash flow, PILOTFIRM1 could store more inventory and lower waiting times for their customers. This would lead to increased profit and customer satisfaction. The interviewee also says that you can maximize capacity, and improve the effectiveness and efficiency of the operation to decrease lead times. The interviewer than asks *how do* uncertainties affect the speed of information and material flows from the supplier to PILOTFIRM1 and then to the customer. The interviewee thinks for a bit, and responds by saying *what* uncertainties affect the speed of information and material flow, not *how*. The interviewee than says this question looks at the unplanned events that can happen, and the previous question on speed looks at the planned events in the supply chain that can happen. The interviewee says that the second question on speed is a bit vague, and is very similar to the dependability question previously. The interviewer agrees.

Flexibility

The interviewer then says that the line of questioning will move onto flexibility in the supply chain. The interviewer asks how PILOTFIRM1 and its suppliers deal with difficult non-standard customer orders and changing product variety. The interviewee responds by saying that PILOTFIRM1 uses modular designs where the different bike hubs for customers are fitted to the same wheel design. Customisation of product is a management call, and that they may customise a batch for a larger customer, but probably not for an individual rider. The interviewee says that customisation would be considered if the price is right. The interviewer asks how PILOTFIRM1 and its suppliers deal with increasing or decreasing customer demand. The interviewee replies that when there is decreasing customer demand, PILOTFIRM1 tries to look at other markets for sales, and that currently the USA is more popular for products than Europe. When there is an increase in demand, they purchase more

materials from suppliers. The interviewee goes on to say that one of their overseas composite suppliers wanted to increase their production volume and so had to modify the factory, resulting in zero production for a while. The supplier gave them plenty of notice, and so PILOTFIRM1 had to fill their storage fridge with composites up to its capacity to keep their production going. The interviewer then asks how PILOTFIRM1 and its suppliers deal with changing delivery dates to meet customer requirements. The interviewee responds by saying it's a balance between keeping available stock to meet customer requirements, which has a negative impact on cash flow, and a JIT operation, which may have an impact on customer satisfaction levels through having little on hand stock. The interviewee says that this question is similar to the dependability line of questioning, and the interviewer acknowledges this. The interviewer then asks how the logistics process adapts to changing sources of suppliers and customers. The interviewee says their logistics process is not complex, and that if required they can change logistics providers pretty easily. Logistics providers will travel pretty much anywhere provided the money is right. The interviewer than asks how easily PILOTFIRM1 can find another supplier for a specific component or raw material. The interviewee responds by saying not too easily, but that it is possible. PILOTFIRM1 usually qualifies two or three suppliers for one component, and generally goes with one supplier unless any problems arise. The interviewee says that there are a lot of questions on flexibility, and whether this makes it more important than the other sections in the framework. The interviewer says that flexibility is supposed to be a response mechanism to uncertainty in the supply chain, but did not mean for it to be more important than the other sections.

The interviewer says to the interviewee, that in their opinion, what areas within the research questions, framework and the interviewer's delivery may need further work. The interviewee says that there are no big problems in the framework itself, and it seems logical. The research questions are a bit too long, and that there may be a problem keeping the interviewees attention. Some questions are too vague and they repeat themselves. The biggest issue is with the quality questions, as quality is such a big thing. The interviewer's delivery of the questions is fine, but more should be done upfront to sell the research to the firms. The interviewer gives his thanks, and the interviewee says that any further help in the research will be happily given. A tour of the PILOTFIRM1 plant is then given.

Initial pilot study analysis and changes to research framework

General

A general overview of PILOTFIRM1 can be seen in the table below.

Table B1: Overview of PILOTFIRM1

Firm	Types of products	Total annual Sales (Rand)	No. of employees	No. of direct suppliers		No. of direct Customers	
				Local	Global	Local	Global
PILOTFIRM1	Carbon fibre products	15 M	40	20	3	3	20-25

Supplier classification for the PILOTFIRM1 pilot case study was done differently to that outlined in the main report. Whilst the suppliers must be geographically distant from the case study firm, the Kraljic matrix was used to classify a part with strategic importance to the firm. The Kraljic matrix (Kraljic, 1983) provides a framework on how to manage supply relationships. Purchased materials in the Kraljic matrix are classified in terms of supply risk and profit impact. Supply risk is assessed in terms of material availability, competitive demand or material substitution. Profit impact is determined in terms of the volume of materials purchased or percentage of the total purchase cost.

Difficulties were found when using the Kraljic matrix for supplier classification. Discussions with the interviewee revealed that items with low supply risk and low profit impact would generally be sourced locally. As the purpose of this research is to look at the long supply chain problem, this makes the non-critical item quadrant of the Kraljic matrix redundant. Another difficulty arose in attempting to fit items into the required quadrants. Day (1986) asked what exactly is meant by supply risk and profit impact, and how could or should we measure these dimensions in practice. This issue was verified in the pilot case study, as the interviewee could not easily fit the items into the quadrants. This could affect the reliability of the research, as another interviewer who uses the Kraljic matrix may find that the

interviewee has different measurements for supply risk and profit impact. These difficulties resulted in the abandonment of the Kraljic matrix for supplier classification. For the purposes of the pilot study, the Kraljic matrix classification that was used will be carried through. This classification can be seen in the table below.

Table B2: Kraljic Matrix Classification

Firm	Kraljic classification	Supplier name	Part supplied to firm	Location
PILOTFIRM1	Non-critical	-	None, non-critical parts generally locally sourced	Local
	Leverage	PilotSupplier1	Pre-preg carbon fibre	Taiwan
	Bottleneck	PilotSupplier2	Logistics provider	Local and international
	Strategic	PilotSupplier3	Pre-preg carbon fibre	Germany

The logistics provider was classified as a bottleneck item, but it is the interviewers' belief that this was done simply to fill that quadrant. This is because the discussion later turned to the fact that no problems were perceived in obtaining alternate logistics services (i.e. a low supply risk), if the price is right.

Customer classification in the pilot study required that the customers must be geographically distant from PILOTFIRM1; and that the part supplied to customers must be of high value. Whilst this classification scheme did work in the pilot case study, it has been modified and developed to focus the customer-firm unit of analysis.

Table B3: Customer Classification

Firm	Customer	Strategic assembly supplied to customer	Location
PILOTFIRM1	PilotCustomer1	Carbon fibre wheels	USA

Material flows

Ordering materials from the Taiwanese supplier (leverage item in the Kraljic matrix) requires little notification from PILOTFIRM1. The notification that is required is the lead time needed for transportation. The Taiwanese supplier of pre impregnated carbon fibre will manufacture a larger batch for PILOTFIRM1 than required, and will store half the batch for PILOTFIRM1 until they need it for the next order. This is done as the supplier achieves economies of scale by manufacturing a larger batch, and the supplier knows that PILOTFIRM1 will use the remaining batch. Ordering materials from the German supplier (strategic item in the Kraljic matrix) requires a great deal more notification from PILOTFIRM1. PILOTFIRM1 is required to account for both the supplier manufacturing time and transportation time in production planning. In addition, when ordering from global suppliers, the material batch size and transportation costs must be evaluated together. Larger batch sizes result in transportation economies, but lead to greater upfront material and storage costs. With pre impregnated carbon fibre requiring refrigeration, batch sizes of ordered materials are limited by the internal capacity of the cold store room at PILOTFIRM1.

The distribution and logistics process at PILOTFIRM1 is not a complex operation. Customers generally organise their own logistics providers, with PILOTFIRM1 notifying the customers when goods are ready for collection. Finished goods wait in dispatch at PILOTFIRM1 until the logistics providers pick them up. If PILOTFIRM1 is required to organise a logistics provider to collect materials from suppliers or deliver goods to customers, it can be easily organised.

It was decided that the material flow measurement category and its sub-measurements of production planning and inventory control, and the distribution and logistics process will not be directly examined in the final research framework. It was found that these sub-measurements were indirectly addressed in the dependability and speed measurements in the pilot study framework when performing the interview. To eliminate repetition and help focus measurement categories on competitive dimension criteria, material flows will be examined within the competitive dimension measurements of speed and dependability in the final research framework.

Information flows

PILOTFIRM1's use of information systems is minimal. There are no specific IT systems in place with its suppliers and customers. An internet application, Google pages, is used by a customer to place orders with PILOTFIRM1. Whilst the benefits of IT are acknowledged by PILOTFIRM1, IT systems are not required due to the small size of the firm.

Information sharing between PILOTFIRM1 and its suppliers is minimal. Basic information like the amounts of inventory needed and when it is required is shared. Information is viewed as a competitive weapon and by sharing it with suppliers PILOTFIRM1 believes it will lose its advantage. Information sharing between PILOTFIRM1 and its customers is greater than with its suppliers. Customers are the key to any business, and to keep them happy they may require more information than suppliers.

With PILOTFIRM1 being a relatively small firm without any specific information systems in place, funding for IT is not needed. However, if PILOTFIRM1 was a larger firm requiring greater IT investment to enable information visibility between suppliers and customers, PILOTFIRM1 believes that they would be required to fund any IT investments out of their own pockets.

Little coordination between suppliers, PILOTFIRM1 and its customers exist. Firms in PILOTFIRM1's supply chain are decentralised where decisions and activities are performed independently from one another. Generalist knowledge transfer may be facilitated through an initiative like AMTS (Advanced Manufacturing Technology Strategy), which helps in the advancement of manufacturing technology skills in South Africa. Shared R&D between supply chain members is wishful thinking, as PILOTFIRM1 believes firms are not willing to share any specific information about their core competencies in business.

The information flow measurement and its sub-measurements of technological, cultural, financial and informational will be examined within the speed measurement in the final research framework. This is done as one of Stalk and Hout's (1990) ideas to convert to a time based (speed) supply chain is to "provide each firm with better and timelier information about product orders and needs". This simplifies the research framework. In addition, the wordings of the technological, cultural, financial

and informational questions in the interview tool are modified to aid in understanding and eliminate vagueness. The literature base is also improved to provide a better theoretical comparison for the single case studies in the final research framework.

Quality

The interview questions used in the pilot study to address quality proved to be too general in nature. PILOTFIRM1 and the aerospace firms to be investigated adhere to stringent quality specifications. This makes quality a vast topic, which is difficult to investigate in a few interview questions. Nevertheless, a basic attempt was made to try and answer the questions in the pilot study.

The approach taken to quality is based on the ISO 9001: 2000 system. Quality issues that arise are documented and fed back into the system to prevent further problems. Suppliers have to have the required quality systems in place to do business with PILOTFIRM1. Customers know that when they receive a finished product from PILOTFIRM1 it is of the specified quality.

Measurement of supplier quality is done according to ISO 9001:2000. Four inspection points before and during the manufacturing process, and a final inspection are performed. With finished carbon fibre wheels going directly to consumers there is no formalised measurement process of quality by the customer. Customers purchase PILOTFIRM1 wheels in the knowledge that the product adheres to the required quality specifications. With finished carbon fibre wheels going to customers, there is no physical quality measurement process.

Continuous improvement at PILOTFIRM1 is done internally according to ISO 9000:2000 standard procedures. There are no specific continuous improvement programmes in place with suppliers and customers.

To try and focus quality measurement in the final research framework, a different approach is required. Initially, an interview question asking what the firm understands by the meaning of quality will be asked. This will help establish whether the quality focus is on internal (technical) or external (customer requirements) specifications. Then the Juran (1999) trilogy of quality planning, quality control, and quality improvement will form the basis for quality questioning. Within

each of these standardised processes, a general question will be asked first (e.g. how is quality planning performed with suppliers/customers), followed by a more specific question (e.g. does the firm trust its suppliers to achieve the planned quality). This approach will allow the semi-structured interview to have flexibility to explore different ideas within an area like quality planning, as well as allow the investigation of a specific topic like trust within quality planning.

Dependability

Dependability in the long supply chain is affected by uncertainties like late supplier shipping, goods waiting at customs, banking and legal administrative procedures, and electricity outages. Supplier dependability is enhanced through information sharing and clarity. If suppliers cannot meet the stipulated production plan, they must notify PILOTFIRM1. When late delivery do problems arise, PILOTFIRM1 tries to achieve dependability by “screaming” at its suppliers to deliver goods in time. With the logistics process generally being the responsibility of the customer, PILOTFIRM1’s responsibility of delivering goods on time ends when it notifies the customer to collect goods in dispatch after their manufacture. When PILOTFIRM1 is unable to get finished goods into dispatch on time for collection as a result of supplier late delivery and internal manufacturing problems, customers are contacted early on in the process. This allows for “damage control”, and helps to keep customers in the loop.

Customer delivery dependability is measured using a questionnaire sent out at the end of each year to obtain performance feedback. There is no formal measurement of supplier delivery dependability. A formal measurement of supplier dependability may not be required as there are only 3 international suppliers to PILOTFIRM1, making late deliveries easily identifiable.

The dependability measurement in the final research framework will be examined using a general approach. This will examine the processes and procedures that the firm takes to ensure supplier and customer dependability as they arise in the interview, allowing other avenues (like measurement) to be discussed. This is done as it was thought that a specific question on the measurement of dependability does not add any value to the dependability competitive dimension.

Speed

Lead time reduction in the supply chain could be aided by increasing inventory levels at PILOTFIRM1. Whilst this requires higher levels of cash flow, there would be a reduction in waiting time when sourcing materials. Internally, manufacturing capacity at PILOTFIRM1 can be maximised to improve both efficiency and effectiveness, leading to decreased lead times.

The question on the uncertainties that affect the speed of information and material flow was found to be vague and similar in nature to a dependability measurement question. It was not answered.

To try and focus the speed measurement, Stalk and Hout's (1990) three ways to convert to a time based supply chain will be used as the sub-measurement categories. This will provide a standardised "best practice" process to reduce lead times in the supply chain.

Flexibility

PILOTFIRM1 deals with difficult non-standard customer orders through the use of modularity, where different bike hubs for different motorbikes are fitted to the same wheel design. Product customisation may be considered when a large batch of wheels is to be manufactured for a customer, if the price is right.

Decreasing customer demand for PILOTFIRM1's products in one market (e.g. Europe) forces PILOTFIRM1 to consider alternative markets (e.g. USA) for their product. Increasing customer demand results in larger amounts of material purchased from suppliers, but limits on supplier capacity must also be understood.

To respond to changing delivery dates to meet customer requirements, PILOTFIRM1 and its suppliers need to balance keeping on hand inventory to respond to customers needs, and maintaining a steady cash flow.

PILOTFIRM1's logistics process can easily adapt to changing sources of suppliers and customers. The logistics process on both the supplier and customer side is not a complex operation, and logistics providers can be recruited easily and deliver to the

necessary place in the required time, provided the firm is willing to pay.

PILOTFIRM1 can find alternate suppliers for a specific component or raw material if required. PILOTFIRM1 usually qualifies two or three suppliers for one component, and generally goes with one supplier unless any problems arise.

The flexibility measurement in the final research framework will take a different approach to that in the pilot study. With the large number of sub-measurements within flexibility, it is difficult to identify which ones to examine. To solve this, it was suggested by the author's supervisor to ask the interviewees definition of flexibility and work from there. This approach will be taken.

A summary of the initial pilot case study data can be seen in the table below.

Table B4: Initial pilot case study research framework summary

Measurement	**Sub-measurement**	**Supplier- Firm**	**Customer-firm**
Material Flow	Production planning and inventory control	Materials batching, balance between lot size and long distance transportation costs	Order when required
	Distribution and logistics process	Little complexity, PILOTFIRM1 organises logistics providers	Little complexity, customers generally organise logistics providers

Table B4: Initial pilot case study research framework summary (continued)

Measurement	Sub-measurement	Supplier- Firm	Customer-firm
Information Flow	Technological	No specific IT systems in place	No specific IT systems in place, use basic internet applications with certain customers
	Cultural	Only what the suppliers need to know, information is viewed as an ownership advantage that should not be shared	More information shared with customers than with suppliers, important to keep customers happy
	Financial	Not applicable, no IT systems in place.	Not applicable, no IT systems in place.
	Organisational	Decentralised coordination, tacit knowledge transfer may be coordinated by external group (AMTS)	Decentralised coordination, customers make contact when goods are needed
Quality	Approach to quality	ISO 9001:2000 as an order qualifier	PILOTFIRM1's quality accreditation and reputation is an order winner
	Measurement of quality	ISO 9001:2000; 4 quality checks before and 1 final check after manufacture	No physical measurement of quality takes place with goods going directly to consumer
	Improvement of quality	No specific improvement programmes in place with suppliers, internally continuous improvement done according to ISO 9000: 2001	No specific improvement programmes in place with customers

Table B4: Initial pilot case study research framework summary (continued)

Measurement	**Sub-measurement**	**Supplier- Firm**	**Customer-firm**
Dependability	Dependability in uncertainty	Dependability enhanced through information sharing and clarity; but "screaming" at supplier may be used if necessary	Dependability of outgoing logistics process not responsibility of PILOTFIRM1; customers notified early if supplier and internal manufacturing delays occur
	Measurement of uncertainty	No formal measurement in place, but late delivery is easily picked up with only 3 international suppliers and minimum material flow	Yearly customer satisfaction survey sent out to obtain feedback on amongst other things, dependability
Speed	Obstacles to lead time reduction	Increasing inventory levels would decrease customer waiting times; improving internal manufacturing capacity	Not known, outgoing logistics is generally not the responsibility of PILOTFIRM1
	Uncertainty in material and information flow	Not known (vague line of questioning)	Not known (vague line of questioning)

Table B4: Initial pilot case study research framework summary (continued)

Measurement	Sub-measurement	Supplier- Firm	Customer-firm
Flexibility	Product flexibility	Incoming materials generally standard	Modular design of products to deal with different orders; product customisation considered if a large batch and the price is right
	Volume flexibility	Increase or decrease purchasing of materials from suppliers	Decreasing customer demand in one market causes PILOTFIRM1 to look to other customer markets; increasing customer demand, look for capacity and increase materials purchasing from suppliers
	Delivery flexibility	On hand inventory to respond to changing delivery dates	On hand inventory to respond to changing delivery dates
	Logistics flexibility	Logistics process not complex, logistics providers can be easily found with changing sources of suppliers	Logistics process not complex and generally the responsibility of the customers, logistics providers can be easily found with changing sources of customers
	Supply flexibility	Alternate suppliers can be found; at least 3 suppliers for the same item are initially qualified by PILOTFIRM1	Not applicable

Final pilot study research framework

The research framework used in the final pilot case study can be seen below. The changes made to get to the final framework are discussed in the *initial pilot study analysis and changes to research framework* section above.

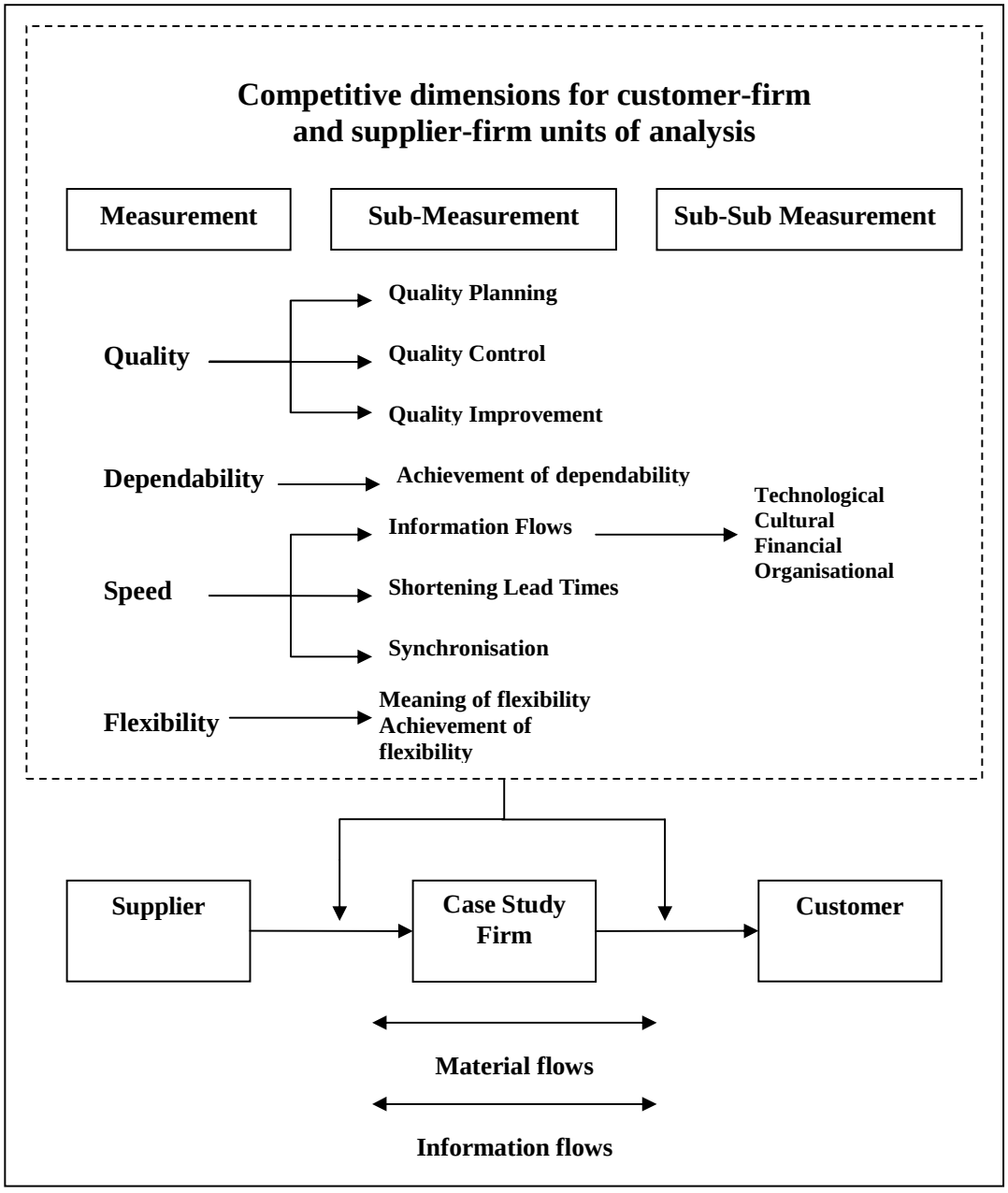

Figure B4: Research framework for final pilot study

Final pilot study interview tool

General

1. Total annual firm sales?
2. Number of employees?
3. Types of products manufactured?
4. Number of direct suppliers (local/global)?
5. Number of direct customers (local/global)?

Supplier Classification

1. Classify a number of suppliers (maximum 3) to the firm that fulfil the following criteria:
    - The supplier is geographically distant (i.e. on another continent) from the firm
    - The supplier must provide a part with strategic importance to the firm
    - The supplier chosen should reflect the general supplier management practices of the firm

Customer Classification

1. Classify a number of customers (maximum 3) to the firm that fulfil the following criteria:
    - The customer is geographically distant (i.e. on another continent) from the case study firm
    - The customer must receive a finished assembly of strategic importance from the firm
    - The customer chosen should reflect the general customer management practices of the firm

Quality

1. What does the firm understand by the meaning of quality?

    Quality Planning

2. How does the firm plan for quality with its suppliers? Customers?
3. Does the firm trust its suppliers to achieve the planned quality? Does the customer trust the firm to achieve its planned quality?

Quality Control

4. How does the firm control or prevent poor incoming quality (material, documentation) from its suppliers? How does the customer control or prevent poor incoming quality (material, documentation) from the firm?
5. How are performance measures used in controlling or preventing poor quality with suppliers? Customers?

Quality Improvement

6. How are quality improvements made in the long supply chain with suppliers? Customers?
7. How does top management participate in continuous improvement initiatives with suppliers? Customers?

Dependability

1. How does the firm ensure on time reliable delivery of goods from its global suppliers? To its global customers?

Speed

Information Flows

Technological

1. How is Information Technology used in communicating with suppliers? With customers?

Financial

2. Who provides funding for IT systems and their implementation to enable information visibility in the long supply chain?

Cultural

3. To what extent is operational information shared between the firm and its suppliers? The firm and its customers?

Organisational

4. How does the firm coordinate its supplier's decisions and activities (logistics, inventory, production planning) to meet customer requirements?

5. How is the level of coordination or the relationship structure (long term/short term relationship; information sharing) between the firm and its supplier determined? Customer?

Shortening Lead Times

6. Reduction of lead time in the supply chain is identified as a method of improving firm competitiveness. What are the barriers that exist in reducing lead time from supplier to the firm? From the firm to the customer?

Synchronisation

7. How are material order volumes and order frequencies determined in the supply chain from supplier? To the customer?
8. Does the firm have knowledge of the relevant levels of inventory and manufacturing capacity that their suppliers have? Does the customer know the relevant levels of inventory and manufacturing capacity that the firm has?

Flexibility

1. What do you understand by the term flexibility?
2. How is flexibility achieved/enabled between the firm and its suppliers? Customers?

Final pilot study interview

General

The interviewee will be herein be referred to as PilotParticipant2. The firm in the unit of analysis is herein referred to as PILOTFIRM1, suppliers as PilotSupplier1, PilotSupplier2, and PilotSupplier3, and customers as PilotCustomer1 and PilotCustomer2 when required.

The interview transcribed below did not use a recording device, and relies on the interviewer's notes and memory. Future transcriptions of the case studies for the main study will be recorded and written in active voice where relevant.

The research objectives, methodology and outcomes were explained to the interviewee. The initial research framework was explained to the interviewee, and areas where modifications were made as per PilotParticipant1's suggestions were highlighted. The interviewee was asked to identify any questions that seemed ambiguous and unnecessary, any flaws that may exist in the final research framework, as well as any suggestions that may improve the quality of the research.

The interviewer initially explains to the interviewee that general information about PILOTFIRM1 is required to paint a richer picture of the firm's structure. This information looks at:

- Total annual firm sales
- Types of products manufactured
- Number of employees
- Number of direct suppliers (local/global)
- Number of direct customers (local/global)

As PilotParticipant1 had already gone through this information, it was deemed unnecessary to go through it again.

Supplier Classification

The interviewee is then asked to classify a maximum of 3 suppliers according to the criteria:

- The supplier is geographically distant (i.e. on another continent) from the firm
- The supplier must provide a part with strategic importance to the firm
- The supplier chosen should reflect the general supplier management practices of the firm

The interviewee queries whether a local distributor to the firm that obtains material from a global source fulfils the geographically distant criteria (i.e. an indirect long supply chain). The interviewer says that for the purposes of this research that can fulfil the criteria, as the global supplier uses the local distributor as its agent. The interviewee goes on to say that it is better to deal with the global supplier directly than through a local distributor. The first reason given for this is that carbon fibre, the primary product obtained from geographically distant suppliers is a complex product: product knowledge and recommendations on the products use is more easily and accurately obtained direct from the suppliers who manufacture it. Distributors are only there to sell the product and have less product knowledge. Secondly, the distributor generally does not pass on information such as product delays or manufacturing problems experienced by the overseas supplier. This means that PILOTFIRM1 would not know about overseas supplier problems until they ordered the required material from the distributor. Thirdly, the distributor does not always stock the required carbon fibre or resins for PILOTFIRM1, even if they know that PILOTFIRM1 has used those materials in the past. The interviewee says that he is interested in dealing with suppliers who add value to PILOTFIRM1, and has developed long term relationships with these global suppliers. If the overseas supplier is shipping a crate of material to another firm in South Africa and space is available in the crate, they will contact PILOTFIRM1 and fill the remaining space in the crate with material for them, thereby providing free transport of material for PILOTFIRM1. The interviewee gives examples of carbon fibre suppliers to the firm from Germany, Italy, the UK and Japan. The German suppliers supply materials through a local distributor, and an approximate materials arrival date is given to

PILOTFIRM1. PILOTFIRM1 is in the process of acquiring less material from the German suppliers as no value is added using a local distributor. The UK supplier also provides composite materials to the automotive industry; this gives a better product match between PILOTFIRM1 and the supplier due to product similarities, and it is easier to talk to people who supply products to the automotive industry. Suppliers are chosen to try and make life easier at PILOTFIRM1.

Customer Classification

The interviewee is then asked to classify a maximum of 3 customers according to the criteria:

- The customer is geographically distant (i.e. on another continent) from the firm
- The customer must be provided with a part of strategic importance from the firm
- The customer chosen should reflect the general customer management practices of the firm

The interviewee identifies a customer as an overseas distributor of PILOTFIRM1 products. These distributors deal with the individual customers directly. Generally the distributors keep stock of PILOTFIRM1 products. With 80 percent of PILOTFIRM1 sales coming from 10 products, these products are generally held by the distributor. Distributors in a country like the USA may do a bulk order, sending PILOTFIRM1 a 3 month forecast for products. A distributor in Singapore where the market is much smaller may order less stock. Once stock is bought from PILOTFIRM1 by a distributor it is the distributor's requirement to sell the stock. Another customer to PILOTFIRM1 are the motorbike OEM's, where products forecasts are sent to PILOTFIRM1 for the necessary carbon fibre wheels.

Quality

The interviewer then asks the interviewee what is understood by the meaning of quality. The interviewee says that quality means that the product is 100% technically correct. Quality is also concerned with the visual aesthetics of the product. As the carbon fibre is visible on the wheel, it is required to look good. The interviewee goes on to say that whilst aesthetics are

important on visible areas, it is not required to make functional non visible areas to such stringent aesthetic quality standards as is done in the manufacture of things like automotive components under the car hood. Quality is also concerned with customer care, as well as traceability. Traceability means that all of the manufacturing steps involved in the making of a motorbike wheel are documented, from material sourcing to finished product. ISO 9000 standards help to define quality. The interviewee says that ISO 9000 provides a logical approach to quality, but should not become the ultimate focus of the manufacturing operation as it can force you out the back door of your business.

The interviewer asks how the firm plans for quality with its suppliers. The interviewee responds by saying that the firm initially qualifies three suppliers for a product. Carbon fibre testing information and documentation must be supplied to PILOTFIRM1 to qualify, and the suppliers must all be ISO 9000 accredited. An emphasis is placed on 100 percent traceability with suppliers. The interviewer then asks how the firm plans for quality with its customers. The interviewee says that a survey is sent out to its distributors and OEM's asking questions about PILOTFIRM1's quality and delivery performance, and a wish list of product changes or new product additions that they would like to see in the future. It was found using the survey that customers wanted BMW wheels manufactured, which resulted in PILOTFIRM1 manufacturing this product. The interviewee says that if a customer wants a new product addition to PILOTFIRM1's line-up, they can fill in a new product form with all of the required dimensions and specifications and PILOTFIRM1 would consider the manufacture of it. In addition, PILOTFIRM1's management visits its suppliers and customer a number of times a year in order to keep up to date and ensure that no problems are visible with suppliers.

The interviewer asks if the firm trusts its suppliers to achieve the planned quality. The interviewee says that there is trust between PILOTFIRM1 and its suppliers. Visits to PILOTFIRM1's global suppliers and customers are made to gain an understanding of their manufacturing facilities, processes and people involved. This, in addition to the qualifying supplier process, helps to ensure the correct quality. Suppliers are trusted enough so that not all incoming batches of material are inspected. The interviewee goes on to say that its German supplier sent a number of carbon fibre rolls of material to PILOTFIRM1 that were missing lengths of material. As they did not do an incoming

inspection this discrepancy was picked up by the Syspro accounting system, as the rolls of material do a fixed number of wheels and fewer wheels were made than usual. The German supplier is now getting phased out of PILOTFIRM1's supplier programme. The interviewer asks if the customer trusts PILOTFIRM1 to achieve its planned quality. The interviewee says yes, and explains that if distributors need drawings and information from PILOTFIRM1 to verify something, it is given to them. The distributors are also required to visit overseas factories on PILOTFIRM1's behalf to ensure that everything there is in the required order and quality is acceptable.

The interviewer then asks how PILOTFIRM1 controls or prevents poor incoming quality from its suppliers. The interviewee explains that product quality is driven by serial numbers and traceability. Each step in the process from purchasing, accounting and manufacturing accounts for the material batch and supplier from the serial number, and this is logged into the computer system. Each step of the internal manufacturing process is signed off by operators, allowing for accountability and traceability. The interviewer asks how the customer controls or prevents poor incoming quality from PILOTFIRM1. The interviewee says that documentation and product serial numbers play an important part in tracing quality problems in defective products in the field. If customers find a problem with PILOTFIRM1's product and an issue was documented in the manufacturing process, a replacement product is issued. PILOTFIRM1 also trades on its reputation, and it has the necessary testing reports on its products which can be sent to customers if required. As each PILOTFIRM1 carbon fibre wheel is a handmade product, they are not identical to one another, but all adhere to the same quality standard. The interviewer asks how performance measures are used in controlling or preventing poor quality with suppliers. The interviewee responds by saying that suppliers need to adhere to the stipulated time and quality measurements. Aluminium materials may need to have the specified test and source documentation sent with the material, but carbon fibre does not generally need this level of documentation attached. The interviewer asks how performance measures are used in controlling or preventing poor quality products going to customers. The interviewee says that the customers generally trust a PILOTFIRM1 product to adhere to the required standards. Some customers may perform checks on the wheel and require technical information on the product, but for

the most part a PILOTFIRM1 product is sold without a customer inspection.

The interviewer asks how quality improvements are made in the long supply chain with its suppliers. The interviewee says that quality improvements and cash flow are linked; greater cash flow allows for more improvements to be made. A design office in Europe does the relevant improvements to wheel designs. The interviewee goes on to say that it is impossible to find an aeronautical composite engineer in South Africa to do Finite Element Analysis (FEA), and an overseas design engineer is brought to the country when major design improvements are to be made to PILOTFIRM1 products. The interviewee says that any design changes done by R&D at PILOTFIRM1 are completed before getting released onto the server for manufacture. The interviewer asks how quality improvements are made in the long supply chain with its customers. The interviewee explains that a survey sent to customers helps identify any improvements to their products, as well as additional motorbike hub configurations that should be made to adapt to other motorbike models. The interviewer asks how top management participates in continuous improvement activities with its suppliers. The interviewee responds by saying that because PILOTFIRM1 is a small company, they have an open door policy to improvement activities, with management and employee teams involved where necessary.

Dependability

The interviewer asks how PILOTFIRM1 ensures on time reliable delivery of goods from its global suppliers. The interviewee responds by saying that if they had greater cash flow, they could have more on hand stock and not have to worry about late supplier deliveries. If a late delivery to a customer as a result of supplier or internal manufacturing delays is to occur, an attempt is made to contact the customer early on and warn them of this. Local distributors of supplier product sometimes give PILOTFIRM1 little warning of delivery delays. Upfront delivery information from global suppliers and local distributors helps PILOTFIRM1 in production planning. The interviewer asks how PILOTFIRM1 ensures on time reliable delivery of goods to its global customers. The interviewee says that customers are encouraged to organise their own logistics services. If it is an initial customer or PILOTFIRM1 has a long term relationship

with a customer, they will organise the logistics process for them.

Speed

The interviewer asks how information technology is used in communicating with suppliers. The interviewee says that information like drawings is available on its servers and can be sent to suppliers and customers if required. The UK supplier has drawings and other information on its servers that can be accessed by PILOTFIRM1 as well. The interviewer asks how information technology is used in communicating with customers. The interviewee says that Google pages are used by a customer in Canada to place orders with PILOTFIRM1; it is a webpage which can only be accessed by password by PILOTFIRM1 and the customer to place and confirm orders. PILOTFIRM1 also puts performance enhancing documents and some technical test results on its website for the customer to read. If the customer requires any other relevant technical information from PILOTFIRM1, such as if they want to make modifications to the wheel, they can contact PILOTFIRM1.

The interviewer then says that the next question is concerned with who provides the funding for IT systems between supplier and customer to enable information visibility, but as no specific systems are in place, this will not be investigated. The interviewee agrees.

The interviewer asks to what extent operational information is shared between PILOTFIRM1 and its suppliers. The interviewee says that they are relatively open with information with suppliers and customers. A non disclosure agreement is signed between PILOTFIRM1's suppliers and its customers. The amount of information shared is dependent on the relationship that PILOTFIRM1 has with its suppliers and customers: some R&D is shared with members where it is beneficial to PILOTFIRM1, whilst others are only supplied with the basic operational information required.

The interviewer asks how the firm coordinates its supplier's decisions and activities to meet customer requirements. The interviewee seems a little confused about the question, and the interviewer explains that this question is asking whether one member in the supply chain makes decisions like procurement policies or production plans for all of the members, or whether

all supply chain members' act independently from one another when making decisions. The interviewee responds by saying that information is shared between suppliers and customers as far in advance as possible, and that a forecast of sales is sent between members when it is made. The interviewer then asks how the level of coordination or the relationship structure between PILOTFIRM1 and its suppliers is determined. The interviewee again seems a little confused, and the interviewer elaborates by saying it is asking how PILOTFIRM1 determines whether to have a long term or short term relationship with a supplier and why. The interviewee says that it prefers to have long term relationships with its suppliers due to the complexity of carbon fibre products. A long term relationship adds value to PILOTFIRM1, as it can yield suggestions and valuable information. It is also preferred to do business with suppliers who are of a similar size to PILOTFIRM1. The German supplier who used to produce 10% of PILOTFIRM1's carbon fibre, but now only produces 1% of its product, does not interact with PILOTFIRM1 on the same level and therefore does not add as much value.

The interviewer then says that the reduction of lead time in the supply chain is identified as a method of improving firm competitiveness. The interviewee agrees. The interviewer then asks what barriers exist in reducing lead time from the supplier to the firm. The interviewee quickly says cash flow, as a higher on hand inventory of carbon fibre could half PILOTFIRM1's supply problems. The interviewer then asks what barriers exist in reducing lead time from the firm to the customer. The interviewee again says that cash flow could solve this problem, as well as the correct management of people in PILOTFIRM1.

The interviewer asks how material order volumes and order frequencies are determined in the supply chain from the supplier. The interviewer says that cash flow again is important, and that bigger inventory levels are preferred at PILOTFIRM1 to ensure that the production plan won't be affected. 80 % of PILOTFIRM1's sales come from 10 bike models, so PILOTFIRM1 generally knows what to keep making. Back orders from the distributor's forecasts drive production, which replenishes the distributors stock. PILOTFIRM1 prefers the distributors to keep on hand inventory, but again this is dependent on the size of the operating market. Production orders not on forecast generally take 6-8 weeks from order date, which accounts for air or shipping freight (shipping is about 10% cheaper than air, but

takes about a week longer), as well as the production of the wheel). The interviewee says that PILOTFIRM1 has elements of JIT production in it, but this is meshed together with the known production plan and they have higher levels of inventory to account for uncertainties.

The interviewer then asks whether the firm has knowledge of the relevant levels of inventory and manufacturing capacity that the supplier has. The interviewee says that when suppliers go through the initial qualification process, they are asked upfront for operational information to prevent any surprises. Trust is also required between PILOTFIRM1 and its suppliers when sharing this information. The interviewee goes on to say that supplier qualification is an important process. If a supplier becomes problematic and is to be phased out, the qualification of a new supplier takes a long period of time. This has a domino effect on all other aspects of the business. The interviewer asks whether the customer has knowledge of the relevant levels of inventory or manufacturing capacity that the firm has. The interviewee responds by saying that the customer is not that aware of this knowledge. As the customer is the distributor of its products and not an OEM as in the case of aerospace companies, it is not necessary. 80 % of PILOTFIRM1 sales come from 10 bike wheels, and this knowledge together with the forecasts in the back order book helps PILOTFIRM1 identify what materials are required from its suppliers. The interviewee goes on to say that machine tooling at PILOTFIRM1 affects productivity levels, as this dictates the number of wheels that can be manufactured.

Flexibility

The interviewer asks what is understood by the term flexibility. The interviewee responds by saying that flexibility is concerned with customer satisfaction and the ability to make a change on a standard product. The interviewee explains that a change on a standard product does not mean a completely customised product, but possibly the change of a bike hub to fit a wheel. By customer satisfaction the interviewee means that customer’s queries can be answered easily, as it is a small company. If a defect in a customer’s wheel occurs and it can be traced to a step in PILOTFIRM1’s manufacturing process, the wheel will be replaced quicker than the standard 6-8 weeks, if materials are available, to ensure customer satisfaction levels. The interviewee also says that there is company flexibility, which is the ability to react to market conditions. As PILOTFIRM1 is a dollar based

company and fluctuations can affect its profitability, it needs to react quickly. The interviewee explains that the internet is used to cut costs, and explains that a component for a wheel was found cheaper on the internet, which was then used to bargain a lower price with its supplier of the same component. The interviewer asks how flexibility is achieved or enabled with its suppliers. The interviewee responds by saying cash flow, and that a large number of the questions asked in this study are concerned with cash flow. The interviewer asks how flexibility is achieved or enabled with its customers. The interviewee says that if a customer wants a different product other than that already manufactured, a minimum lot size is imposed. If the customer only wants a different hub to fit a standard product, then a smaller lot size is required. This is determined according to a set of guidelines that has been set up for quoting. The interviewee goes on to say that PILOTFIRM1 is a one stop shop for composites, and that composite design, testing and manufacture can be done if required.

The interviewer says that the interview is over, and gives his thanks to the interviewee for his time. The interviewer asks if there are any questions that the interviewee did not understand or seemed ambiguous, and any suggestions to the improvement of the framework that could be made. The interviewee says that it seems logical, but that I should include something about technical skills shortages in the framework. The interviewee goes on to say that a shortage in technical skills from the lower levels of composite lay-up technicians through to aeronautical composite engineers is experienced. A problem also experienced is head-hunting of staff from PILOTFIRM1 from bigger companies like Denel, who offer larger salaries than PILOTFIRM1 can. The interviewee also says that whilst the improvement of the South African aerospace industry is a good thing, we are viewed by the big companies like Boeing and Airbus as a country with cheap overheads and good management skills. With Eskom electricity hikes we may not be able to compete on cost anymore, and these companies may outsource production elsewhere. The interviewee goes on to say that an investigation into wind turbine composite blades should be made in the future, as it has a lower barrier to entry due to less stringent quality standards required, and it is an emerging field of interest and no South African firm manufactures them yet. Carbon fibre props for light aircraft and Para gliders should also be investigated for South African manufacture.

Final pilot study analysis and changes to research framework

General

The general information in the final pilot study is the same as that obtained in the initial pilot study.

Table B5: Overview of PILOTFIRM1

Firm	Types of products	Total annual Sales (Rand)	No. of employees	No. of direct suppliers		No. of direct Customers	
				Local	Global	Local	Global
PILOTFIRM1	Carbon fibre products	15 M	40	20	3	3	20-25

Supplier Classification

PilotSupplier1, the German composite manufacturer, supplies composite materials through a local distributor in South Africa. PILOTFIRM1 cannot directly purchase materials through the German supplier, and has to use the local distributor. PilotSupplier2 is a composite manufacturer in the UK, who also provides composite materials to the automotive industry. PILOTFIRM1 orders directly through PilotSupplier2. Supplier classification is seen in table B6 below.

Table B6: Supplier classification

Firm	Supplier name	Strategic part supplied to firm	Location
PILOTFIRM1	PilotSupplier1	Composite materials	SA, distributor of German stock
	PilotSupplier2	Composite materials	UK

Customer Classification

PilotCustomer1 is a distributor of PILOTFIRM1 products in the USA. PilotCustomer1 deals with the individual customers and

places orders with PILOTFIRM1. PilotCustomer1 generally holds carbon fibre wheel stock on its shelves. Once stock has been ordered it is the distributor's product and responsibility to sell. PilotCustomer2 is a distributor of PILOTFIRM1 products in Singapore. With Singapore being a far smaller market then the USA, little stock is held. PilotCustomer3 is an OEM in the USA. PilotCustomer3 orders from PILOTFIRM1 when required. Customer classification is seen in table B7.

Table B7: Customer classification

Firm	Customer	Strategic assembly supplied to customer	Location
PILOTFIRM1	PilotCustomer1	Finished carbon fibre wheels	USA
	PilotCustomer2	Finished carbon fibre wheels	Singapore
	PilotCustomer3	Finished carbon fibre wheels	USA

Quality

Quality is interpreted on both internal and external dimensions. Internally, the product needs to be "100% technically correct", and traceability of each step in the manufacturing process is key. Externally, quality is concerned with customer care and customer requirements, which is evident through the administering of yearly surveys to obtain feedback on both PILOTFIRM1's service levels and possible product improvements. With the motorbike wheel being a visible component, the aesthetic dimension of quality is important.

Quality planning with suppliers begins with the qualification process. Each PILOTFIRM1 product requires the qualification of 3 suppliers, with ISO 9000 accreditation and the relevant material test results being order qualifiers. Material traceability is an upfront criterion that must be fulfilled. Supplier factory visits are also performed by management to get an idea of manufacturing processes and the people involved before qualifying suppliers. PILOTFIRM1 prefers to operate directly with a global supplier like PILOTFIRM1S2, even if a local distributor of material is available. A number of reasons are

given for this. Firstly, carbon fibre is a complex product. Product knowledge and recommendations are more easily and accurately obtained direct from the supplier who manufactures it. Distributors are generally only there to sell the product and have less product knowledge, as in the case of distributor PilotSupplier1. Secondly, the distributor generally does not pass on information like product delays or manufacturing problems experienced by the overseas supplier. This means PILOTFIRM1 does not know about overseas supplier problems until they order the required material from the distributor. Thirdly, the distributor does not always stock the required carbon fibre or resins for PILOTFIRM1, even if PILOTFIRM1 has frequently used those materials in the past. PILOTFIRM1 attempts to choose suppliers who add value to the firm, and wants to develop long term relationships with these suppliers. The relationship with PILOTFIRM1S2, the UK carbon fibre supplier to the automotive industry is a good supplier match with PILOTFIRM1, due to product similarities. Quality planning with customers is aided by feedback from both the distributors, who interact directly with individual customers, and the OEM's. Product additions and alterations to PILOTFIRM1's product line are considered from customer input.

Trust between PILOTFIRM1 and its suppliers does exist, but has developed over time as a result of accepted supplier behaviour. In the initial relationship, safeguards are implemented to prevent opportunism: The initial supplier qualification process; overseas supplier factory visits by PILOTFIRM1 and its customers at intervals; and the signing of a Non Disclosure Agreement (NDA) are all undertaken. Together with these safeguards, quality inspection of incoming overseas supplier material is frequently done in the initial phases of the supplier-buyer relationship. If incoming material is of the planned quality over a period of time, quality inspections are then only done periodically. Trust between PILOTFIRM1 and its customers exists as well, but again has developed over time. Customers like PilotCustomerC1 inspect PILOTFIRM1's overseas suppliers initially and then periodically if they are to distribute PILOTFIRM1's product. Requests may also be made by the customer for PILOTFIRM1's technical test results for verification of product quality.

Supplier quality control is ensured through traceability of material and product. Each step in the process from purchasing, accounting and manufacturing accounts for the material batch and supplier from the serial number, and this is logged into the

computer system. ISO 9000 standards help to define the quality control process. But PILOTFIRM1 management says that whilst ISO 9000 provides a logical approach to quality, it should not become the ultimate focus of the manufacturing operation, as it can force you out the back door of your business. General time and delivery performance measures are used to track and control suppliers, but performance measures relating to quality are more specific. Materials like aluminium need to have the specified test and source documentation sent with the material, but may not be required for all materials, including carbon fibre based materials. Customer quality control of PILOTFIRM1 product in the field is again ensured through traceability of documentation and product serial numbers. PILOTFIRM1's management says that PILOTFIRM1 trades on its good reputation for quality with its customers. Whilst each PILOTFIRM1 carbon fibre wheel is a handmade product and are not identical to one another, they all adhere to the same quality standards. Some customers may perform checks on the wheel and require technical information on the product, but for the most part a PILOTFIRM1 product is sold without any "traditional" quality control procedure.

Quality improvements are not generally made with suppliers. This is most likely due to suppliers only providing the "basic" raw materials of carbon fibre and aluminium, and PILOTFIRM1 internally doing all the design and manufacture of the wheels. A focus is on internal product improvement, where a design office in Europe is used to obtain the relevant technical expertise which cannot be found in South Africa. With PILOTFIRM1 being a relatively small firm (40 employees), management and employees work together when required in making improvement changes. Internal continuous improvements are strongly linked to the availability of funding; more improvements and research could be conducted if greater cash flow existed. Customer suggestions and requirements are passively used when making quality improvements. PILOTFIRM1 sends out a survey to customers to identify any improvements that can be made to their products, as well as whether any additional products could be added to PILOTFIRM1's range.

Dependability

PILOTFIRM1's ideal response to ensuring on time reliable delivery of goods from its global suppliers would be to increase cash flow. An increase in cash flow allows PILOTFIRM1 to have more on hand stock, and therefore not have to worry about late

supplier deliveries. Local distributors of composites like PilotSupplier1 are less likely to notify PILOTFIRM1 on delivery delays, and are less favoured over their international suppliers like PilotSupplier2 who will generally contact PILOTFIRM1 when problems occur. If a late delivery to a customer as a result of supplier or internal manufacturing delays is unavoidable, the customer is notified as early as possible to try and minimise the damage. With PILOTFIRM1's practice of generally making customers collect their goods from PILOTFIRM1 using their own logistics provider, PILOTFIRM1 does not incur the responsibility of outbound product delivery delay times.

Speed

Information technology as an enabler of information flow is utilised on a basic level between PILOTFIRM1, its suppliers and customers. Technical data like product specifications and drawings, found on PILOTFIRM1's internal server, are sent to suppliers and customers via email if requested. Suppliers will also send the required data via email if required. Some technical test results and performance enhancing documents on PILOTFIRM1 products are found on the PILOTFIRM1 website for the public to access if required. A customer in Canada has utilised Google pages, an online web application, to place orders with PILOTFIRM1. This is a online password protected page that allows PILOTFIRM1 and the customer to place and confirm product orders, simplifying the procurement process.

With no specific IT systems in place (ERP, EDI etc.) between supply chain members, the question regarding the funding of IT systems is not relevant.

The amount of operational information that is shared between PILOTFIRM1 and its suppliers is dependent on the relationship that PILOTFIRM1 has with its suppliers and customers: some R&D is shared with members where it is beneficial to PILOTFIRM1, whilst others are only supplied with the basic operational information required. Safeguarding the information sharing process is the signing of a Non Disclosure Agreement (NDA) with supply chain members.

The coordination of supplier's decisions and activities to meet customer requirements is enhanced by sharing information between suppliers and customers as far in advance as possible. Product forecasts are sent by customers to PILOTFIRM1 to

ensure that their requirements can be met. PILOTFIRM1 as the middleman then uses the customer's requirements to calculate their material requirements, which are sent to suppliers. Long term relationships between PILOTFIRM1 and its suppliers are preferred due to the complexity of carbon fibre products. Long term relationships add value to PILOTFIRM1, as they can yield suggestions and valuable information to the business. Suppliers who are of a similar size to PILOTFIRM1 are also preferred, as they interact with PILOTFIRM1 on the same level, and are more willing to listen to their needs. PILOTFIRM1 management cites the example of a supplier who initially produced 10% of a PILOTFIRM1 composite material, but after expansion only produced 1% of the required composite. It became more difficult to interact with the supplier and obtain the same valuable input due to the smaller volumes. This has lead to PILOTFIRM1 phasing out this supplier.

PILOTFIRM1's ideal response to reducing lead time in the supply chain between supplier and customer is to increase cash flow levels. More money means more on hand inventory of carbon fibre, which could "half" PILOTFIRM1's supply problems. More money also means more finished goods can be kept in stores, allowing PILOTFIRM1 to respond quicker to the customer's needs. Internally, better management of people at PILOTFIRM1, ensuring that jobs are done properly, can lead to reductions in lead time. Internal manufacturing capacity levels (e.g. machine tooling) which dictates the number of wheels that can be made also has an impact on lead time.

Material order volumes and order frequencies from the supplier to PILOTFIRM1 are primarily determined from customer's forecasts, generally given 3 months in advance. Production orders not on forecast generally take 6-8 weeks from order date, which accounts for air or shipping freight (shipping is about 10% cheaper than air, but takes about a week longer), as well as the production of the wheel. As a standard rule, 80 % of PILOTFIRM1's sales come from 10 bike models, so PILOTFIRM1 generally knows which materials to order from suppliers. PILOTFIRM1 supplier capacity levels are examined upfront when going through the initial qualification process. This, together with periodic visits by PILOTFIRM1 and its customers to suppliers, helps ensure uninterrupted supply. Customers are unaware of PILOTFIRM1's capacity and on hand inventory levels of raw material and finished goods. With PILOTFIRM1's end customers receiving a finished product (carbon fibre wheel) that

does not impact on the production plans of customers finishing a product (e.g. building a car or airplane), customer knowledge of PILOTFIRM1 capacity and inventory is less important. What is important is that the customer receives their products according to the forecast or plan sent to PILOTFIRM1. PILOTFIRM1 prefers their distributor customers to keep some finished goods inventory in stock as buffer, dependent on the size of the operating market. PilotCustomer1, the US distributor, would be expected to keep some carbon fibre wheel products in stock due to the large size of the US market, but PilotCustomer2, the Singapore distributor would not keep stock due to the smaller market.

It was decided not to use the Cardiff business change model (Towill, 1991) to categorise information in the speed competitive dimension for the final research framework in the main study. As cost was not to be examined directly as a competitive dimension, the financial barrier to information flow was not relevant. The technological and cultural barriers to information flow could be examined directly within Stalk and Hout's (1990) framework, and aspects of organisational barriers could be examined within the dependability dimension.

Flexibility

Flexibility is interpreted on a number of dimensions. The ability to make a modification to a carbon fibre wheel, such as in fitting a new bike hub to the wheel, corresponds to manufacturing *mix flexibility*. This is aided using modular design. A standard range of wheel designs, together with a standard range of bike hub designs that can be fitted to any wheel, results in a greater product mix. Supply chain *responsiveness to target market flexibility* corresponds to PILOTFIRM1's concern for customer satisfaction, which is described as the ability to answer customer queries and respond quickly to field defects. Supply chain *sourcing flexibility* is evident on the PILOTFIRM1 supplier side, where lower prices for the same product found on the internet are used to bargain with the existing supplier for a price reduction. Flexibility on the customer side appears to deal with *product flexibility and volume flexibility*. This is seen in PILOTFIRM1 possibly manufacturing a product different to its existing product line, provided a minimum lot size is met.

A summary of the final pilot case study data is given in table B8:

Table B8: Final pilot case study research framework summary

Competitive dimension	Measurement	PILOTFIRM1 (supplier-firm unit)	PILOTFIRM1 (customer-firm unit)
Quality	Meaning of quality	• Internal dimension: product must be 100% technically correct • External dimension: customer requirements need to be met, customer feedback is important • Aesthetics	
	Quality planning	• Initial qualification of 3 suppliers, with ISO 9000 and required material test results being order qualifiers • Material traceability a criterion • Global suppliers preferred over local distributors due to better product knowledge, communication over material delays and product availability • Safeguards to prevent supplier opportunism in place, but trust has developed over time	• Inputs by both product distributors and OEM's on product changes and additions • Customer checks of PILOTFIRM1 product and suppliers to ensure planned quality, trust has developed over time
	Quality control	• Material traceability using serial numbers • ISO 9000 defines quality control process • Performance measurements focused on quality	• Material traceability in the field uses serial numbers • Customers generally do not perform traditional quality control checks, but initial screening of PILOTFIRM1 products is done

Table B8: Final pilot case study research framework summary (continued)

Competitive dimension	Measurement	PILOTFIRM1 (supplier-firm unit)	PILOTFIRM1 (customer-firm unit)
Quality	Quality improvement	• Quality improvements not generally done with suppliers, focused more on internal product improvement	• Customer input passively used in quality improvements
Dependability	General approach	• An increase in cash flow to increase buffer inventory would aid reliability on the supply side	• Customer management important if late delivery of product is unavoidable • Customers generally organise outbound logistics process, PILOTFIRM1 not responsible for transportation delays
Speed	Information flows (Technological)	• Basic IT usage, email	• Basic IT usage, email and some web applications (Google pages)
	Information flows (Cultural)	• Information sharing dependent on type and length of relationship, Non-disclosure agreements initially put in place	• Information sharing dependent on type and length of relationship, Non-disclosure agreements initially put in place
	Information flows (Financial)	• Not relevant	• Not relevant
	Information flows (Organisational)	• Long term relationships with suppliers preferred due to complexity of carbon fibre products • Suppliers of a similar size to PILOTFIRM1 preferred	• Product forecasts from customers aid in coordinating PILOTFIRM1 and its suppliers activities

Table B8: Final pilot case study research framework summary (continued)

Competitive dimension	Measurement	PILOTFIRM1 (supplier-firm unit)	PILOTFIRM1 (customer-firm unit)
Speed	Shortening lead times	• An increase in cash flow means more on hand inventory, could "half" PILOTFIRM1's supply problems • A focus on internal capacity improvements to reduce lead times	• Increased cash flow could lead to greater finished goods inventory, respond quicker to customers
	Synchronisation	• Generally 80% of PILOTFIRM1's sales come from 10 bike models, determining which materials to order from suppliers • Supplier capacity examined in the initial qualification process, together with periodic visits	• Customer orders based on 3 month forecast, unaware of PILOTFIRM1 capacity levels • Distributors of PILOTFIRM1 products may keep additional finished stock, dependent on market size
Flexibility	Supply chain flexibility Manufacturing flexibility	• Sourcing flexibility, focused on cost reduction	• Responsiveness to target market flexibility, where quick response to customer queries and field defects is required • Product flexibility and volume flexibility, where a different product to the existing line may be manufactured provided a minimum lot size is met • Mix flexibility, aided by modular design

Appendix C

Appendix C contains the final interview tool used in this research. Standard definitions for some questions in the interview tool are provided to aid with validity of results. These standard definitions are used if the interviewee is unsure of the meaning of the question.

Final Interview Tool

General

Date:
Time:
Place:
Interviewee:
Position:
Contact details:

Firm	Total annual sales	Number of employees	Types of products	Number of Direct suppliers		Number of direct customers	
				Local	Global	Local	Global

Applicable to supplier-firm unit of analysis (all questions below)

Classify a maximum of 3 suppliers to the firm that fulfil the following criteria:

- The supplier is geographically distant (i.e. on another continent) from the firm
- The supplier must provide a part with strategic importance to the firm. Why makes that part strategically important?

Firm	Supplier name	Strategic part supplied to firm. Why?	Location

Speed

Better and timelier information

1. What type of information is shared between the firm and suppliers?
2. How is Information Technology used in communicating with suppliers?

Lead time compression

3. How could the time between the ordering of materials from suppliers and delivery of these materials to the firm be reduced?

Synchronisation

4. How does the firm determine *when* orders are going to be placed with suppliers?

5. Could you tell me how the *quantity* of material ordered from suppliers is determined?

6. Could you tell me about any delays in receiving materials as a result of supplier capacity problems?

Dependability

Processes and procedures to ensure dependability

1. Can you tell me about the processes and procedures that are in place with suppliers to achieve on time reliable delivery of goods?

Quality

Meaning of quality

1. Could you explain what quality means for the firm and its suppliers?

Quality Planning

2. How are quality requirements determined with suppliers?

3. Can you describe the type of relationship that exists with your suppliers?

4. Would you say that the firm trusts its suppliers to deliver the required quality? How do you define trust?

Quality Control

5. How is poor quality controlled or prevented with suppliers?

6. What type of performance measures are used in controlling or preventing poor quality with suppliers?

Quality Improvement

7. Can you explain how quality improvements are made in the long supply chain with suppliers?

Flexibility

Meaning of flexibility

1. Can you explain what flexibility means for the firm and its suppliers?

Achievement of flexibility

2. How is flexibility achieved with suppliers?

Other

Ways to improve competitiveness

1. Can you describe any other areas not examined in the questions above that may improve competitiveness for the firm and its suppliers?

Applicable to customer-firm unit of analysis (all questions below)

Classify a maximum of 3 customers to the firm that fulfil the following criteria:

- The customer is geographically distant (i.e. on another continent) from the firm
- The customer must receive a part of strategic importance from the firm. What makes that part strategically important?

Firm	Customer name	Strategic part sent to customer. Why?	Location

Speed

Better and timelier information

1. What type of information is shared between the firm and customers?
2. How is Information Technology used in communicating with customers?

Lead time compression

3. How could the time between finished product in the firm and the delivery of the product to the customer be reduced?

Synchronisation

4. *When* does the customer place a product order with the firm?

5. Could you tell me how the *quantity* of product ordered by customers is determined?

6. Could you tell me about any delays that have occurred when sending finished goods to customers as a result of capacity problems?

Dependability

Processes and procedures to ensure dependability

1. Can you tell me about the processes and procedures that are in place with customers to achieve on time reliable delivery of goods?

Quality

Meaning of quality

1. Could you explain what quality means for the firm and its customers?

Quality Planning

2. How are quality requirements determined with customers?

3. Can you describe the type of relationship that exists with your customers?

4. Would you say that the customer trusts the firm to deliver the required quality? How do you define trust?

Quality Control

5. How is poor quality controlled or prevented with customers?

6. What type of performance measures are used in controlling or preventing poor quality with customers?

Quality Improvement

7. How are quality improvements made in the long supply chain with customers?

Flexibility

Meaning of flexibility

1. Can you explain what flexibility means for the firm and its customers?

Achievement of flexibility

2. How is flexibility achieved with customers?

Other

Ways to improve competitiveness

1. Can you describe any other areas not examined in the questions above that may improve competitiveness for the firm and its customers?

Standard definitions for final interview tool

Speed

Speed is defined as “how fast customers can be served”. This is the elapsed time between a customer requesting a product or service, and receiving it in full (Slack *et al*, 2007, p 403).

Dependability

Dependability or reliability is to keep the delivery promises one makes to the customer.

Quality

Quality means to “do things right”. Quality has an external dimension, which takes a strategic long term view which focuses on the customer needs; and an internal dimension, which takes a technical shorter term view and is concerned with the product being free from deficiencies.

Quality planning requires the identification of customers and their product needs, as well as the processes (manufacturing processes, suppliers, logistics) required to produce products that respond to those needs. *Trust*, a requirement for quality planning, reflects the confidence of one party in a two-way relationship that the other party will not exploit its vulnerabilities.

Quality control is the activity of evaluating actual performance, comparing actual performance to the customers needs, and taking action on the difference. Quality control may be aided through the use of a *performance measurement system*, which is defined as a “set of metrics used to quantify both the efficiency and effectiveness of actions” (Neely *et al*, 2000, p. 1229).

Quality improvement involves a continual reduction of waste and improvement of the quality of material and information flows between suppliers, manufacturers and customers.

Flexibility

Flexibility, according to Upton (1994, p. 73) is “the ability to change or react with little penalty in time, effort, cost or

performance”. Flexibility is often viewed as an adaptive response to environmental uncertainty (Gupta and Goyal 1989; Gerwin 1993). Flexibility includes manufacturing flexibility and supply chain flexibility.

Appendix D

Appendix D presents the table used for cross case analysis.

Table for cross case analysis

Table D1: Cross case interview analysis

Competitive dimension	Second Order Measurement	Third Order Measurement	Case A, B etc.
Speed	Better and timelier information	Communication	
		IT	
	Lead time compression	-	
	Synchronisation	Material order volume and frequency	
		Capacity constraints	
Dependability	Processes and procedures	-	
Quality	Meaning of quality	-	
	Quality planning	Quality planning process	
		Trust	
	Quality control	Quality control process	
		Performance measurement	
	Quality improvement	-	
Flexibility	Meaning of flexibility	-	
	Achievement of flexibility	-	
Other	Ways to improve competitiveness	-	

Appendix E

Appendix E contains the transcription of the audio interview with participant 1 for Case A.

Case Study A

Interview with participant 1

The interviewee will be herein be referred to as participant 1. The firm in the unit of analysis is herein referred to as Firm A, suppliers as supplier A1, A2 and customers as Customer A1, A2 when required.

The first part of this interview has been recorded. The last part of this interview was completed telephonically as the interviewee had other engagements. This telephonic conversation covered the last 6 questions of the interview tool (from *quality control* to the *other* question in the customer-firm unit of analysis) and was done later in the same day as the actual face-to-face interview. This was done as the time and cost required in travelling the 200km+ in order to do face-to-face interviews for a small proportion of the interview tool was deemed excessive. The telephonic interview was not recorded, and relies on authors hand-written notes and memory.

General

Table E1: Firm A details

Firm	Total annual Sales (R)	No. of employees	Types of products	No. of direct suppliers		No. of direct customers	
				Loc	Glob	Loc	Glob
Firm A	1 M+	600+	Automotive and in the future, aerospace interiors	10	15	N/A	N/A

Applicable to supplier-firm unit of analysis (all questions below)

Classify a maximum of 3 suppliers to the firm that fulfil the following criteria:

- The supplier is geographically distant (i.e. on another continent) from the firm

- The supplier must provide a part with strategic importance to the firm. Why makes that part strategically important?

Table E2: Supplier details for Firm A

Firm	Supplier name	Strategic part supplied to firm. Why?	Location
Firm A	Supplier A1	"Leather supplier" Main component in automotive seat covering, and possibly aircraft seat covering	Local and international
	Supplier A2	"Scarce materials" Materials that suppliers manufacture infrequently, as opposed to materials suppliers would manufacture frequently. Production planning needs to account for infrequent material manufacturing from suppliers	Local and international

Participant 1 puts forward an alternative explanation for a supply chain, where "...for me a long supply chain is also a complex product or raw material that needs to go into my product...for example...(my product involves) a very timeous process...which makes it a complex supply chain, or a long supply chain."

Speed

Better and timelier information

1. What type of information is shared between the firm and suppliers?

"I'm in the belief the more the supplier knows about...material we need and our manufacturing, the more he knows about our company, the better for the relationship"

“I’m pretty much on giving relationship building.”

2. How is Information Technology used in communicating with suppliers?

“Look, everything today is electronic which…has lost that personal touch…I’d rather quickly write an email then picking up the phone and phoning…every company basically has…an automatic…MRP system…the system is too often to blame. The demand change and the requirement change and whatever…and you would phone your supplier and say look, where is my order, what’s happening, and (he says) ill look into the system, and its not going to be ready in time…system this, system that….its not always happening with the suppliers, we are also at fault, we also have an automated MRP system, and we are sending out the release electronically to the suppliers, not checking what does that mean to the suppliers…verification of orders, that is imperative.”

Lead time compression

3. How could the time between the ordering of materials from suppliers and delivery of these materials to the firm be reduced?

In order to gauge the time when to order materials from suppliers, one has to first understand when customers place orders, which “…varies from daily, to weekly, to every three weeks, depending on how much stock you are prepared to carry. Stock carried is obviously of vital importance, everybody wants to carry as little stock as possible. So, the less stock you want to carry, the more frequent you need to get those releases out to your suppliers to make sure that the fluctuations, or that what you ordered is covered…”

The interviewer asks whether a just in time approach is applicable in ordering materials from overseas suppliers: “Just in time obviously overseas…could be possible, but there are too many outside external factors…” that make the just in time approach less viable.

Synchronisation

4. How does the firm determine *when* orders are going to be placed with suppliers?

“Look we would normally do it at the beginning of the week, but that could vary also from company to company...so by the end of the (previous) week you can run your MRP and see how much stock you’ve got, how does that fall in for the next weeks production, and by Monday morning you can then send out the new release...even if a release of an order to a supplier hasn’t changed, just send it out, because it keeps that communication link going.”

5. Could you tell me how the *quantity* of material ordered from suppliers is determined?

“That you obviously do at the onset. When you start the relationship with the supplier you would ask him: how big are your batch runs, what are your packing quantities, from there you decide on your most economical order quantity...”

6. Could you tell me about any delays in receiving materials as a result of supplier capacity problems?

“Ja...its obviously priority setting by the supplier...if my MRP has gone wrong or something, ill quickly phone the supplier and say that something went wrong with my MRP or so you got this wrong...often a very good excuse is, oh, the customer once did something, which could be, that the customer, something went wrong on his side... And then obviously another external factor is the pickup of the consignment at the supplier, flight delays, it gets bumped...”

Dependability

Processes and procedures to ensure dependability

1. Can you tell me about the processes and procedures that are in place with suppliers to achieve on time reliable delivery of goods?

“Obviously with the release, make sure that the release is understood by the supplier, so verification of the release by the supplier…then not just assuming that the supplier has sent you parcels and they’ve been picked up and whatever, check up and make sure that it has been dispatched. Especially with the suppliers overseas, making sure they have the documentation.”

Quality

Meaning of quality

1. Could you explain what quality means for the firm and its suppliers?

“Quality can be very subjective…at the end of the day it depends on the customer…the customer would put out his requirements to you, but your contribution would also sit a lot in that.”

Asking participant 1 what is meant by contribution: Contribution means that the company would be able to give the customer recommendations on the product sold to them, such as its usage, quality levels etc. This would then dictate material and quality levels needed from suppliers.

Quality Planning

2. How are quality requirements determined with suppliers?

“Obviously you would document and make sure that, what you get…from your suppliers, you can even verify that with your customers…look, the days are over where you would get material in and inspect 100 percent and things like that, you expect the right material to come in, normally we would do some random sampling testing, inspection…”

3. Can you describe the type of relationship that exists with your suppliers?

“Look, its all about partnership…it should be a win-win situation for both of us, you cannot be successful without a successful supplier.”

4. Would you say that the firm trusts its suppliers to deliver the required quality? How do you define trust?

“Again, it’s a feeling. You know there are certain suppliers with time that you can trust fully.”

Asking participant 1 how he defines trust: “it’s over time, where, you would put unreasonable demands on the supplier, and yet he would be successful, various issues like that, and yet they come to the fore. The other ones are just depending, it could be professionalism, management, it could be various things, you know when you don’t get that warm feeling about them…”

Quality Control

5. How is poor quality controlled or prevented with suppliers?

“Obviously in aviation there are quality systems…that are vitally important, that should not be there for the purpose of having a system, you must live the system, once you live the system you could be 70 or 80 percent sure that you are going to get good parts out of it. Otherwise you can insist on 100 percent inspection, 300 percent inspection, you can insist on putting in additional audits in process…depends on severity…you can even get an inspection team of your supplier…”

6. What type of performance measures are used in controlling or preventing poor quality with suppliers?

“…depending again on the processing of the material…there are vast things that you can do.”

Quality Improvement

7. Can you explain how quality improvements are made in the long supply chain with suppliers?

“…we always say…make sure that there are quality management systems that is (devised? *Inaudible part of recording*), make sure there are process audits done…you can do a system audit, you can do a process audit, you can do a quality control audit…”

Flexibility

Meaning of flexibility

1. Can you explain what flexibility means for the firm and its suppliers?

"...we say to a supplier, sorry (the needs were wrong? *Inaudible part of recording*), but I need fifty of these parts, I know they are not on my order, and...firstly from a verbal point of view, when the guy tells me Ill see what I can do, that when he's showing me he's looking for flexibility. If he actually does it, then he convinces me that he is more flexible. Admitting to flexibility is very important...its all about how you define flexibility, flexibility is unrealistic demands, or unreasonable demands, and yet the supplier is achieving it..."

Achievement of flexibility

2. How is flexibility achieved with suppliers?

"...there's always room for improvement (in flexibility)...for me to understand the process at the supplier, and buying-in of the suppliers to become more flexible. You often get people and suppliers who say forget it, it's the best that we can do, that we are not open to improvements or bigger turnaround times..."

Other

Ways to improve competitiveness

1. Can you describe any other areas not examined in the questions above that may improve competitiveness for the firm and its suppliers?

"Very important, we often moan in South Africa...on the finance side, payments that go are normally 30 days, yet the norm in Europe is 90 days...which again affects the cash flow of a company and the supplier. Obviously every customer wants a 90 day payment to their suppliers...leads to regularly getting in more funds helps you more so, to be more flexible...basically payment terms."

Applicable to customer-firm unit of analysis (all questions below)

Classify a maximum of 3 customers to the firm that fulfil the following criteria:

- The customer is geographically distant (i.e. on another continent) from the firm
- The customer must receive a part of strategic importance from the firm. What makes that part strategically important?

Table E3: Customer details for Firm A

Firm	Customer name	Strategic part sent to customer. Why?	Location
Firm A	Customer A1	"Safety component" Hold an important function in aviation	Local and international
	Customer A2	"Unique interior product" Seating, for aesthetic reasons. "It makes that airline more unique to another one. It could be one of the reasons why the airline would get more customers, apart from the price and the value of the aircraft plane and stuff like that."	Local and international

Speed

Better and timelier information

1. What type of information is shared between the firm and customers?

"To try and tell the customer that you are obviously the best...you would try to convince and maintain to your customer that the customer is first...by giving him the best price, the best quality, and delivery when he wants it."

2. How is Information Technology used in communicating with customers?

"...general things...like a website and information and everything that goes into it...requirements would go via EDI...communications should be email/telephonically, not just email...and visits, personal visits."

Asking participant 1 how visits would be facilitated with long supply chain customers:
"...we would go once a year or every six months, scheduling one or two weeks depending on how many customers you want to see or suppliers..."

Lead time compression

3. How could the time between finished product in the firm and the delivery of the product to the customer be reduced?

"Unfortunately due to logistics, you can reduce time but then costs go up..." A balance exists between the time taken for overnight air freight and shipping of the product, and the costs associated with these "modes" of transport.

Synchronisation

4. *When* does the customer place a product order with the firm?

"...lets just say we become an approved supplier..., then we would get regular orders and that would mean electronically once a week. However if we would deal with a general aviation, where we need to get specific aircraft (parts? *Inaudible part of*

recording) and airlines...(something about refurbishments? *Inaudible part of recording*), that would be a once off order, not a follow up order."

5. Could you tell me how the *quantity* of product ordered by customers is determined?

Describing the fact that the quantity of product differs from customer to customer, "it could be a three seater, or it could be a five hundred seater, or something like that..."

6. Could you tell me about any delays that have occurred when sending finished goods to customers as a result of capacity problems?

"Firstly either you've got capacity constraints in manufacture, or my suppliers let me down, I didn't get warned...at times to plan and produce that specific model, or there was a quality problem obviously, so there could be various reasons why I couldn't use the customer's requirements on time...external factors.... It could also be during peak season, I hadn't booked ahead, on aircraft space, and there is no flight, there is no space on that particular airline that I'm using...it could be seasonal effects, tourists, overbooking the planes...then we would try to use other aircraft, other airlines I mean...I would come to you as a passenger (flying overseas)...and say can you take these extra boxes...I would pay for that...just to don't let the customer stand..."

Dependability

Processes and procedures to ensure dependability

1. Can you tell me about the processes and procedures that are in place with customers to achieve on time reliable delivery of goods?

"Obviously you need to manage your lead times...and make sure whatever (happens? *Inaudible part of recording*)...a contingency plan is in place, and that comes with time. There is no specific route that you can take, I promise you."

Quality

Meaning of quality

1. Could you explain what quality means for the firm and its customers?

"...our ideal is obviously to have 0 ppm (parts per million) with the customer every month, year in, year out, that's what we're trying to achieve. To have no warranty claims from the customer. Maybe in a nutshell if you exceed your customer's expectations, then you've achieved quality."

Quality Planning

2. How are quality requirements determined with customers?

"You would sit down with paper and you would document...make sure, to again understand what the customer's requirements are, what he would want out of it, and normally we would say is that...we internally would add a level to that to make sure that we are always achieving the customers requirements."

3. Can you describe the type of relationship that exists with your customers?

"For me there must be mutual respect...I would try to be in the 80/20 principle...I want to be in the top 20 of my customers favourable suppliers"

4. Would you say that the customer trusts the firm to deliver the required quality? How do you define trust?

"They don't need to worry about me, he knows they will work...(*the interviewer asks whether this is a reputation thing*)...ja. And the initial contact...the first impression...and the first communication you make...have I got a warm feeling or a cold feeling."

Quality Control

5. How is poor quality controlled or prevented with customers?

Quality needs to start with satisfying the customer. All means should be used to correct outgoing problem parts to the customer. The use of photos and other data is used to prevent production problems. If parts of poor quality are sent to the customer, a service centre in Germany sorts out the problem.

6. What type of performance measures are used in controlling or preventing poor quality with customers?

Data is collected on internal production and on suppliers. Inspector's sheets may provide reasons for poor quality. A failures modes and effects analysis (FMEA) may be performed to find reasons for poor quality. A number of measures may be used, and it is important to "look at all possible options."

Quality Improvement

7. How are quality improvements made in the long supply chain with customers?

Quality is achieved by target setting, where the customer is asked for quality goal requirements, such as "is he happy with 100 ppm?" An issue lies with customers asking for unrealistic quality targets. Customers do not realise that increasing quality levels results in an increase in costs, as additional quality control methods need to be implemented. Quality inspectors may need to be hired to achieve increased quality levels, and an increase in part complexity may require different tools.

Flexibility

Meaning of flexibility

1. Can you explain what flexibility means for the firm and its customers?

Flexibility is "subjective", and depends on where you are in the supply chain. The customer expects flexibility, but "does not understand the ripple effect that exists." The level of flexibility changes as one moves down the supply chain, where the guy at the bottom of the chain needs to be the most flexible to respond to the customers needs. Flexibility is related to cost, "at the end of the day it's always about cost", with increased levels of stock, freight and internal production adding to increased flexibility but also increased costs.

Achievement of flexibility

2. How is flexibility achieved with customers?

Increased stockholding results in quicker response to the customers needs. Internal flexibility is also important to aid in customer response. Flexibility also exists in the freight delivery of goods to customers, which is highly dependent on cost. Quick delivery of goods to the customer can be achieved using a more expensive mode of transport like overnight air freight; slower but cheaper delivery can be done using ship freight.

Other

Ways to improve competitiveness

1. Can you describe any other areas not examined in the questions above that may improve competitiveness for the firm and its customers?

Organisational efficiency plays an important part in improving competitiveness. Automation of the MRP function between supply chain members, where systems communicate with one another may improve efficiency. Labour, which also plays an important role in improving flexibility, can be seen to improve organisation efficiency through multi-skilling staff members.

South Africa loses on the time dimension in improving competitiveness as a result of the long supply chain, but makes it up on the cost dimension as a result of cheaper buildings and labour, making us “on-par” with Europe.

Appendix F

Appendix F contains the transcription of the audio interview with participant 2 for Case B.

Case Study B

Interview with participant 2

The interviewee is herein referred to as participant 2. The firm in the unit of analysis is herein referred to as Firm B, suppliers as supplier B1, B2 and customers as Customer B1, B2 and B3 when required.

The full interview was recorded.

General

Table F1: Details for Firm B

Firm	Total annual Sales (R)	No. of employ	Types of products	No. of Direct suppliers Local	Global	No. of direct customers Local	Global
Firm B	25 Million	52	Tooling systems	Supply listing of 102, 90% of that comes down to 15 suppliers	Specialist suppliers of mass produced tooling aids About 12 suppliers	Customer base of 132 About 12 prime customers	"Deal with most of the major aerospace companies" About 6 customers

Applicable to supplier-firm unit of analysis (applicable to all questions below)

Classify a maximum of 3 suppliers to the firm that fulfil the following criteria:

- The supplier is geographically distant (i.e. on another continent) from the firm
- The supplier must provide a part with strategic importance to the firm. Why makes that part strategically important?

Table F2: Supplier details for Firm B

Firm	Supplier name	Strategic part supplied to firm. Why?	Location
Firm B	Supplier B1	Special clamps and cylinders that are used on machining fixtures. There's probably only six of these suppliers in the world, and we have a close relationship with Supplier B1. The equipment is not produced locally, and without their supply we wouldn't be able to support the marketplace with machines."	Germany
	Supplier B2	Tooling aids "...the aerospace industry for instance has a tendency to specify certain tooling aids on their tools, these are things like special springs or a special clamp, and they come from companies like Supplier B2 in the US."	US

"I need to stress from the beginning, because of the nature of the work that we do, we don't have what I would regard as key suppliers offshore. We have specialist suppliers who in real terms provide a minor amount of our bought-out, but having said that, some of them are quite important." *The interviewer asks whether he regards local suppliers as more strategic than the overseas ones* "Id regard them as more important, whether strategically they are more important, Id regard that as an open ended question, as the bulk of our buy out is raw materials, and so there are alternatives. Let the value of our important parts be relatively low compared with our turnover, the fact that they are strategically important is given. For instance, we have a supplier in Germany called Supplier B1, who provide us with special clamps and cylinders that we use on machining fixtures. There's

probably only six of these suppliers in the world, and we have a close relationship with Supplier B2. The equipment is not produced locally, and without their supply we wouldn't be able to support the marketplace with machines."

"...the aerospace industry for instance has a tendency to specify certain tooling aids on their tools, these are things like special springs or a special clamp, and they come from companies like Supplier B2 in the US or various other UK based companies"

"Supplier B1 have customisation to a degree, Supplier B2 no."

Speed

Better and timelier information

1. What type of information is shared between the firm and suppliers?

"We purely buy from their catalogue, in both instances that have very comprehensive catalogues, they provide us with graphic information so that we can import it into our designs, embed their product in there, and in both instances they have online purchasing facilities."

2. How is Information Technology used in communicating with suppliers?

"...all of our procurement is done online with our supplier, so their whole catalogue is online, we can access it, we can pay them online using credit cards, and we track their delivery online, it's very rare that we ever speak to them."

Lead time compression

3. How could the time between the ordering of materials from suppliers and delivery of these materials to the firm be reduced?

"I think they've actually got a pretty slick system...an Supplier B1 order is literally from taking the order to landing they take us five days, they always have stock. Supplier B2 slightly different, they often have to make the stuff but you still there talking about maybe 15 to 20 days. We've got a lot to learn." *The interviewer asks the interviewee how he thinks they do it* "they've

standardised, and they provide a service where they provide a range of tooling aids, but they supply it for the worldwide market, they've got the advantage of the US market which is a little bigger than ours..."

Synchronisation

4. How does the firm determine *when* orders are going to be placed with suppliers?

"We probably buy from Supplier B2 on an ongoing basis, not large amounts of money...but it's every month. Supplier B1 would be every two to three months, but it could run into the millions."

5. Could you tell me how the *quantity* of material ordered from suppliers is determined?

"That flows from our design...those buys are proprietary parts, so they are not making anything for us, it's a standard item that we require to incorporate into our product."

6. Could you tell me about any delays in receiving materials as a result of supplier capacity problems?

"The only time we ever get a problem is with our own department of customs...if you are buying things online from the states, the states will not use our postal services anymore, they use couriers, so we pay the penalty for using couriers, so then the courier has their contacts in customs and drives it through from there."

Dependability

Processes and procedures to ensure dependability

1. Can you tell me about the processes and procedures that are in place with suppliers to achieve on time reliable delivery of goods?

"Again, it's an automated process, so from the minute we place the order online, we can actually track it online, so they

acknowledge immediately, they give us full visibility into their system, we know when its moved from warehouse to dispatch, we know the flight numbers, we know when its going to land...remarkable."

"...its not impractical to give our customers access to our systems through a portal on the net, we want to drive it that way because the last few years, if you become transparent, and you allow a customer to see where you are, you have to make it happen. So that's what they've done...in Europe, the whole thing is transparent from day one, they're putting their money where their mouths are." *The interviewer comments that the European visibility is pretty remarkable*. "I still think the culture (in South Africa) is one of (failing the customer, fending him? *Inaudible part of recording)*...and literally making him happy, so you making him happy so he goes away and waits patiently for his delivery, rather than focusing on making sure he gets his delivery, so I think that's where the shift is going to go...be transparent. In fact it's a shift from, if your my customer, I shouldn't give my information to show my status, you should be able to just look at me and see where I am, because the system is designed to be transparent...to be blunt with you I think there's too much of: lets not let the customer know we're late because it might jeopardise our next order, rather let that customer know you're late and what you're doing about it to fix the problem so you're not late the next time so he's got confidence that your prepared to deal with the issue...but it's a shift, in terms of attitude."

Quality

Meaning of quality

1. Could you explain what quality means for the firm and its suppliers?

"Simple statement, I think quality is protecting the bottom line...its not just quality of product, its quality of every single system you've got in the company to make sure it works, that's what an integrated management system is all about"

"...you don't set a quality standard that you don't need, and you don't put in a system to keep your customer happy, you actually put in a system to make sure that you would produce what you said you would produce."

Quality Planning

2. How are quality requirements determined with suppliers?

“We define a specification for the product that we want or the material that we want delivered, plus the delivery criteria. So I regard it as a quality issue to provide me with that product with that specification within that timeframe. Some people do not seem to understand that quality is about the delivery as much as it is about the product, and I think that’s probably why that we as a country have a reputation of having things wrong...quality issues.”

3. Can you describe the type of relationship that exists with your suppliers?

“Good”

4. Would you say that the firm trusts its suppliers to deliver the required quality? How do you define trust?

“We monitor them; we’ve got a quality department that monitors them. Only our quality department can actually add a supplier onto our vendor list, not our supply department, so they have to approve them from a quality point of view before they can go onto the list, and we keep statistics on their performance, with regards to their quality and their delivery performance, and if they call foul, they will come off. In the first instance we will try to work out the problem...if they can’t sort it out we will take them off.”

“Trust is integrity of supply...they supplying a product at the right specifications at the right time...one of the failings of our local industry, is that industry doesn’t always report back to its customers when it’s going to be late, it’s a reactive process...trust is when one of our suppliers comes back to us before the due date and tells us he’s got an issue.”

Quality Control

5. How is poor quality controlled or prevented with suppliers?

“We would evaluate them. With (local) raw materials, the certificate is normally the guide, so it doesn’t normally happen. But otherwise we inspect the product and if we had an issue we would return it. To be frank with you we’ve been in business a long time and we haven’t had many quality problems with our suppliers, we’ve got a pretty good…supply chain and suppliers.”

6. What type of performance measures are used in controlling or preventing poor quality with suppliers?

“We keep statistics on their delivery performance, and also their quality standards, their specification.”

Quality Improvement

7. Can you explain how quality improvements are made in the long supply chain with suppliers?

“We actually don’t have suppliers who are involved in bespoke manufacturing on our behalf, so generally they’ve perfected their processes in the first instance. In the event that we would have a problem it would be a case of monitoring them statistically and raising non-conformances against them…and monitoring their progress to recover…”

Flexibility

Meaning of flexibility

1. Can you explain what flexibility means for the firm and its suppliers?

“Flexibility all comes from them being upfront with us, it comes back to what I was saying earlier, if they have an issue of whatever, whether it’s a timing issue or a quality issue, and they relay that information to us timeously, we can normally be flexible to a degree, to accommodate that situation within our own material planning. The wheels fall off when we only find out about it on the day that it was due.”

Achievement of flexibility

2. How is flexibility achieved with suppliers?

"By reaching out to the supplier before the delay and grabbing that information as well, but that's time consuming...so it's expediting and verification."

Other

Ways to improve competitiveness

1. Can you describe any other areas not examined in the questions above that may improve competitiveness for the firm and its suppliers?

"...payment, cash flow...we're almost unique in a country in the interest rates you pay...our suppliers are under considerable pressure from a cash flow point of view...and we're obviously seriously under pressure from a cash flow point of view...a common denominator in South African industry...our overseas suppliers don't appear to be under the same sort of pressure...that's another area that I would like to see the government getting involved..."

Applicable to customer-firm unit of analysis (applicable to all questions below)

Classify a maximum of 3 customers to the firm that fulfil the following criteria:

- The customer is geographically distant (i.e. on another continent) from the firm
- The customer must receive a part of strategic importance from the firm. What makes that part strategically important?

Table F3: Customer details for Firm B

Firm	Customer name	Strategic part sent to customer. Why?	Location
Firm B	Customer B1	Ground support equipment (service tooling) for a local aircraft. "We produce the parts, we send them to Sweden and they send them back here again Strategic for cost implications	Sweden
	Customer B2	Ground support equipment (service tooling) Strategic for cost implications	Sweden
	Customer B3	Ground support equipment (service tooling) "We export it to India..." Strategic for cost implications	UK

Speed

Better and timelier information

1. What type of information is shared between the firm and customers?

"Totally transparent, complete transparency...because of the strategic importance of our supply, because we're at the front end, we're making equipment that they need to manufacture, we're normally required to give them ongoing timing information and disclose to them any quality issues and technical issues that we would have..."

2. How is Information Technology used in communicating with customers?

"All of our communication is IT, so whether that's elementary stuff like email, to predetermined crafted reports which often is the case...we're actually setting up a portal now to give the customers access to, but at the moment its more direct communication...we have to press the send button, they can't collect from us yet."

Asking the interviewee about the collaborative exchange web-portal, an online standardised communications portal: "I see problems, I see problems in, if we're not careful we are going to create, a system that could become the job...I think it's one of the downsides of IT, your systems got to work for you, if you're not careful, you can overcomplicate it, and before you realise, the guys who are in there running it have lost sight of what you do, and they believe that the job is the system."

Lead time compression

3. How could the time between finished product in the firm and the delivery of the product to the customer be reduced?

"It's not an easy question to answer because you've got degrees of confidence within the customer base, does that make sense (*the interviewer shakes his head*). Figuratively, not literally, (a customer) may be very slick in getting their information together, but (another customer) may be sloppy...generally the common denominator is that we seem to have the European approach to manufacture, which means that we get on with it before we've got all our ducks in a row...we don't do enough upfront...that is the area that we need to focus on, getting our act together at the front end... the ones (customers) who are slick generally have their upfront information right."

The interviewer asks what leads into getting the upfront information right from the start: "Being methodical, honouring the process, completing the process, specification control..."

Synchronisation

4. *When* does the customer place a product order with the firm?

"When they've reviewed our quotation and have decided that they want to deal with it...to try and explain the point, the old procurement approach would be, we want multiple suppliers because we want security, if this supplier doesn't deliver we will go to this one. The modern approach is to reduce your supply base, and say we will actually develop this supplier to become strong, to become better, and to become more viable economically, and there's a lot of benefits to that approach...its an enlightened approach."

5. Could you tell me how the *quantity* of product ordered by customers is determined?

This is dependent on the customer.

6. Could you tell me about any delays that have occurred when sending finished goods to customers as a result of capacity problems?

"...labour issues, absenteeism...we're in one-off engineering, so we're only making it once, so if we've got projects that are on schedule, on schedule, on schedule in a twelve week cycle, and two minutes before a (turner? *Inaudible part of the recording*) is distracted, and it happens, we're suddenly twelve weeks late, yet we could have been reporting to the customer that this project is on time...you can't anticipate that."

Dependability

1. Can you tell me about the processes and procedures that are in place with customers to achieve on time reliable delivery of goods?

"Continuous monitoring, daily production meetings, follow ups...we're monitoring statistically our performance all the time, with regard to how many hours we are selling, we're converting obviously jobs into hours, we're monitoring how many hours we're booking, right to the physical job itself."

Quality

1. Could you explain what quality means for the firm and its customers?

“Like I said before, it means protecting the bottom line, but in the true sense of the word we recognise that if we don’t give our customer exactly what they want when they want it, we haven’t got a very good quality system, and if we don’t achieve that then our bottom line is in jeopardy. So it’s a financial issue. I think it’s very important to track quality and quality control back to rands and cents...because it is a rands and cents issue. I mean let’s be realistic; if you could make more money by producing rubbish, what do you think you would produce...Quality is not to give someone more than they are anticipating, is it, if you look at our mission statement, we give our customers exactly what they want, not more, not less.”

Quality Planning

2. How are quality requirements determined with customers?

As mentioned above, “...give the customer what they want.”

3. Can you describe the type of relationship that exists with your customers?

“I think relatively good.”

4. Would you say that the customer trusts the firm to deliver the required quality? How do you define trust?

“Yes, very much so, we’ve got a strong reputation of always getting it right. If we have a problem anywhere it’s on timing. And we’ve got a reputation of being of the better companies to do that, but it’s still one-off engineering and that’s the most difficult thing to get right.”

Quality Control

5. How is poor quality controlled or prevented with customers?

“Continuous monitoring, I mean we’re approved beforehand, so they wouldn’t give us the work if they thought we couldn’t do it.

And depending on what the product is, I mean, we will always do 100% quality control internally, some of our customers would be monitoring us through the process, and will in fact buy off the (*Inaudible part of the recording)*, some of our customers say that they are not going to do that anymore, we're responsible for making sure that they move the emphasis onto the functionality of the tool rather than the actual tool as such...the criteria becomes the actual functionality of the work that we do..."

6. What type of performance measures are used in controlling or preventing poor quality with customers?

"We breakdown the job in advance, and identify what quality steps need to be embedded into our manufacturing process. Some of them will require the tradesman himself to do the monitoring, some of them will require the product to be taken in process to our quality control department and have independent checks done, and in all cases we do a 100% check of the product before it's shipped. Within our system, only quality control can authorise the dispatch of a product, nobody else."

Quality Improvement

7. How are quality improvements made in the long supply chain with customers?

We've got a non-conformance system, so any non-conformance that we have, whether that's internal or external goes into the system, so that can be energised by picking up a fault here, or it can be energised by the customer picking up something. We then analyse it, determine what the remedial action is, what was the cause, what are we going to do to prevent it happening, we actually put a cost to it, and we actually statistically capture it, so we're monitoring whether we've had this sort of problem before."

Flexibility

Meaning of flexibility

1. Can you explain what flexibility means for the firm and its customers?

"Flexibility, as far as our customers is concerned, is when we do a good job of anticipating what our order intake is going to be

before we've got it, and being abreast and tuned in to their processes as they are attuned into ours...if we work as an island, where I do my bit and then you have to give me inputs and I don't talk to you, and when you give it to me and the wheels fall off...I can actually hold you accountable, but I haven't added value to the relationship, my relationship should be that I should be aware of what you are doing, continually monitoring you, talking to you and making sure you fully understand your input has an effect on me. If it means, and it depends on the size of the project, that I'm actually sitting in your review meetings as well, so that I'm actually making sure that I understand, then I'm allowing myself to be better positioned and flexible to accommodate you."

Achievement of flexibility

2. How is flexibility achieved with customers?

"In simple terms, relationships...that's the most difficult part by the way."

Other

Ways to improve competitiveness

1. Can you describe any other areas not examined in the questions above that may improve competitiveness for the firm and its customers?

"I think it's about the professional project manager...but I've got personal opinions about project managers, I think a lot of that...project management and relationship is the same thing, in my view, and I think we are going in the wrong direction when we have actually project managers who don't have people skills...so you've got to have project managers with people skills, who can actually develop relationships as well as monitoring..."

Appendix G

Appendix G contains transcriptions of the audio interviews with participant 3 and participant 4, participant 5 and participant 6 for Case C.

Case Study C

Interview with participant 3 and participant 4

The interviewee's are herein referred to as participant 3 and participant 4. The firm in the unit of analysis is herein referred to as Firm C, suppliers as supplier C1, C2 and C3 and customers as Customer C1 when required.

As per their request, the interview was conducted with both Participant 3 and Participant 4 at the same time. Participant 3 spoke most of the interview. Participant 4 put little input into the interview, possibly due to the interviewees hearing impairment and the fact that English is not the interviewee's first language.

The full interview was recorded.

General

Table G1: Details for Firm C

Firm	Total annual Sales (R)	No. of employ	Types of products	No. of Direct suppliers Local	Global	No. of direct customers Local	Global
Firm C	62 Million	30	Distribution of aircraft components; paints, materials utilised in the aircraft maintenance sector (e.g. carpets, aluminium cladding) and manufacture	0	Substantial due to nature of the distribution business. Cannot separate suppliers to overseas offices and local offices	"Numerous"	"Numerous", but focused geographically on Africa

Participant 3: "Obviously our dealing with the OEM's or tier 1 suppliers in South Africa...is predominantly on paints, but there are other products that are potentially viable as well...we are both in Cape Town and Johannesburg, Johannesburg being the distribution centre and the stockholding location. For the paints we also carry it here in Cape Town because we supply to other OEM's... in Strand. We then also have, since about 11 years ago

or thereabouts, an office in Toulouse, France...So a lot of it happens that we consolidate material in France and ship it out to us in South Africa, which helps in one respect, from a consolidation point of view...it's quite important that you bear in mind that we have an office in France, because it already helps quite a bit in the long supply chain."

Participant 3: "Cape town is administration."

Participant 3: "We're specifically in the aviation sector as far as aircraft parts and raw materials, and the paint."

Applicable to supplier-firm unit of analysis (applicable to all questions below)

Classify a maximum of 3 suppliers to the firm that fulfil the following criteria:

- The supplier is geographically distant (i.e. on another continent) from the firm
- The supplier must provide a part with strategic importance to the firm. Why makes that part strategically important?

Table G2: Supplier details for Firm C

Firm	Supplier name	Strategic part supplied to firm. Why?	Location
Firm C	Supplier C1	Paint "That represents about 20% of our annual turnover at the moment, and it's a product that we supply and stock…"	Germany
	Supplier C2	Filters "That's strategic because it's a very common replacement item during aircraft maintenance"	USA
	Supplier C3	Windshields for aircraft "Its an item that an aircraft could get grounded if a bird strikes it, so the urgency and access to stock is probably quite imperative to an airline"	France

Speed

Better and timelier information

1. What type of information is shared between the firm and suppliers?

Participant 3: "In many ways it's like a partnership, open two way channel."

Participant 4: “in our particular industry, as soon as we start dealing with people, companies which are milky, the opposite of being crystal-clear, that’s going to be problems. So the relationship that’s extremely important to achieve quality standards is crystal-clear relationship and high quality standards, so trust.”

2. How is Information Technology used in communicating with suppliers?

Participant 3: “Generally it’s...just through email and reports to them, vendor reports, on the activity in the marketplace that we catering for for their products”

Participant 3: Firm C uses specific software tailored for the aerospace industry for its distribution activities: “that plays quite a key role for us to draw information that they would want to know about the activity of the products. So we would be able to draw from there who we’ve quoted, how many times have we quoted, volume of potential sales, what sales we did get orders for, so in that way the primary information that they want to know. However between the paint manufacturer and us, that’s a little bit more detailed, because we share presentations with clients, and they come out on a yearly basis and we do a talk to the clients. Their feel of the market in Africa and South Africa in quite good, through our cooperation and our partnership.”

Lead time compression

3. How could the time between the ordering of materials from suppliers and delivery of these materials to the firm be reduced?

Participant 3: “There are a couple of aspects. The paint, we have to split them, they are two categories of product from a point of view of how it’s handled for transportation. The paints are classified as dangerous goods, you can’t just catch the first available flight and it will come out to Africa. There’s regulations, IATA regulations that it has to comply with, so that’s one part out of the three. The other two are more straightforward because they are not dangerous goods, they are just physical boxes containing the parts. Then from the problems that would arise or the delays for the paints would be the availability of space and the time required, because normally if

it's a large volume you've got to get it onto a freighter and book space effectively. Once it's on board its very quick. Once the regulatory requirements of the paints or parts are booked and on a plane then, then it's quite quick to get here. Then once it's here, then as Participant 4 mentioned, then customs is one of the delays. It depends how you ship it, so far I've talked about air freight, but then if the paints are brought in by sea freight, then the cycles are considerably longer. And it's not only getting it here, its waiting for a vessel that's coming...so for sea freight your planning, even though once its on route, its only 3 weeks to get from Europe to South Africa, but generally you've got to count for 6 weeks to 8 weeks, because of the dwell period in Europe before it can get onto a vessel...then obviously the offloading. You've also subject to delays because of the elements...there was a boat that arrived here that stayed out for nearly ten days, it couldn't come in because the winds were too high."

Synchronisation

4. How does the firm determine *when* orders are going to be placed with suppliers?

Participant 3: "For known projects, we try to establish from the customer a consumption forecast, then we obviously monitor what we have in stock, when it reaches a certain level we reorder bearing in mind their frequency of off take of that product. A good example is to utilise the paint and (local supplier). Typically a manufacturer that is drawing for production line requirements, so those are known products that they are using. They give me a forecast so I know what they expect to have and available in the country for their production. Then I've obviously got to plan for their forecast what I have in stock and obviously account for sea freight. For them I try to avoid air freight because it's significantly more costly."

5. Could you tell me how the *quantity* of material ordered from suppliers is determined?

Participant 3: "Then we would be ordering at least 3 months consumption, because bear in mind, we start here in month one, and I've just mentioned to you that it can take up to, between six and eight weeks for that shipment to arrive here. So the time the shipment physically arrives here, its already drawn two month's worth of stock, we've only got one month left (as a buffer)...the

problem we have here is that what they declare as the forecast, obviously they know that what they've got to produce 10 of those a month and they require X amount of paint a month, that's fine. But there will be reworks that have to happen on that part, and that means that the painting starts escalating from one month to the next, and it's caught us out a couple of times, where we've had to airfreight to accommodate that rework. But unfortunately, that's unforeseen and partly why sometimes keeping that one buffer month stock is not a bad idea. But sometimes it's too little."

6. Could you tell me about any delays in receiving materials as a result of supplier capacity problems?

Participant 3: "It does arise, when I order 10 kg's of paint from the manufacturer, generally that would be on the shelf. If I order 300 kg's of that same paint from the manufacturer then obviously the production time is a bit different. And that obviously in itself, knowing finitely how long to produce the longer batches is quite important to be aware of...it isn't a regular occurrence.

Dependability

Processes and procedures to ensure dependability

1. Can you tell me about the processes and procedures that are in place with suppliers to achieve on time reliable delivery of goods?

Participant 3: "Again, back to our software that we use, the purchase orders that are placed, there's a due date and when it's the due date most of these terms with these manufacturers are X works...X works means that it will be ready at their facility by that date. From there onwards we have to arrange freight forwarders to pick it up from them and do the transfer to South Africa. What we put on our purchase orders as being the due date then is only confirmed once we get their acknowledgement of the order which could be different...from a process point of view we have an understanding of what their standard lead times are, from there it's all stated on the purchase order unless otherwise advised by the manufacturer, which can happen."

Quality

Meaning of quality

1. Could you explain what quality means for the firm and its suppliers?

Participant 3: "Well A), we control our suppliers...we are ISO accredited and FAA AC 0056 accredited, which is more associated with distribution of aircraft parts...not only are suppliers controlled but we should have a mechanism of monitoring the requested delivery date versus the actual delivery date. Because that impacts on our quotation that we have done to the customer at the end of the day of the expected delivery date...from a quality point of view, beyond the supplier control and the lead time control, then obviously it's the product control."

Quality Planning

2. How are quality requirements determined with suppliers?

Participant 3: "Generally speaking there's prescribed specifications associated or standards associated with the product, or a defined part number for the product, as per the OEM."

3. Can you describe the type of relationship that exists with your suppliers?

Participant 3: "Bear in mind that with most suppliers you want to have a good relationship, you don't want to have a situation where you don't trust each other or you can't rely on each other. If you have that type of situation you will always demand payment upfront, or having to outlay cash, when at the end of the day, you have a good relationship, you can be able to get credit terms for a supplier, and then you also help yourself to have a positive cash flow. There's many aspects, but in a nutshell, it's a positive relationship."

Participant 4: "...its extremely important that you have a quality system to implement full traceability of the product that you're dealing with, because you need traceability of the product that you are dealing with, because you are need traceability for 10 years or more, so that's an extremely important factor."

4. Would you say that the firm trusts its suppliers to deliver the required quality? How do you define trust?

Participant 4: "Yeah, because we've got a...qualification system of each supplier, so obviously we've have to check, who they are, and we have to trust them, and then we follow up on the quality system on a monthly basis."

Quality Control

5. How is poor quality controlled or prevented with suppliers?

Participant 3: "So let's just say when you say poor quality it could just be a missing certificate associated with it, then there's a discrepancy reporting system through the software, and obviously through the monthly quality management system meetings that we have with full system and procedure to follow in the dealing of discrepancies."

Asking whether there's a difference between minor and major quality issues, Participant 4 replies: "The system is the same, be it minor or major, it doesn't move through."

6. What type of performance measures are used in controlling or preventing poor quality with suppliers?

Participant 3: "From a performance measure, obviously the quality side of the product is a performance measure in itself, that we do, and the way it's done is through whether its all compliant to what we need, versus not of good quality. So that's from a quality of product point of view, there's that in place, but there's not performance measure on the product and on the supplier from the point of view of delivery lead times required versus actual, there isn't that measure as yet." A problem arises in the measurement of delivery lead times as a result of freight consolidation of goods. Suppliers overseas who deliver goods to logistics hubs for freight are not measured on the required versus actual time taken for delivery to these hubs. This could be done, but would require the services of the freight or forwarding company. In addition, the components like customs, shipping, loading and unloading of goods that constitute the lead time are difficult by nature to measure individually. In general, this is all incorporated into an average overall lead time, be it for shipping or air freight.

Quality Improvement

7. Can you explain how quality improvements are made in the long supply chain with suppliers?

Participant 3: "I think...that specific feedback would be related more to the distributorships that we have, such as the paint and those other products. It wouldn't be a widespread feedback that we give to ad hoc suppliers that we use, non-distributorships. That kind of feedback would be given back to the manufacturers that we distribute for through the vendor reporting that I mentioned previously...then from a performance evaluation of product quality, that obviously, there is a control on the quality management system whereby if the supplier is not performing to a quality standard, in other words if the product is not performing up to a quality standard that we have set, for example if you have a discrepancy level relative to the items that you deliver has an error higher than three percent, then on an annualised basis we give them a report saying you've done x, y and z and these are the percentages associated with your monthly performance and quality of the product, and you should do corrective action."

Flexibility

Meaning of flexibility

1. Can you explain what flexibility means for the firm and its suppliers?

Participant 3: "Flexibility of payment terms are probably one of the key aspects. Flexibility in so far as them placing stock with us on consignment, also a key aspect, not that any of them do that, but hopefully they will." *The interviewer asks why suppliers do not place stock with suppliers on consignment.* "Some of the manufacturers don't feel that they have control over the material anymore once its somewhere else. But some items which are critical items for the operation of an airline, where generally speaking the aircraft is on the ground and has to be delivered as efficiently as possible. It's a good reflection on the product support of those OEM's if they can deliver in a couple of hours instead of a couple of days, so it's a huge perception as well...for the paint they would rather stay away from any consignment, they would rather increase our payment terms that we have with them, rather than putting stock on consignment. So that gives you the

flexibility to A) sell the product before you actually have to pay for it, so that's a give and take situation"

Achievement of flexibility

2. How is flexibility achieved with suppliers?

Payment terms as outlined above.

Other

Ways to improve competitiveness

1. Can you describe any other areas not examined in the questions above that may improve competitiveness for the firm and its suppliers?

Participant 3: "The one main thing is the freight costs are a huge impact to the bottom line price of a product. It doesn't matter what product it is. It's a big contributor to that price. And that in itself, unfortunately no one wants to pay for that freight, especially if they are buying it from a distributor, they expect it to be here the price you quoted is inclusive of everything, which is quite tough to control that…you're not going to get away from it."

Participant 3: "Obviously a lot of our overseas suppliers require payment in hard currency which you know, for itself in a South African company, the bank charges and costs associated to paying that hard currency, when you add it up to the number of suppliers that you have, it's a significant chunk of money, and the banks are not really interested in reducing those charges, which is quite a negative impact. Which unfortunately you don't always see those costs into your calculations that much…because you only realise when you have bank charges associated to foreign payments. But that's obviously applicable to everyone and anyone that imports."

Participant 4: "On the suppliers, there's not very much that can be done, except increasing volumes to get better price. All the rest is quite incompressible. I mean, the freight we can't do anything about it…the only thing that could be done is the volume…and consolidation…in South Africa we're stuck, there's nothing we can really touch on that…the thing that could be done

here is volume and consolidation. In other words, if we have all the South African manufacturers had an outlet in Europe consolidating things from that outlet…and you save on freight…"

Participant 3: "In itself, if you had to have consolidation in a different dynamic, where you're an importer, you're an importer, I'm an importer, and you have a centralised consolidation…where you put your stuff together with mine, already your volume goes up, transportation wise, and believe me, rates per kg come down quite considerably. So the volume is important…so also to try coordinate shipments out of New York to South Africa or out of Paris to South Africa, where we could share resources if we get everything together and reduce the freight cost…" *The interviewer asks whether this has been looked at* "No…there are all individual companies that are in the supply chain cycle that are there to make money. So the freight forwarder will consolidate for shipment yours and mine, but will charge you individual rates, you individual rates and me individual rates based on your size of shipment, where the consolidation will be a ton but yours is only 100kg, you're going to get the 100 kg rate…" *Participant 4:* The only option is to have one specific entity in which all the partners in AISI have got shares for instance, and that particular entity is just collecting freight from Miami, lets say, and getting this freight to Johannesburg…from Paris, Frankfurt, whatever, and it will be a pool of companies controlling this thing…not a forwarding agent…"

Applicable to customer-firm unit of analysis (applicable to all questions below)

Classify a maximum of 3 customers to the firm that fulfil the following criteria:

- The customer is geographically distant (i.e. on another continent) from the firm
- The customer must receive a part of strategic importance from the firm. What makes that part strategically important?

Table G3: Customer details for Firm C

Firm	Customer name	Strategic part sent to customer. Why?	Location
Firm C	Customer C1 "Any of the airlines that we deal with outside South Africa"	"The issues relating to one of them really lies with all of them" Supply to airlines or maintenance organisations, from paint, to aircraft hardware, to aircraft components Financial reasons	Senegal, Ethiopia, Mauritius

Participant 4: "We supply France from our stock, to our other outlets when we've got stock here that they want, then we supply them."

Speed

Better and timelier information

1. What type of information is shared between the firm and customers?

Participant 3: "Obviously from a sales point of view, that interaction is very important, once the sale has taken place the most important thing is to notify them about the shipping details so that they can track or traceability of the shipment."

2. How is Information Technology used in communicating with customers?

Participant 3: "Quotations are done on our software, order acknowledgement is done on software. And then shipping and order status...is done on software and electronically transmitted via email."

Lead time compression

3. How could the time between finished product in the firm and the delivery of the product to the customer be reduced?

Participant 3: "...the software itself is almost like a one entry point. So you do the quotation, then you get the customer order for lets just say all items on that quotation. From that quotation you do the requisition which is the order acknowledgement to the client so you don't have to retype anything. From there you can also place your order with your supplier overseas. From that you then do the receipt form from the material coming in from the supplier, and you do your delivery notes to the client and you do your invoice...so its all, the processes are quite a straight line. You don't have to repeat entry points which was the case previously." *Participant 4:* "...we have shrunk our complete cycle of receiving, delivering...the last thing we should do to save a bit of time is barcoding..."

Synchronisation

4. *When* does the customer place a product order with the firm?

Participant 3: "If our price is good...well sometimes its not just if our price is good, but a delivery condition may be good. It depends on their situation they find themselves in. If I've got a part...in stock and I'm in Johannesburg and the airline is in Johannesburg and the aircraft is grounded for that part then they will be prepared to pay double the price for what they could get it overseas to get the aircraft off the ground again. So there's many different dynamics..."

5. Could you tell me how the *quantity* of product ordered by customers is determined?

Participant 3: "They have their own prescribed quantities that they require which is obviously relative to their own stockholding, they carry min/maximum levels and the reorder process is on their side. We at times prescribe minimum order quantities or price break quantities which is then up to them to take it or not to take it...but they decide on quantities."

6. Could you tell me about any delays that have occurred when sending finished goods to customers as a result of capacity problems?

Participant 3: "Flight availabilities…customs"

Participant 4: "…most of the delays we cannot control, I mean like customs the other day…there's nothing that we can do. If it's the airline there's nothing that we can do…the weather, that's the normal delays that can't be controlled by us."

Participant 3: "Access to some clients is availability of flights between Johannesburg and the client. It isn't like out of Joburg that the airlines fly to each and every country. There are cases that pose a bit of a problem. I must admit it isn't like the biggest problem, but generally the delays that are incurred are outside our control…but at the end of the day it's also important to have a reliable freight forwarder to ensure that they push, you know what I mean…"

Dependability

1. Can you tell me about the processes and procedures that are in place with customers to achieve on time reliable delivery of goods?

Participant 3: "Procedures, per say, there are obviously written procedures, as to what, once material is dispatched out of the store for tracking, the airway bill, it is part of a written procedure. By tracking the airway bill you are basically expediting the process from freight forwarder to dispatch to material. In a way you are still reliant on the previous questions, remarks we gave you, availability of flight etc. all play a role which are aspects which are out of our control. But internally, from a quality point of view, there is processes to expedite the process…at the end of the day with any customer the idea if you give them the information they have the option to follow it up or leave it alone, but at least they know that something is coming their way and if there is a problem then they can come back and check…'

Quality

1. Could you explain what quality means for the firm and its customers?

Participant 3: "I think the whole process of A) having a quality system and supplying a quality product, that is one of the silent quality issues that they all like to see even though the problem comes always back to the same thing...they always like to gauge your quality by delivering your material on time, which sometimes with the elements of potential delays in the whole cycle is a little bit out of our control, but...the fact that everything we supply goes and arrives at their facility without discrepancies associated with product quality, that becomes invisible to the guy that is shouting and saying that you never deliver on time. So ill say that product quality is...very very important and key to continuing to do business with you. But the one that we always get hammered on and simply as a negative would be the delivery delay."

Quality Planning

2. How are quality requirements determined with customers?

Participant 4: "International aviation regulation..."

Participant 3: "But then there's customer specific...those (above) are regulatory requirements that are generally observed by manufacturers and OEM's. So those are by default part of what they need. But there are other criteria that each airline or each customer will have that isn't necessarily prescribed specifically, because obviously they but a broad scope of products. For example, if they buy paint, some of them will require that the product that you deliver have at least 80 percent of the shelf life remaining. That could be different from airline to airline...but then they do prescribe their own requirements on their purchase orders."

3. Can you describe the type of relationship that exists with your customers?

Participant 3: "A good one (*participants laughing*)...every customer, you know can be the best guy when you get them out of the shit, then tomorrow they couldn't care less...We have a pretty good relationship, again a clean cut relationship with them as far

as possible, though within the customer themselves there's always a lot of dynamics where a guys there today and shifted to another department and you start all over again. So the relationships with some customers are long standing."

Participant 4: "...it's extremely important to mention when talking about a relationship with a customer, that corruption is a big problem, because...corruption number one degrades quality standards which in aviation you can't afford..." "You could be continuously selling something to a client...over many years, and all of a sudden they could stop buying it just between an unclear relationship between that buyer and some other supplier, and you've got no control over that."

4. Would you say that the customer trusts the firm to deliver the required quality? How do you define trust?

Participant 3: "Ja...number one we have pretty much an open house policy in so far as they want to come and audit us, they're welcome to come and audit us by arrangement. So that's one of their main points. And then we're a distributor for product A, and that's an OEM product already prescribed in the aircraft manufacturer's manual, then you know that they have confidence in that OEM, and therefore if they have confidence in us and we delivering the right quality product at the right traceability then there's no problem in the link between the supplier and us...so its pretty transparent."

Quality Control

5. How is poor quality controlled or prevented with customers?

Participant 3: "So we have a customer complaint system in our QMS, quality management system, and we monitor that at monthly quality meetings, and obviously the action taken, some become formal, are major requirements that are required extensive investigation to track back what happened. If it is a scenario associated with the supplier then it's reported and announced to the supplier...But continuously the main point about those investigations is that the customer is continuously notifying what is happening so communication to and from the customer is very important. And has to be timeous as well...quick action."

6. What type of performance measures are used in controlling or preventing poor quality with customers?

Participant 3: "Again it's a measure of the number of customer complaints versus the number of line items delivered to the customer is the one measure. Then obviously we have very simple, to get responses, customer satisfaction questionnaire...so the one thing that important for you to realise is that the number of discrepancies...is that you don't want to have a high volume of customer complaints or rubbish being supplied to your customer. You'd rather be stopping that at the receiving point of the process. So the volume of discrepancies associated to deliveries from suppliers to us is significantly higher to what we then have to the customer and us. So the big volume is already controlled through the software."

Quality Improvement

7. How are quality improvements made in the long supply chain with customers?

Participant 3: "Again part of the customer complaint process in the form that is completed there is...so you'll open your customer complaint form, you investigate, you report back and you close that off, and at that point you have an option to create a preventative action request or a corrective action request which in itself will create improvements in the quality system."

Flexibility

Meaning of flexibility

1. Can you explain what flexibility means for the firm and its customers?

Participant 3: "One year payment (*interviewee's laughing*)...I think that's the one thing that you've got to understand about this aviation business in South Africa and Africa. It is extremely small. So if you compare yourself to our office in France which deals with the America's and Europe and North Africa...at the end of the day they've got a thousand customers, if that one doesn't behave himself you going to put the foot down and say PAY or we don't supply. In Africa on the other hand you've got 10, 15, 20 customers that are regular customers, and 50 percent

of them are reliable in payment, in all the criteria that are set out. But the other 50 percent, they pay now, they don't pay tomorrow, they not consistent. But then you've got a catch 22, you've got 30 customers, I can cut back down to 15 and make less volume, which means that if I've got 30 people here then I'd only need 10 people to deal with it. So you either going to shrink it to a proportion, what is the number of customers, or you are lenient, and you let these customers go a bit beyond their payment terms and accommodate that in your prices...it's a very complex dynamic in Africa, because of the market size..."

Achievement of flexibility

2. How is flexibility achieved with customers?

Payment terms, as above.

Other

Ways to improve competitiveness

1. Can you describe any other areas not examined in the questions above that may improve competitiveness for the firm and its customers?

Participant 3: "I think that one key aspect is that...in South Africa a habit exists that...one guy will start an activity and six months down the line somebody else will try to copy it. There isn't a drive to say that one specialist or two...is associated with doing X. and another specialist to doing Y. So there's always internal fighting to try and replicate someone else's activities. That's one side of it. The other side of it which is quite important is...within the AISI framework or idea it's good because we try to support one another as aviation related companies. But unfortunately outside that environment in the airline sector or the MRO sector the culture of trying to support local companies just isn't there. It's basically to the extent that yes there is a cost like we've discussed throughout this questionnaire to get it into the country, there is a cost of customs duty...and I've got to make money. But there's always a belief that no, I'm a local company and I can buy it in the USA at 10 percent or 15 percent cheaper. There isn't a culture to develop a supplier base locally and a support base where in the long term everyone would benefit...and you would develop the aerospace industry...but that is quite a difficult one."

Participant 4: “What is missing as well is…defining a code of conduct within the aerospace industry…in which companies and individuals could register themselves and some simple mechanism to avoid corruption…”

Interview with participant 5

The supplier interviewee is herein referred to as participant 5. The firm in the unit of analysis is herein referred to as Firm C, the supplier as Supplier C1.

The telephonic interview was conducted with one of Firm C's suppliers, Supplier C1. The interview was granted to the author provided a copy of the questions was emailed to participant 5 beforehand.

Participant 5 noted that he is not currently involved with Firm C's business, but has been in the past. The telephonic interview was not recorded and relies on the interviewer's memory and hand written notes. The German language barrier meant that certain questions had to be explained to the interviewee for him to understand the concepts.

General

Table G4: Supplier details for Firm C

Firm	Supplier name	Strategic part supplied to firm. Why?	Location
Firm C	Supplier C1	Paint	Germany

Applicable to supplier-firm unit of analysis (applicable to all questions below)

Speed

Better and timelier information

1. What type of information is shared between the firm and suppliers?

Supplier C1 has a "long relationship" with Firm C, and says it is a "pleasure" to work with them. A "lot of information" is shared

with Firm C. Rough order details like material types, delivery times, amounts, and costs are given. Monthly invoicing reports are also shared. If Supplier C1 has any new technologies or projects in the pipeline, these details are also shared with Firm C to allow them to tell their customers.

2. How is Information Technology used in communicating with suppliers?

“Phone”, “Email” and “Fax” is used when communicating with Firm C.

Lead time compression

3. How could the time between the ordering of materials from suppliers and delivery of these materials to the firm be reduced?

Firm C generally places orders in advance with Supplier C1, which allows for the timely shipping of goods. If goods are required to be transported quickly, air freight is used.

Synchronisation

4. How does the firm determine *when* orders are going to be placed with suppliers?

Firm C places orders on a “regular basis” with Supplier C1. Firm C also keeps material stocks at their premises. If an AOG or Aircraft on Ground occurs, Supplier C1 can also airfreight goods to Firm C within 48 hours.

5. Could you tell me how the *quantity* of material ordered from suppliers is determined?

The quantity of material ordered by Firm C is “fluid”, as the aerospace “market (is) not so regular.”

6. Could you tell me about any delays in receiving materials as a result of supplier capacity problems?

Shipping from Hamburg in Germany to Cape Town or Johannesburg may be late one or two days. Customs can also add

on delays. Firm C also keeps on hand stock if delays do occur. If required, airfreight can be arranged for quicker delivery.

Dependability

Processes and procedures to ensure dependability

1. Can you tell me about the processes and procedures that are in place with suppliers to achieve on time reliable delivery of goods?

There are no specific processes and procedures in place to achieve on time reliable delivery of goods. The process involves getting the order, defining the lead time required for that order, and then trying to meet the lead time.

Quality

Meaning of quality

1. Could you explain what quality means for the firm and its suppliers?

Quality is a “high demanded issue.” The interviewee says that although they are not the cheapest in the market, they are the best in product quality; and service and support quality, which are the “soft skills.”

Quality Planning

2. How are quality requirements determined with suppliers?

Quality specifications are set up by the OEM. Nearly all OEM’s, airlines and maintenance companies have their own specifications for quality.

3. Can you describe the type of relationship that exists with your suppliers?

It is “nearly a friendship” between Supplier C1 and Firm C, where Firm C is not thought of as a different company to Supplier C1.

4. Would you say that the firm trusts its suppliers to deliver the required quality? How do you define trust?

There is a “high level of trust” between Firm C and Supplier C1. Because of the distances involved, Firm C knows the market better than Supplier C1, and they have to trust Firm C. There is trust because they are “familiar with us.”

Quality Control

5. How is poor quality controlled or prevented with suppliers?

Firm C is familiar with all quality failures that can occur, and realise that problems can occur in the application of the paint by the customer, which is not a fault of the paint product itself. If serious quality problems do arise with product, the reclaim is sent to Supplier C1 in Germany.

6. What type of performance measures are used in controlling or preventing poor quality with suppliers?

No performance measures are in place.

Quality Improvement

7. Can you explain how quality improvements are made in the long supply chain with suppliers?

The interviewee says that the long supply chain is not that long, as South Africa is “only half around the world” from Germany. No quality improvements as such are made with Firm C. Care is always taken to make sure that the freshest material is going out to Firm C.

Flexibility

Meaning of flexibility

1. Can you explain what flexibility means for the firm and its suppliers?

A most important issue is to be flexible in the aerospace market, because the customer wants it yesterday.

Achievement of flexibility

2. How is flexibility achieved with suppliers?

Firm C has a mixing rack at its premises in South Africa, which allows it to mix certain paints together themselves for their customers.

Other

Ways to improve competitiveness

1. Can you describe any other areas not examined in the questions above that may improve competitiveness for the firm and its suppliers?

It is important to have a good guy in the field and a good managing director of a company as is the case with Firm C. A long lasting relationship exists between Supplier C1 and Firm C, and it is “important to know who is speaking on the other side of the relationship.”

Firm C reports their needs to Supplier C1, which is important as Supplier C1 is away from the South African market. Inputs from Firm C may be used for research into a new product line.

Interview with participant 6

The customer interviewee is herein referred to as participant 6. The firm in the unit of analysis is herein referred to as Firm C, the customer as Customer C1.

The telephonic interview was conducted with one of Firm C's customers, Customer C1. The interview was granted to the author provided a copy of the questions was emailed to participant 6 beforehand.

Participant 6 is currently involved in Firm C's business. The telephonic interview was not recorded and relies on the interviewer's memory and hand written notes.

General

Table G5: Supplier details for Firm C

Firm	Customer name	Strategic part sent to customer. Why?	Location
Firm C	Supplier C1	Aircraft spares	Mauritius

Speed

Better and timelier information

1. What type of information is shared between the firm and customers?

Spares part numbers, quantity of materials, and frequency of material usage

2. How is Information Technology used in communicating with customers?

"Telephone, fax, email"

Lead time compression

3. How could the time between finished product in the firm and the delivery of the product to the customer be reduced?

For fast moving items, Firm C is expected to keep safety items for Customer C1

Synchronisation

4. *When* does the customer place a product order with the firm?

A consignment contract exists between Firm C and Customer C1, which says Firm C must deliver with a reasonable price and a reasonable lead time. Stock must be available for Customer C1 at all times.

5. Could you tell me how the *quantity* of product ordered by customers is determined?

The quantity ordered by customers from Firm C is based on their requirements and safety stock held.

6. Could you tell me about any delays that have occurred when sending finished goods to customers as a result of capacity problems?

Firm C has not always delivered parts to Customer C1 within the lead time that they have mentioned. If some cases parts have been received on time, but documentation has not been sent.

Dependability

Processes and procedures to ensure dependability

1. Can you tell me about the processes and procedures that are in place with customers to achieve on time reliable delivery of goods?

A team at Customer C1 “chases” suppliers to make sure that they respect their promises.

Quality

Meaning of quality

1. Could you explain what quality means for the firm and its customers?

"Good product" and (*Inaudible part of conversation*)

Quality Planning

2. How are quality requirements determined with customers?

Quality tests are done regularly on incoming products from Firm C. Quality manuals need to be up to date. (*Inaudible part of conversation*)

3. Can you describe the type of relationship that exists with your customers?

Participant 6 has known Firm C for "some years." A "partnership" exists.

4. Would you say that the customer trusts the firm to deliver the required quality? How do you define trust?

Yes, "based on experience" Firm C knows what Customer C1 wants. Trust means that Customer C1 receives the part from Firm C in the way that they requested to have the part.

Quality Control

5. How is poor quality controlled or prevented with customers?

Parts from Firm C are inspected in the receiving section at Customer C1's premises. Parts of poor quality are returned to Firm C.

6. What type of performance measures are used in controlling or preventing poor quality with customers?

A vendor rating is assigned to Firm C by Customer C1, which looks at the lead time of parts being on time and not on time, and whether the invoice and certificate is sent with the materials.

Quality Improvement

7. How are quality improvements made in the long supply chain with customers?

Documentation must be up to date, and the certificate or copy of the certificate from the OEM must be sent to Customer C1. The certificate is very important.

Flexibility

Meaning of flexibility

1. Can you explain what flexibility means for the firm and its customers?

A “win-win” situation needs to exist between Firm C and Customer C1, where Firm C must better understand that both parties must do well.

Achievement of flexibility

2. How is flexibility achieved with customers?

Again, a “win-win” situation must occur, where Firm C must realise that Customer C1 should not pay for any mistakes that they’ve made.

Other

Ways to improve competitiveness

1. Can you describe any other areas not examined in the questions above that may improve competitiveness for the firm and its customers?

Firm C must review their profit margin on goods sold to Customer C1.

Appendix H

Appendix H contains transcriptions of the audio interviews with participant 7, participant 8, participant 9, participant 10, participant 11 and participant 12 for Case D.

Case Study D

Interview with participant 7

The interviewee is herein referred to as participant 7. The firm in the unit of analysis is herein referred to as Firm D, suppliers as supplier D1, D2 and D3 and customers as Customer D1, D2 and D3 when required.

The full interview was recorded.

General

Table H1: Details for Firm D

Firm	Total annual sales (R)	No. of employees	Types of products	Number of Direct suppliers		Number of direct Customers	
				Local	Global	Local	Global
Firm D	325 M	650	Interior and exterior aircraft components	5 suppliers making up 80%; 40 suppliers making up 90%; 200 total	6 suppliers making up 80%; 12 suppliers making up 90%; 150 total More global than local expenditure (60/40 split)	10	10

Applicable to supplier-firm unit of analysis (all questions below)

Classify a maximum of 3 suppliers to the firm that fulfil the following criteria:

- The supplier is geographically distant (i.e. on another continent) from the firm
- The supplier must provide a part with strategic importance to the firm. Why makes that part strategically important?

Table H2: Supplier details for Firm D

Firm	Supplier name	Strategic part supplied to firm. Why?	Location
Firm D	Supplier D1	Specialised materials "provide half of our total expenditure" on a specific supplier	USA
	Supplier D2	Precision formed sheet metal components "in terms of money expended"	UK
	Supplier D3	Aircraft components- Rod ends and fork ends "in terms of money expended"	France

Speed

Better and timelier information

1. What type of information is shared between the firm and suppliers?

"...all engineering, demand...supplier performance...we measure them on those two legs, delivery and quality, we have graphs which quality maintain on a monthly basis, and every quarter, those graphs are sent out to all of our top suppliers"

"...there is far more communication with our suppliers (then customers)...there is always follow ups to orders...we place orders very regularly for reasonably frequent deliveries, in terms of rescheduling, in terms of problems were having with suppliers...every month a report is sent to every single supplier looking 60 days ahead...to say that these are the deliveries that you owe us in the next 60 days, can you perform...there is an incredible amount of communication between ourselves and our suppliers...in terms of volume, which is greater than that with

(specific customers)...because it is much more frequent...we are following up on orders every single day...in terms of sheer frequency and volume...its not a good or a bad thing, it's the way the business works"

2. How is Information Technology used in communicating with suppliers?

A lot of the conversation here centres on the incorporation of local suppliers into the AISI and collaborative exchange web based portal.

"...you've...got C2C, or system to system, where our system talks to (their system), and those are mainly overseas companies."

"...the next step is to get the overseas suppliers into this system (AISI and collaborative exchange web based portal), but the overseas suppliers don't...want to take a step back...they've got their C2C, they want a system to system interface, they want their system to talk to our system through Collaborative Exchange,...at the moment were not quite there yet...but were taking baby steps with AISI."

Lead time compression

3. How could the time between the ordering of materials from suppliers and delivery of these materials to the firm be reduced?

"that varies enormously, there are some suppliers where you can basically order off the shelf, you place an order, they get it prepared and send it to the hub (logistics hub)...it may take 7 days, it may take 10 days, it may stay at the hub for two weeks because it has just missed the one shipment, and it waits for the next consolidated shipment... so it could be 3 to 4 weeks, if we really need it urgently and they've got it off the shelf we have it flown out straight away, it probably means a matter of 6 days, 7 days and we've got it here."

"On the other hand you've got certain components like for instance standards which are AGS or Aircraft General Spares, where there are shortages on the market as a whole, and some of those are 80 weeks...(you deal with these shortages) with a great deal of difficulty...there have been instances where we've been quoted a 32 week lead time, so we place an order for a 32 week

delivery, comes week 31...and our supplier phones up and says they've postponed it by another 2 months...so we've had some pretty interesting times with that kind of thing.... If all else fails we go to the OEM... (we say) we cannot get this stuff, can you supply us, generally between (specific customers) we find they generally keep reasonable stock of the long lead time stuff...or (a customer) will intervene with the supplier, and say you will supply Firm D, they (the supplier) then prioritise delivery and put Firm D at the top of the list...they (OEM's) have a lot of leverage with suppliers."

Synchronisation

4. How does the firm determine *when* orders are going to be placed with suppliers?

" ...built into the system...build in all of our lead times, our stock times, the full lead times, together with the actual shipment lead time which we take at the extreme...assume it missed a consolidation, so we err rather on the right side. Then the system comes up and tells us we need to place an order by a certain date...hoping that the lead time quoted to us is correct...generally it is, but you do get the odd one like standards (AGS)..."

5. Could you tell me how the *quantity* of material ordered from suppliers is determined?

"...we are moving over to a...EBQ based order, but it doesn't apply to all lines, because you've got minimum order quantities for instance, so your EBQ may be 12 but you can only order 70 as a minimum order...and then of course you've got price breaks...so if you want 5 it will cost you 5 dollars, if you want 100 it will cost you 90 cents...we apply our minds to which one we are going to purchase."

6. Could you tell me about any delays in receiving materials as a result of supplier capacity problems?

"Oh yeah, absolutely, oh yeah...it's not unusual in certain categories like...raw materials as one category, we've got details, which are like catalogue items...then you've got consumables, then you've got paints, then you've got adhesives, and the last one is electrical. So those are the 6 categories that we use to categorise...(in) raw materials generally speaking, we've had instances where the mills have broken down...you deal with it on

a one to one basis. Details we've had a lot of delays with certain suppliers who have not performed the way that they should, and we've applied whatever leverage we have to try get them perform...and sometimes on the rare occasion we've had to get the OEM involved.... With regard to consumables, generally not a problem, paints, adhesives, we've had a lot of delays with paints...as a result of capacity between the paint supplier and (OEM)...the paint supplier sends the raw material to (the OEM) even before they make the paint...afterwards a sample is sent to (the OEM) to check...then they can ship that batch to whoever ordered it... (This problem) they've overcome it. Adhesives, not really, electrical, not really..."

Dependability

Processes and procedures to ensure dependability

1. Can you tell me about the processes and procedures that are in place with suppliers to achieve on time reliable delivery of goods?

"...we've put a system in place where we place orders timeously, hopefully, unless we slip up on this side...they know the delivery date on the order is the date it exits the factory door...we have a 60 day report sent out to every supplier...(where the supplier will) please confirm it (the goods) will go out on time (from this report)...this is sent out every month, continually on a two month window...we generally pick up most issues on this 60 day report"

Quality

Meaning of quality

1. Could you explain what quality means for the firm and its suppliers?

"...quality means, to us, besides the fact that they deliver on time, which they deliver the right stuff to the right quality, and generally that is accompanied by test reports or certificates of conformance or whatever the case might be."

Quality Planning

2. How are quality requirements determined with suppliers?

"...when we go out to a supplier, these suppliers, most of them, are suppliers to (specific customers), and we will on our purchase orders generally state the standard or spec to which they must perform, in other words (the customer) has a specification, (the customer) has a number of different spec's they work to, on our purchase orders we say that you will deliver to that and that spec, and they then give us a certificate of conformance when they deliver to state that what we have received conforms to that specification."

3. Can you describe the type of relationship that exists with your suppliers?

"I think that the relationship that exists is arm's distance, for no other reason but that we are probably separated by ten to twenty thousand kilometres. So the relationship that we have with suppliers is not what we would like it to be, I mean obviously we would like to go and visit them, look in someone's eyes...it develops much more personal relationships, much better relationships on an eyeball to eyeball basis. But unfortunately we have to do it from a distance, we don't have too much of an option. Its arms length at best, but generally its pretty cordial, knowing that we do not have too much leverage of ourselves with the suppliers...to most of the big suppliers there we represent a fractional part of their turnover, 0,01% of their total turnover, so we don't have a lot of leverage in terms of that."

Asking if there is any way to improve these relationships besides face to face communication: "more professional communication, encouraging people to work better...using graphs". We like them (suppliers) to think that they're in partnership with us. "

4. Would you say that the firm trusts its suppliers to deliver the required quality? How do you define trust?

"Yes, because most of the suppliers have already been approved by the OEM's...of course there's no such thing as trust when you get to the aircraft industry, guys have got to perform to a certain standard, and you don't trust people to perform, you want documentation...you want to know that they are performing

within that standard, its not like buying a spare tyre, its something more substantial...you're trusted to perform to that standard, but you've got to have documented proof."

"...if you have a supplier that is continually not performing, then clearly your level of trust is going to go down..."

Quality Control

5. How is poor quality controlled or prevented with suppliers?

"(Quality) is picked up on inspection (at Firm D), we have a two level inspection...level 1 is a basic inspection...the right stuff...the right quantities...level 2 may require further testing..."

Asking about what happens when the box arrives at Firm D and its of poor quality: "Well immediately it goes into what we call grief, and its registered, and then the buyer takes it up with the particular supplier, and if necessary quality themselves get involved, in terms of a corrective action report, which goes out to the supplier to say that...we want a root cause and what you are doing about it..."

6. What type of performance measures are used in controlling or preventing poor quality with suppliers?

"...the quality and delivery report that goes out once a quarter...and a grief register, which is done on a daily basis, whatever arrives goes into a grief register...buyers take it up with the suppliers themselves...."

Quality Improvement

7. Can you explain how quality improvements are made in the long supply chain with suppliers?

"...most of the suppliers have been quality rated by the OEM's...quality is taken care of via the OEM's"

Flexibility

Meaning of flexibility

1. Can you explain what flexibility means for the firm and its suppliers?

“It means being able to change schedules, delivery schedules, or delivery quantities, or react to AOG’s, or Aircraft On Ground, which is the highest priority of requirement…”

Achievement of flexibility

2. How is flexibility achieved with suppliers?

“Generally just by mutual communication…that’s all we can do from this distance.”

Other

Ways to improve competitiveness

1. Can you describe any other areas not examined in the questions above that may improve competitiveness for the firm and its suppliers?

“I can’t think of anything off hand…we seem to have covered most…all of the aspects I can think of.”

Applicable to customer-firm unit of analysis (all questions below)

Classify a maximum of 3 customers to the firm that fulfil the following criteria:

- The customer is geographically distant (i.e. on another continent) from the firm
- The customer must receive a part of strategic importance from the firm. What makes that part strategically important?

Table H3: Customer details for Firm D

Firm	Customer name	Strategic part sent to customer. Why?	Location
Firm D	Customer D1	Sole supplier for interior panels for an OEM aircraft	America
	Customer D2	Avionic racks for an OEM aircraft	France
	Customer D3	Manufacture of the wingtip for an OEM aircraft	UK

Speed

Better and timelier information

1. What type of information is shared between the firm and customers?

"Almost everything from our systems, manufacturing capacity, resource capacity, financial aspects of the business, procedures and policies, more procedures than policies, ...so its basically everything...quality audits."

"...they look at our business right from the front end right to the back, they know probably as much about us as well know about ourselves."

2. How is Information Technology used in communicating with customers?

Planning and engineering done via 'Catia' database

"A lot of electronic interfacing, in terms of right from the very word go,...most of the orders we receive we receive via system

interfaces, such as the Customer D1 one is Exostar, systems like that."

"A lot of it is done electronically"

"Obliged to use" Exostar and Supairworld with Customer D1 and Customer D3 for purchase orders and Advanced Shipping Notices (ASN's).

"Basically the link is, I would say, highly technical, and formalised"

"There again it (IT) depends on which department you are talking about, quality department have got other means of gaining access, we (purchasing) have got, for instance access to Customer D1's site, in terms of that we pull off engineering drawings, we pull off RFP's, Request for Proposals, RFQ's, Request for Quotes, we respond on that, we download files"

"There is a variety of electronic interfaces"

Lead time compression

3. How could the time between finished product in the firm and the delivery of the product to the customer be reduced?

"Theoretically, theoretically we would like to operate as a just in time, in other words stuff arrives at the back door and that, but theory and practice are very very far removed from one another, but and as there are other facets of the whole thing that need to be taken into consideration, for instance, cost. We, order thousands of different lines from mainly the states and Europe, if we had to ship them out one by one, we would be paying an absolute fortune for freight. Freight is not cheap, air freight is not cheap, there is not a lot we can ship out ocean freight...lead times, it's the kind of product you don't put out on the sea, there's all sorts of dangers, product being affected by damp air, ...corrosion plays a big part, packaging plays a big part, and cash flow plays a big part...if you order something now that you are only going to receive in 6 weeks time, you've gotta pay in 30 days, so you actually paying for the product long before you receive it,...what we try and do is fly the stuff out because it is light, generally speaking aircraft stuff is light, except billets and sheet metals and stuff like that, but it still pays us to fly that

stuff out anyway, to a large extent but some of that does come by ocean”

“We consolidate shipments, so we’ve got hubs from our freight people, they’ve got hubs overseas,... what our suppliers do is they ship to these hubs, ... well once every fortnight or once a week or depends on just where it is they will consolidate shipments and send that entire shipment out to us...that is cost effective, but not lead time effective. There is always a balancing act to be made between cost and lead time”

“I would probably say 96/97% of everything we use in the aerospace industry in South Africa is imported, for the simple reason that there is no one in Africa who is product or process qualified to produce aircraft quality products...so the result is we have no option but to import stuff.”

“In the aircraft industry the general rule is that everything on the aircraft should be traceable back to origin”

Synchronisation

4. *When* does the customer place a product order with the firm?

Based on the number of manufacturing days that Firm D has available, customers are required to place purchase orders within this lead time

5. Could you tell me how the *quantity* of product ordered by customers is determined?

“...they work to a schedule...you can only produce so many aircraft per month”

“...they send us a schedule, for the most part, of what they will be requiring sometime ahead, and then we feed it into our systems here, as a demand, and that pulls through to the bill of materials and to the demand and to the MRP...and enables us to place an order timeously”

“We generally know from past experience that we’ve got stable contracts...we know what we producing every month...it’s a drumbeat”

6. Could you tell me about any delays that have occurred when sending finished goods to customers as a result of capacity problems?

“We’ve had some (internal) bottlenecks in the process...that at this point we have overcome”

“Where we do get bottlenecks now is as a result of shortages...on the supply side,... what you find on the supply side is that you are short of certain things, so you build up work in process because cant finish it, so then all of a sudden the stuff comes in and now you’ve got thousands of these things to be painted so now you’ve got a bottleneck...again. It’s something that has to be managed”

It’s a result of various things. It’s a result of inaccurate inventory counts, it’s a result of buyers just slipping up, it’s a result of incorrect min/max’s for instance, it’s a result in changes in schedule...from customers changes,...sometimes the times too little for changes, but they’re the customer”

Dependability

Processes and procedures to ensure dependability

1. Can you tell me about the processes and procedures that are in place with customers to achieve on time reliable delivery of goods?

“We’ve got...processes and procedures, we’ve got it for all of these (showing processes and procedures on the computer screen),...these are processes and procedures for every aspect of the business,...in purchasing,...where it goes to, when it goes to, all your notes,... it describes the activities along this path ”

We’ve got procedures in all parts of the business, that’s part of the requirements of Customer D1 and Customer D3...they want to see that you’ve got it documented, and not only documented,...you must show them, not tell them.”

Quality

Meaning of quality

1. Could you explain what quality means for the firm and its customers?

“Quality means delivering the right goods, at the right time, in the right quantities, to an acceptable quality”

“It’s a broad focus, it covers every aspect...that affects the end product”

From the *quality policy document*, quality means:

a. Customer focus
b. Business
c. Resource
d. Assurance of commitment by all employees

Quality Planning

2. How are quality requirements determined with customers?

“Two things, delivery and quality...now when I say quality obviously Customer D1 has a requirement for 99,7% conformance...with regard to delivery...in general terms we are allowed 5 days early and...2 days late,...in general there is a window”

The main reasons for being late are “a combination of...late deliveries from the supplier, for whatever reason, and probably just production planning.”

3. Can you describe the type of relationship that exists with your customers?

“An extremely good relationship, we work extremely well...we have our ups and downs, we have our fistfights with them...overall our relationships are Customer D1 are very good,... and with Customer D3 good”

4. Would you say that the customer trusts the firm to deliver the required quality? How do you define trust?

“Their trust is earned… in the beginning…Customer D1 had their own inspectors here, where they would inspect the final product themselves, and they would stamp it off and say alright this is ok…they got confident that we could do it ourselves and have issued the authority to stamp off the final product and so on,…they got to get confidence in you, and also measured very much by quality,…if we had to send quality to Customer D1 of 80%, trust me they would have inspectors here within a week.”

With regards to whether the product is inspected that side (overseas), “No, once you have the authority…they can take it straight out the packing and put it straight on the aircraft.”

Quality Control

5. How is poor quality controlled or prevented with customers?

“The minute it happens we get an NCR or non conformance report, talking specifically about Customer D1 …they tell us that they have received a particular part number and…for one or other reason we found a non conformance…we investigate it from this side and find out what the situation is, we do a 5 why and try get down to the root cause and address the root cause, very often it involves redoing WIP or redoing finished products,…call it out of stores.”

6. What type of performance measures are used in controlling or preventing poor quality with customers?

“We have shop floor data collection,…which is captured to a very large extent now,…captures hours worked, scrap rates, all of that kind of thing.”

Quality Improvement

7. How are quality improvements made in the long supply chain with customers?

“Quality improvements basically come…from the OEM”, where changes for example may be made in materials used by Firm D to make the OEM’s end product…“that improvement comes from them, we just produce to plan…they give us the tools, their tools, and we produce it, that’s it.”

Flexibility

Meaning of flexibility

1. Can you explain what flexibility means for the firm and its customers?

"...the only flexibility in terms of Customer D1 and Customer D3 is really a flexibility with regard to adapting the changes that they want, and it could be in terms of materials, it could be in terms of design...the initiative is not in our camp, the initiative is in the OEM's camp."

"...the flexibility that you are talking about is really the production flexibility, not design flexibility, when can we get the tool produced (to make a new part or required change for the OEM)...how long will it take us to produce the first article...and then we go backwards and say that we can produce the first article in 86 M (Manufacturing) days...they place an order for a tool and then for how many components they want."

Achievement of flexibility

2. How is flexibility achieved with customers?

"Flexibility for seats and galleys is an internal programme, the design office needs to be extremely flexible, as we are the design authority for the galleys and seats, so being the design authority we can change our design according to what the customer wants...according to certain specifications...to that spec...and test it."

Other

Ways to improve competitiveness

1. Can you describe any other areas not examined in the questions above that may improve competitiveness for the firm and its customers?

"No...we've covered communication, we've covered production, we've covered quality...sometimes the only issue we have is extremely short lead times from the customer", where the customer will ask for a change from the current 50 manufacturing

days it takes to produce a part to 40 manufacturing days, and this has to be done "...if you want to continue business...and that's the kind of flexibility you talking about now...you gotta jump, sometimes we getting supplies in, expediting them which costs you more money which you cannot pass onto the customer."

Interview with participant 8

The interviewee is herein referred to as participant 8. The firm in the unit of analysis is herein referred to as Firm D, suppliers as supplier D3, D4 and D5 and customers as Customer D1, D2 and D3 when required.

Participant 8 was unfamiliar with the dependability and quality competitive dimension questions on the customer-firm unit of analysis side, as participant 8 is more involved on the supplier side. These questions have either been left out by participant 8 or have brief answers. The full interview was recorded.

General

Applicable to supplier-firm unit of analysis (all questions below)

Classify a maximum of 3 suppliers to the firm that fulfil the following criteria:

- The supplier is geographically distant (i.e. on another continent) from the firm
- The supplier must provide a part with strategic importance to the firm. Why makes that part strategically important?

Table H4: Supplier details for Firm D

Firm	Supplier name	Strategic part supplied to firm. Why?	Location
Firm D	Supplier D3	Rod ends and fork ends. Sole manufacturer for these parts, and Firm D cannot deliver product to OEM's unless they have these parts	France
	Supplier D4	AGS (Aircraft General Spares). Bolts, washers. Stockists for Firm D, Service Level Agreements (SLA's) in place that have reduced lead time	UK, but administration done in Germany
	Supplier D5	Sheets and billets. Customer D3 negotiates consolidated product quantities and prices with raw material mills. Supplier D5 supplies material to Firm D based on Customer D3's negotiated amounts and prices	France

Speed

Better and timelier information

1. What type of information is shared between the firm and suppliers?

On Firm D's side to their suppliers: Combit agreement as published by Customer D3, forecasts and conditions of purchasing

On suppliers to Firm D: Prices and lead times

As a process, Customer D3 asks for Firm D's consumption for products, together with inventory stock levels. An allocation letter is then presented, together with a work package number. This number is quoted to Supplier D5, which allows Supplier D5 to then go directly to the mill and receive billets and material (aluminium) directly with Customer D3's agreement in place at the agreed rates.

Supplier D4, at their request, introduced weekly telecoms with Firm D to enhance communication, there being "no specific reason".

2. How is Information Technology used in communicating with suppliers?

MRP internal system, output of MRP is manipulated and sent to suppliers as an excel spreadsheet.

AISI shared portal closest to EDI, electronic order sent to suppliers, when it is opened they have acknowledged that they have seen the order. This portal is not really used anymore as staff in the company who ran it have left the country.

Future state of communication with suppliers may be EDI with some, another type with others. But not all suppliers will be willing to participate in electronic communications.

Lead time compression

3. How could the time between the ordering of materials from suppliers and delivery of these materials to the firm be reduced?

"(Time) can only be reduced if they become stockists for us"

Supplier D4 is a stockist, had lead times of 210 days, and now reduced to 28 days. This was achieved by giving forecasts, establishing SLA's with them.

Supplier D5 (160 days to 98 days) not holding stock, need to place orders in advance. They won't manufacture and keep stock

for Firm D. Therefore Firm D needs to plan their production in advance.

Airfreight and ocean freight play an important part in lead times (together with cost).

Synchronisation

4. How does the firm determine *when* orders are going to be placed with suppliers?

This is done according to the MRP system, which takes into account customer demand, stock levels and lead times. The system prompts the user when reordering of materials is required. The reason for MRP was a “drive to reduce inventory”. MRP implementation was completed late last year (2008), so results have not been seen yet.

5. Could you tell me how the *quantity* of material ordered from suppliers is determined?

Quantities are based on Economic Batch Quantities (EBQ’s) from the MRP system, accounting for customer demand and current stock levels. This is calculated monthly and monthly orders are placed with suppliers. Accumulated shipping times (around 40 days) are factored into the ordering process.

6. Could you tell me about any delays in receiving materials as a result of supplier capacity problems?

Supplier capacity problems have been experienced in Firm D not receiving enough material from suppliers. In a Customer D2 project, Firm D had problems receiving materials from suppliers. To sort out this problem, they contacted Customer D2 who then contacted Customer D3, as Customer D2 supplies Customer D3. Firm D cannot speak to Customer D3 directly; they have to speak to Customer D2. Either Customer D2 or Customer D3 contacted the supplier and material supply resumed to Firm D shortly afterwards.

Dependability

Processes and procedures to ensure dependability

1. Can you tell me about the processes and procedures that are in place with suppliers to achieve on time reliable delivery of goods?

Similar to the quality process, where we measure performance in terms of quality and delivery conformance

Supplier performance feedback done quarterly and suppliers are given the "opportunity, basically, to raise their opinion on that"

Quality

Meaning of quality

1. Could you explain what quality means for the firm and its suppliers?

Quality can be broken down into two segments, the first being documentation. Documentation consists of the certificate of conformance (CFC), which looks at the composition of materials and "confirmation that certain materials conform to specification"), invoices, etc. Secondly, physical characteristics look at things like material size, dimensions and shelf life (80% of shelf life) for sealants, paints.

Quality Planning

2. How are quality requirements determined with suppliers?

A list of quality criteria exists, e.g. burn test results, certificates. "A long list of quality criteria".

3. Can you describe the type of relationship that exists with your suppliers?

"We've got tough suppliers, we've got tough customers"

"Give them what they need so they can deliver a good service to us", in terms of forecasts, performance feedback,

“We don’t always have the opportunity to visit them”, but some of them have been here.

“There’s no generic statement” as relationships are different.

In general, good suppliers, but suppliers have been terminated as they have not conformed to specifications.

“One of the barriers we’ve got is language”, especially French suppliers. “Identified a certain supplier that is quite clued up” in France as a middleman, they liaise with French suppliers on our behalf, “it’s made quite a huge difference in the supply chain”.

4. Would you say that the firm trusts its suppliers to deliver the required quality? How do you define trust?

“Depending on the commodity”

If the product is an, AGS, we not going to check every bolt, but metal sheets supplied by Supplier D5 are checked by Firm D. Trust in a sense is specified by the customer.

Quality Control

5. How is poor quality controlled or prevented with suppliers?

Non-conformance results in a “grieve process”, given to the buyer who needs to solve the problem. In certain cases the supplier quality person gets involved, depending on the seriousness of the problem, resulting in a corrective action report being sent to the supplier for completion, asking for what their corrective action will be.

6. What type of performance measures are used in controlling or preventing poor quality with suppliers?

Performance feedback to suppliers for quality and late/early delivery criteria.

Quality Improvement

7. Can you explain how quality improvements are made in the long supply chain with suppliers?

Performance feedback and grieves, non conformance reports, quality guys talking to suppliers.

Flexibility

Meaning of flexibility

1. Can you explain what flexibility means for the firm and its suppliers?

“(Flexibility) means a lot to me, but not so much to suppliers”

An example is Supplier D3, where Firm D saw that a beneficial change in the ordering process between the companies could be made. But Firm D was not interested in this change. But other suppliers are willing to accommodate changes.

“Flexibility is a matter of perception”

It depends on the suppliers, there is “no generic statement for all suppliers” that explains flexibility.

Achievement of flexibility

2. How is flexibility achieved with suppliers?

In the case of Supplier D5, “quite difficult”, “it is not possible to convince them”
“It is a matter of communication”.

Other

Ways to improve competitiveness

1. Can you describe any other areas not examined in the questions above that may improve competitiveness for the firm and its suppliers?

“Establish SLA’s between ourselves and them (suppliers)”. This is done with the top ten suppliers “in terms of the value that we spend” and “strategic value that they add to our supply chain” to go into contract with them. “But even then we have to really struggle to get the agreement signed”, possibly because “we make

up such a small percentage of their turnover", but "I really don't know".

"They see the order as relevant and as a contract, but if you move one step forward, in terms of, to be more advanced, to move to the next level, they are very reluctant, they have a lot of stories."

Supplier audits, which have not been touched on, involve sending a questionnaire to overseas suppliers.

Supplier approval, "theres a process to deal with that", is done by Customer D3.

Applicable to customer-firm unit of analysis (all questions below)

Classify a maximum of 3 customers to the firm that fulfil the following criteria:

- The customer is geographically distant (i.e. on another continent) from the firm
- The customer must receive a part of strategic importance from the firm. What makes that part strategically important?

Table H5: Customer details for Firm D

Firm	Customer name	Strategic part sent to customer. Why?	Location
Firm D	Customer D1	Sole supplier for certain interior panels for an OEM aircraft	America
	Customer D2	Avionic racks for an OEM aircraft	France
	Customer D3	Manufacture of the wingtip for an OEM aircraft	UK

Speed

Better and timelier information

1. What type of information is shared between the firm and customers?

Demand from Firm D's side to Customer D3

"From their (Customer D3) side, non conformances, they come and do regular audits on us,contracts on us, weekly telecoms".

2. How is Information Technology used in communicating with customers?

"Some form of EDI where we receive orders from customers like Customer D1"

Lead time compression

3. How could the time between finished product in the firm and the delivery of the product to the customer be reduced?

This can be done by improving internal capacity at Firm D.

Synchronisation

4. *When* does the customer place a product order with the firm?

"No generic statement"

Normally, 6 orders for 6 months, then a forecast for up to 12 months, same as that done at Firm D.

5. Could you tell me how the *quantity* of product ordered by customers is determined?

Quantity of product ordered is established within the forecasts.

6. Could you tell me about any delays that have occurred when sending finished goods to customers as a result of capacity problems?

“Customer D1 strike last year...we had to take a knock.” “Now they are back on track... suddenly we are late”.
Firm D can’t really do anything, “they are the client, we are quite small... insignificant”

Dependability

Processes and procedures to ensure dependability

1. Can you tell me about the processes and procedures that are in place with customers to achieve on time reliable delivery of goods?

Not really involved in outbound deliveries

Quality

Meaning of quality

1. Could you explain what quality means for the firm and its customers?

Inspectors, standards, “part of the quality plan”

Quality Planning

2. How are quality requirements determined with customers?

“(Determined) by their (customers) specifications”

3. Can you describe the type of relationship that exists with your customers?

“Good communication levels”, but a negative type tone is detected

4. Would you say that the customer trusts the firm to deliver the required quality? How do you define trust?

Talk to quality controllers

Quality Control

5. How is poor quality controlled or prevented with customers?

Talk to quality controllers

6. What type of performance measures are used in controlling or preventing poor quality with customers?

Talk to quality controllers

Quality Improvement

7. How are quality improvements made in the long supply chain with customers?

Talk to quality controllers

Flexibility

Meaning of flexibility

1. Can you explain what flexibility means for the firm and its customers?

“Flexibility means that if they (Customer D1) go on strike, we need to cater for that, and also then if they...resolve their strike, to then suddenly be able to cater for their backlog”

“In my mind we are far more flexible than our suppliers”, as if customers change their demand, Firm D will manage, but suppliers are reluctant to change for Firm D.

“Some are more accommodating like Supplier D4, but then you have Supplier D3.”

Achievement of flexibility

2. How is flexibility achieved with customers?

“It’s a mindset”

“It’s the culture of the company” determine how they handle it.

Supplier D3’s supply chain manager is not willing to accommodate changes as they have booked far in advance, its difficult to reschedule.

Other

Ways to improve competitiveness

1. Can you describe any other areas not examined in the questions above that may improve competitiveness for the firm and its customers?

The crux of improving competitiveness lies in accurate forecasts and SLA’s with suppliers and customers.

Interview with participant 9

The interviewee is herein referred to as participant 9. The firm in the unit of analysis is herein referred to as Firm D. Participant 9 did not identify suppliers or customers for the units of analysis, as the participant is primarily involved in the Firm D's internal operations. For this reason, the majority of questions have not been answered.

The full interview was recorded.

General

Applicable to supplier-firm unit of analysis (all questions below)

Classify a maximum of 3 suppliers to the firm that fulfil the following criteria:

- The supplier is geographically distant (i.e. on another continent) from the firm
- The supplier must provide a part with strategic importance to the firm. Why makes that part strategically important?

Table H6: Supplier details for Firm D

Firm	Supplier name	Strategic part supplied to firm. Why?	Location

Speed

Better and timelier information

1. What type of information is shared between the firm and suppliers?

"...my responsibility is to see that stock codes are loaded onto the system, that the stock has bin allocation...where I can find it, in which condition I can store it, things like that"

The following topics were then discussed between the author and Participant 9: Internal inventory management practices; cycle counting; FIFO of raw materials; warehousing of materials; inventory measurement problems; incorrect material usage; redundant stock policies and procedures, problems in production planning, floor stock and material cell replenishment, shop floor data collection.

2. How is Information Technology used in communicating with suppliers?

Lead time compression

3. How could the time between the ordering of materials from suppliers and delivery of these materials to the firm be reduced?

Synchronisation

4. How does the firm determine *when* orders are going to be placed with suppliers?

5. Could you tell me how the *quantity* of material ordered from suppliers is determined?

6. Could you tell me about any delays in receiving materials as a result of supplier capacity problems?

Dependability

Processes and procedures to ensure dependability

1. Can you tell me about the processes and procedures that are in place with suppliers to achieve on time reliable delivery of goods?

Quality

Meaning of quality

1. Could you explain what quality means for the firm and its suppliers?

"...a lot of our problems is because of stock that we receive and there's no certificate of conformance...we cannot accept that because we need a tracking lot number for them...a grief is then raised, people are notified...very very time consuming."

"...we don't have that much interaction with the customer and the supplier..."

Explaining how goods' receiving is complicated "...they have to go and look at the supplier database to see if that particular item that we have now bought from supplier X is really approved...if its not on the list we cannot approve it."

"The one thing that I can tell you that I think should be done on the procurement side but is now basically done in receiving...is the checking of the approved suppliers and to see whatever is bought is approved with regards to that supplier, that should actually be a check with procurement", "...that takes time..."

The problem lies in that even though suppliers are approved, it is only approval for a specific part from this supplier. Sometimes a part is received by an approved supplier, but this specific part itself is not approved. "...so it can get a bit messy..." "I think that before a buyer places an order from whatever supplier they must make sure, not on receiving..."

Quality Planning

2. How are quality requirements determined with suppliers?

3. Can you describe the type of relationship that exists with your suppliers?

4. Would you say that the firm trusts its suppliers to deliver the required quality? How do you define trust?

Quality Control

5. How is poor quality controlled or prevented with suppliers?

6. What type of performance measures are used in controlling or preventing poor quality with suppliers?

Quality Improvement

7. Can you explain how quality improvements are made in the long supply chain with suppliers?

Flexibility

Meaning of flexibility

1. Can you explain what flexibility means for the firm and its suppliers?

Achievement of flexibility

2. How is flexibility achieved with suppliers?

Other

Ways to improve competitiveness

1. Can you describe any other areas not examined in the questions above that may improve competitiveness for the firm and its suppliers?

Applicable to customer-firm unit of analysis (all questions below)

Classify a maximum of 3 customers to the firm that fulfil the following criteria:

- The customer is geographically distant (i.e. on another continent) from the firm
- The customer must receive a part of strategic importance from the firm. What makes that part strategically important?

Table H7: Customer details for Firm D

Firm	Customer name	Strategic part sent to customer. Why?	Location

Speed

Better and timelier information

1. What type of information is shared between the firm and customers?
2. How is Information Technology used in communicating with customers?

Lead time compression

3. How could the time between finished product in the firm and the delivery of the product to the customer be reduced?

Synchronisation

4. *When* does the customer place a product order with the firm?

5. Could you tell me how the *quantity* of product ordered by customers is determined?

6. Could you tell me about any delays that have occurred when sending finished goods to customers as a result of capacity problems?

Dependability

Processes and procedures to ensure dependability

1. Can you tell me about the processes and procedures that are in place with customers to achieve on time reliable delivery of goods?

Quality

Meaning of quality

1. Could you explain what quality means for the firm and its customers?

Quality Planning

2. How are quality requirements determined with customers?

3. Can you describe the type of relationship that exists with your customers?

4. Would you say that the customer trusts the firm to deliver the required quality? How do you define trust?

Quality Control

5. How is poor quality controlled or prevented with customers?

6. What type of performance measures are used in controlling or preventing poor quality with customers?

Quality Improvement

7. How are quality improvements made in the long supply chain with customers?

Flexibility

Meaning of flexibility

1. Can you explain what flexibility means for the firm and its customers?

Achievement of flexibility

2. How is flexibility achieved with customers?

Other

Ways to improve competitiveness

1. Can you describe any other areas not examined in the questions above that may improve competitiveness for the firm and its customers?

Interview with participant 10

The interviewee is herein referred to as participant 10. The firm in the unit of analysis is herein referred to as Firm D and suppliers as supplier D2, D3 and D4. Suppliers identified by participant 10 are a combination of those identified by participant 7 and participant 8, as per the research methodology. A number of questions on the supplier-firm unit of analysis side have been left unanswered, as they are not applicable to participant 10. Participant 10 is not involved on the customer side of Firm D, and these questions have been left unanswered.

The full interview was recorded.

General

Applicable to supplier-firm unit of analysis (all questions below)

Classify a maximum of 3 suppliers to the firm that fulfil the following criteria:

- The supplier is geographically distant (i.e. on another continent) from the firm
- The supplier must provide a part with strategic importance to the firm. Why makes that part strategically important?

Table H8: Supplier details for Firm D

Firm	Supplier name	Strategic part supplied to firm. Why?	Location
Firm D	Supplier D2	Precision formed sheet metal components "in terms of money expended"	UK
	Supplier D3	Rod ends and fork ends. Strategic "in future, from what I've heard, we haven't ordered a lot of stuff from them...but in future"	France
	Supplier D4	AGS (Aircraft General Spares). Bolts, washers.	UK, but administration done in Germany

Speed

Better and timelier information

1. What type of information is shared between the firm and suppliers?

"...from my (quality) perspective...quality performance, with regard to product received, documentation."

2. How is Information Technology used in communicating with suppliers?

"At the moment we are just using emails, normal emails."

Lead time compression

3. How could the time between the ordering of materials from suppliers and delivery of these materials to the firm be reduced?

"...if they are strategic to us you will give them a forecast, so obviously whenever you need they will stock (just half, your stuff?) for maybe twelve months, then that's the only

way...whatever time you request stuff its gonna be there, but if they are not strategic...they don't contribute a big percentage to your production for them it not...that's the problem we are having currently with a lot of suppliers, we are buying bits and pieces from different suppliers, whenever you need something, then you have to wait for the normal period for the lead time, but if your strategic you contribute maybe 10 to 15 percent of the profit then obviously they will regard you as an important...customer "

Synchronisation

4. How does the firm determine *when* orders are going to be placed with suppliers?

5. Could you tell me how the *quantity* of material ordered from suppliers is determined?

6. Could you tell me about any delays in receiving materials as a result of supplier capacity problems?

Dependability

Processes and procedures to ensure dependability

1. Can you tell me about the processes and procedures that are in place with suppliers to achieve on time reliable delivery of goods?

Quality

Meaning of quality

1. Could you explain what quality means for the firm and its suppliers?

Delivering a conforming product with the correct quality with all completed correct relevant documentation

Quality Planning

2. How are quality requirements determined with suppliers?

3. Can you describe the type of relationship that exists with your suppliers?

The relationship is “easy”

Asking whether there have been any issues “...we’ve had quality issues, Supplier D3 we’ve got issues...ok with Supplier D2 it was product quality...product I’m referring to raw material, it can be finished goods...with Supplier D3 it was documentation in the beginning. But currently no, we are not having serious problems with Supplier D3. Other than that with suppliers like Supplier D3, there’s a problem because now they are still a mediator, they’re still buying from somebody else, that’s where the bigger problem comes with Firm D, most of the guys we’re buying from they are vendors or distributors, so we might place an order on them, they will place an order on somebody else...so that when stuff arrives at Firm D, and you have a problem, you still have to solve the things going back through the chain...so for example we bought from a vendor here in South Africa, just a distributor here, doesn’t touch the product, doesn’t do anything to the product, and he bought from another distributor...for example in the UK, and that guy in the UK bought from another manufacturer in the UK, and if you have a problem you still have to follow that...*Asking how you solve this*...what happens in most cases is that we try...and get the intermediate supplier, come in, we do a little bit of training with them to say ok, these are the things you need to look out for, before you...push the product to Firm D. But sometimes they do, sometimes they don’t.”

Asking how quality problems are sorted out for a global supplier “...Supplier D3 sends a representative in...and we go through whatever problems we having with her and she goes back...and speak to all other distributors that are under her”

Asking whether representatives from global suppliers come to Firm D to sort out quality problems “...not a lot, but on the purchasing side they do come...local guys yes, but international, not a lot”

4. Would you say that the firm trusts its suppliers to deliver the required quality? How do you define trust?

Quality Control

5. How is poor quality controlled or prevented with suppliers?

(If poor quality arises) “you have to go back to the supplier with a quality notification to say your documentation is not correct...it does not conform to our quality requirements...it will depend on what issues, sometimes they have to replace, sometimes we have to scrap the product here, and they have to send replacements...”

“...documentation is easy, but when we are talking about quality of product and stuff like that it takes a little bit longer. Cause if your shipment has arrives and you are going to scrap what ever you got then you still got to wait for a couple of weeks, that’s where the problem is.”

6. What type of performance measures are used in controlling or preventing poor quality with suppliers?

“...wrong quality, shelf life, (sufficient?) documentation, wrong quantity, identification and traceability, packaging problems, wrong product, damaged product and warranty...”

“...we send a supplier quality notification, plus a corrective action report, where applicable...”

Quality Improvement

7. Can you explain how quality improvements are made in the long supply chain with suppliers?

Flexibility

Meaning of flexibility

1. Can you explain what flexibility means for the firm and its suppliers?

Achievement of flexibility

2. How is flexibility achieved with suppliers?

Other

Ways to improve competitiveness

1. Can you describe any other areas not examined in the questions above that may improve competitiveness for the firm and its suppliers?

"...the longer the supply chain...if you got a distributor in South Africa, whose buying from a distributor overseas, and whose buying from the manufacturer...so obviously you have a long supply chain, then when you have a problem, you still have to go through the same route, and if somebody in-between there is not cooperating its going to impact your production...and we had a similar situation previously...*asking how the problem was sorted out*...we ended up involving management..."

Applicable to customer-firm unit of analysis (all questions below)

Classify a maximum of 3 customers to the firm that fulfil the following criteria:

- The customer is geographically distant (i.e. on another continent) from the firm
- The customer must receive a part of strategic importance from the firm. What makes that part strategically important?

Table H9: Customer details for Firm D

Firm	Customer name	Strategic part sent to customer. Why?	Location

Speed

Better and timelier information

1. What type of information is shared between the firm and customers?

2. How is Information Technology used in communicating with customers?

Lead time compression

3. How could the time between finished product in the firm and the delivery of the product to the customer be reduced?

Synchronisation

4. *When* does the customer place a product order with the firm?

5. Could you tell me how the *quantity* of product ordered by customers is determined?

6. Could you tell me about any delays that have occurred when sending finished goods to customers as a result of capacity problems?

Dependability

Processes and procedures to ensure dependability

1. Can you tell me about the processes and procedures that are in place with customers to achieve on time reliable delivery of goods?

Quality

Meaning of quality

1. Could you explain what quality means for the firm and its customers?

Quality Planning

2. How are quality requirements determined with customers?

3. Can you describe the type of relationship that exists with your customers?

4. Would you say that the customer trusts the firm to deliver the required quality? How do you define trust?

Quality Control

5. How is poor quality controlled or prevented with customers?

6. What type of performance measures are used in controlling or preventing poor quality with customers?

Quality Improvement

7. How are quality improvements made in the long supply chain with customers?

Flexibility

Meaning of flexibility

1. Can you explain what flexibility means for the firm and its customers?

Achievement of flexibility

2. How is flexibility achieved with customers?

Other

Ways to improve competitiveness

1. Can you describe any other areas not examined in the questions above that may improve competitiveness for the firm and its customers?

Interview with participant 11

The supplier interviewee is herein referred to as participant 11. The firm in the unit of analysis is herein referred to as Firm D. The supplier is referred to as supplier D1. The telephonic interview was not recorded and relies on the interviewer's memory and hand written notes.

General

Table H10: Supplier details for Firm D

Firm	Supplier name	Strategic part supplied to firm. Why?	Location
Firm D	Supplier D1	Specialised materials	USA

Speed

Better and timelier information

1. What type of information is shared between the firm and suppliers?

A long term agreement is in place between Firm D and Supplier D1. Firm D sends an annual consumption forecast to Supplier D1 based on customers needs. Quarterly orders are then placed with Supplier D1.

2. How is Information Technology used in communicating with suppliers?

Email is used to place orders with Supplier D1 through Firm D's purchasing agent.

Lead time compression

3. How could the time between the ordering of materials from suppliers and delivery of these materials to the firm be reduced?

Supplier D1 produces a quarterly run of materials all at once for Firm D. The material from these quarterly runs is released based on Firm D's actual orders to Supplier D1, eliminating the time taken for production each time. This allows Supplier D1 to achieve efficiencies of scale by manufacture of the whole batch at once.

Synchronisation

4. How does the firm determine *when* orders are going to be placed with suppliers?

Firm D places an order 60 days in advance of the quarterly production with Supplier D1.

5. Could you tell me how the *quantity* of material ordered from suppliers is determined?

A long term agreement is in place between Supplier D1 and Firm D, to ensure "security of supply." Quantity is determined by quarterly order amounts plus a possible 25% increase above that amount.

6. Could you tell me about any delays in receiving materials as a result of supplier capacity problems?

The biggest delays are due to the high levels of testing of materials involved in the aerospace industry. Some OEM's also get involved in the testing process.

Dependability

Processes and procedures to ensure dependability

1. Can you tell me about the processes and procedures that are in place with suppliers to achieve on time reliable delivery of goods?

A change to quarterly production runs allows for “flux” in the system, where spikes in demand can be covered by “backfill” of orders.

Quality

Meaning of quality

1. Could you explain what quality means for the firm and its suppliers?

Quality means “meeting the specifications for the product we supply.” Quality is detailed, with little room for variance.

Quality Planning

2. How are quality requirements determined with suppliers?

The initial part or component specifications are very stringent, with OEM’s highly involved in determining these specifications. Once specifications are determined, manufacturing processes are kept standard. “Partnership models” are highly important when setting quality requirements.

3. Can you describe the type of relationship that exists with your suppliers?

A “buy-sell relationship” exists with Supplier D1. Firm D sends its forecast to Supplier D1, and Supplier D1 manufactures the product for them.

4. Would you say that the firm trusts its suppliers to deliver the required quality? How do you define trust?

Supplier D1 and Firm D work closely together with one another, and have met before. A level of trust exists, where any variations are identified and communicated between the two companies. An “open line of communication” exists.

Quality Control

5. How is poor quality controlled or prevented with suppliers?

Internal quality systems at Supplier D1; ISO 9000; internal checks and balances done with QC department at Supplier D1; customer complaints are fed into the QC system at Supplier D1.

6. What type of performance measures are used in controlling or preventing poor quality with suppliers?

The number one measure used is ISOTIF, which means “In Spec, On Time, In Full”

Quality Improvement

7. Can you explain how quality improvements are made in the long supply chain with suppliers?

“Any quality changes originate from trust”, as identified earlier. Two methods exist when trying to improve quality:

- From interaction with the customer, where Supplier D1 checks that their product yields are at the same level with Firm D, and if any changes could be made to benefit the customer.
- From internal systems, where the ISOTIF measure plays an important part.

Flexibility

Meaning of flexibility

1. Can you explain what flexibility means for the firm and its suppliers?

“Limited flexibility in product quality” exists in the aerospace industry. The number one thing for flexibility is “visibility” into the OEM’s demand. If a problem occurs at the OEM, material fluctuations down the supply chain occur as a result of poor communication down the supply chain.

Achievement of flexibility

2. How is flexibility achieved with suppliers?

A quarterly forecast from Firm D together with Supplier D1’s ability to produce 25% more material above that forecast helps to

achieve flexibility. Firm D does not have great visibility into the OEM's demand, which leads to "fluctuation in demand for our product."

Other

Ways to improve competitiveness

1. Can you describe any other areas not examined in the questions above that may improve competitiveness for the firm and its suppliers?

Communication is important throughout the supply chain, and visibility is extremely important.

Interview with participant 12

The customer interviewee is herein referred to as participant 12. The firm in the unit of analysis is herein referred to as Firm D. The customer is referred to as customer D1. The interviewee has not worked directly with Firm D for 3 years, but still has working knowledge of the relationship. The telephonic interview was not recorded and relies on the interviewer's memory and hand written notes.

General

Table H11: Customer details for Firm D

Firm	Supplier name	Strategic part supplied to firm. Why?	Location
Firm D	Customer D1	Sole supplier for certain interior panels for an OEM aircraft	Seattle, USA

Speed

Better and timelier information

1. What type of information is shared between the firm and customers?

"A lot of information" is shared with Firm D, in the form of production planning information; manufacturing and engineering information; and performance feedback information. Production planning may include projected delivery information, purchase order information and a forecast for the next 12-18 months outlining what Firm D must deliver to Customer D1. Manufacturing and engineering includes everything relating to engineering, as well as the provision of technical assistance to Firm D if required. Performance feedback information includes quality and delivery information.

2. How is Information Technology used in communicating with customers?

Daily communication is done “old-school”, through the use of phone calls and emails. Data placement is done on the web through the use of online information exchange portals, where both parties can securely connect and get data. Commercial applications are also used for communication.

Lead time compression

3. How could the time between the ordering of materials from customers and delivery of these materials to the customers be reduced?

Firm D absorbs a large deal of risk in the relationship with Customer D1. Because Customer D1 does not want to stock inventory, constant JIT delivery is required to Customer D1’s premises in the USA. To ensure that Firm D meets Customer D1’s stringent lead time requirements for JIT delivery, Firm D is required to keep large on-hand stock of material.

Synchronisation

4. How does the firm determine *when* orders are going to be placed with customers?

An ERP system is used to create a master schedule, which dictates when orders are to be placed with Firm D.

5. Could you tell me how the *quantity* of material ordered from customers is determined?

Production requirements are triggered from the shop floor, which is a minimum order which is very small. Shopfloor production requirements together with the ERP system feed into a 12-18 month demand forecast for Firm D.

6. Could you tell me about any delays in receiving materials as a result of firm capacity problems?

Firm D does a very good job in mitigating delays, a primary reason being “they are willing to hold stock for us.” Delays may result in parts having to be scrapped upon arrival at Customer D1, and Firm D having to redo the work. Parts may get lost in

transit, especially at Amsterdam airport. The logistics provider plays an important part in preventing delays in delivery to Customer D1.

Dependability

Processes and procedures to ensure dependability

1. Can you tell me about the processes and procedures that are in place with the firm to achieve on time reliable delivery of goods?

Customer D1 has a “process and procedure for everything” that Firm D has to comply with. These may include “shipping terms” and “on-dock” requirements. Weekly, if not bi-weekly discussions are held with Firm D to ensure that processes and procedures are followed. A “small window” for early and late deliveries of product from Firm D to Customer D1 exists, which is only getting smaller over time.

Quality

Meaning of quality

1. Could you explain what quality means for the firm and its customers?

Quality is one of the “highest priorities”. With Customer D1 undergoing tremendous stock turns of product, Firm D needs to achieve 100 percent quality and 100 percent on time delivery. Customer D1 uses the “carrot and stick approach” in achieving quality, where a financial reward is given for required and above quality levels, and penalties are imposed for poor quality levels.

Quality Planning

2. How are quality requirements determined with customers?

Quality goals are determined with suppliers based individually on what is required. Firm D needs to deliver 100 percent on time quality levels, but at the very least 99 or 98 percent on time quality. Quality and delivery is watched over time to see whether trends develop.

3. Can you describe the type of relationship that exists with your customers?

A “very good relationship” currently exists between Customer D1 and Firm D. Initially the relationship started off on rocky ground. Extreme logistical challenges as a result of the long supply chain proved difficult. Over time the relationship has improved, and the interviewee has said that they “enjoyed working with Firm D” in the past. Suppliers are “judged on the basis of merit”, meaning that a good relationship depends on a suppliers performance according to a set of stipulated criteria.

4. Would you say that the customer trusts the firm to deliver the required quality? How do you define trust?

“Customer D1 does” trust Firm D, where this trust is based on historical performance. Trust has an “expectation” to it, where because Firm D has historically met Customer D1’s requirements, they will maintain doing so in the relationship.

Quality Control

5. How is poor quality controlled or prevented with the firm?

A “multilayered approach” is taken to quality control. Firstly, when parts come into Customer D1, quality is monitored to see whether it is a once off quality issue or a trend exists. Customer D1 documents the problem, and a root-cause analysis is performed by Firm D with inputs from Customer D1 to find the source of the problem. Secondly, if this does not correct the quality issue or it is a recurring problem, Customer D1 field personnel are sent to Firm D to determine where the problem lies.

6. What type of performance measures are used in controlling or preventing poor quality with the firm?

Again, a “multilayered approach” is taken in measuring performance. Both monthly and quarterly feedback is done, as well as a yearly “production readiness review,” where Customer D1 personnel audit Firm D’s facilities on site.

Quality Improvement

7. Can you explain how quality improvements are made in the long supply chain with the firm?

Quality improvements made are dependent on which supplier it is, and goes back to the relationship that exists between Customer D1 and its suppliers. Some suppliers, like Firm D, have a great desire to improve. But otherwise quality improvements are made when required.

Flexibility

Meaning of flexibility

1. Can you explain what flexibility means for the firm and its customers?

"There's not much flexibility" between Customer D1 and Firm D in meeting delivery and quality criteria, as the programme that Firm D supplies for is highly constrained. For other suppliers for other programmes there is "greater flexibility because the (delivery) rate is slower."

Achievement of flexibility

2. How is flexibility achieved with the firm?

Not asked.

Other

Ways to improve competitiveness

1. Can you describe any other areas not examined in the questions above that may improve competitiveness for the firm and its customers?

Improving competitiveness is more of an "issue of marketing than performance." Because of South Africa's geographic location, the country is at a disadvantage because the world does not know what we do. "Active marketing" is required to get the word out on what South African aerospace does.

Some parts that Firm D supplies can be obtained far quicker from suppliers in the USA, and are not that complex. For South African aerospace to succeed, we need to be “offering a certain service and technology” to differentiate ourselves and make us stand out. Constant innovation in the future is required to be included in new aerospace programmes.

Appendix I

Appendix I contains transcriptions of the audio interviews with participant 13, participant 14 and participant 15 for Case E.

Case Study E

Interview with participant 13

The interviewee is herein referred to as participant 13. The firm in the unit of analysis is herein referred to as Firm E, supplier as Supplier E1 and customers as Customer E1.

The full interview was recorded.

General

Table I1: Firm E details

Firm	Total annual Sales (R)	No. of employees	Types of products	Number of Direct suppliers		Number of direct customers	
				Local	Global	Local	Global
Firm E	12-15 M	46	Aerospace products: seat rails, wingtips, UAV's.	30-40	2-3 irregularly, "very limited"	10	1

Applicable to supplier-firm unit of analysis (all questions below)

2. Classify a maximum of 3 suppliers to the firm that fulfil the following criteria:

    - The supplier is geographically distant (i.e. on another continent) from the firm
    - The supplier must provide a part with strategic importance to the firm. Why makes that part strategically important?

Table I2: Supplier details for Firm E

Supplier name	Strategic part supplied to firm. Why?	Location
Supplier E1	"All my aerospace materials…from pre-preg materials…raw materials…everything"	South Africa

Speed

Better and timelier information

1. What type of information is shared between the firm and suppliers?

"…down to detail level…what we are making, why we are making it…Supplier E1 forms a big part of product development…The customer will come to us and say this is the requirements…and (Supplier E1) will be sitting in on the meeting so we can sort out what materials we need."

2. How is Information Technology used in communicating with suppliers?

"Email, telephone, that kind of thing…basic (*Inaudible part of the recording*) forms of communication."

Lead time compression

3. How could the time between the ordering of materials from suppliers and delivery of these materials to the firm be reduced?

"…we don't have problems with stockists… (*Inaudible part of the recording*)…for example my pre-preg, I need to keep a fair amount of stock in my freezer to be able to actually…it's a six week manufacturing lead time plus another four weeks for delivery and stuff. So I've got to plan at least 3 months ahead. Between us and Supplier E1 we need to keep at least three months worth of stock. So I generally…Supplier E1 is quite kind

to me, I keep a months worth of stock in my...(freezer? *Inaudible part of the recording*)...otherwise my production literally stands still. Generally the other products is not as bad, we can generally fly it in quite quickly. The pre-preg's are particularly bad because the supplier overseas manufacture the material for us specifically, we're their only customer for this kind of material. So it was developed for us..."

Synchronisation

4. How does the firm determine *when* orders are going to be placed with suppliers?

"We (can do? *Inaudible part of the recording)* forecasts, where I need three rolls of pre-preg every month, so based on current production. If I need to ramp up or ramp down production then I let Supplier E1 know that in three months time I'm going to need more."

5. Could you tell me how the *quantity* of material ordered from suppliers is determined?

"...for pre-preg and stuff like that I've got a Bill of Materials for each product I make, then for the next three months this is my forecast for production...then I normally add between 10 and 15 percent for scrap rate...I also take a look at my scrap rate, if my scrap rate is high then I generally order more material..."

6. Could you tell me about any delays in receiving materials as a result of supplier capacity problems?

"Right now...pre-preg, there was some issue with the lead times before they could actually start producing the pre-preg for me, and then it takes a while to actually receive that material, so I'm only getting my material on the 23rd of April. I officially ran out of material last week. So what I have to do is I have to buy (other brand) material which is a bit of a schlep because it's not qualified product. So everything I'm doing with (other brand) material I'm doing with full qualification on the product..."

Asking what the reasons were for the regular pre-preg material delays "It was just a manufacturing delay, that was the (peoples? *Inaudible part of the recording)* response."

“We’ve been thinking of bringing in materials ourselves...but we decided it’s not worth all the schlep of shipping...we know squat about bringing things into the country, that’s what Supplier E1 is good at, we pay them their fee.”

Dependability

Processes and procedures to ensure dependability

1. Can you tell me about the processes and procedures that are in place with suppliers to achieve on time reliable delivery of goods?

“Basically...the forecasts are sufficient.”

Quality

Meaning of quality

1. Could you explain what quality means for the firm and its suppliers?

The interviewee is slightly confused about what this question means, asking whether it means material quality product quality. The interviewer explains that quality can encompass a large number of things, and that the question is looking for how the interviewee interprets quality “Straight from material quality, to my product quality, to my service quality to the customer, if you don’t have a combination of that you (don’t have quality?).”

Quality Planning

2. How are quality requirements determined with suppliers?

“We ask...for the manufacturers CFC for every product that comes here...*the interviewer asks if CFC means conformance certificate*...ja, so we don’t actually accept the product that doesn’t have that. Then we do a critical inspection of everything that’s coming in, we have an incoming inspection...”

3. Can you describe the type of relationship that exists with your suppliers?

“...a good working relationship...we rarely have issues.”

4. Would you say that the firm trusts its suppliers to deliver the required quality? How do you define trust?

"Ja...our trust is with (a specific person from Supplier E1), he knows our requirements, he knows how critical or not critical a bill of materials is to us and to the success of the project, to the business as a whole, so he understands that... (*Inaudible part of the recording).*"

Quality Control

5. How is poor quality controlled or prevented with suppliers?

"If it fails incoming inspection our buyers are on the phone to Supplier E1, they either send it back with our driver or they pick it up and either replace the roll or refund us whatever the case may be."

6. What type of performance measures are used in controlling or preventing poor quality with suppliers?

"Nothing at this stage of the game. We are in the process of implementing the whole ISO thing, so we are busy with it but nothing at this stage of the game..."

Quality Improvement

7. Can you explain how quality improvements are made in the long supply chain with suppliers?

"No, we've never really had to make improvements...except about a year ago we started importing...(*Inaudible part of recording*). That was more because guys like... (companies)...required certificates of conformances with batch numbers of materials, then it was easier to have a certificate of conformance from a supplier."

Flexibility

Meaning of flexibility

1. Can you explain what flexibility means for the firm and its suppliers?

“Flexibility is key in this industry...what I like about our relationship with Supplier E1 is we can chop and change and go mad with our orders with the way they deliver, with everything. At any given time they don’t moan...because I might have orders for the next six months... (*Inaudible part of recording*)...to complete a new product, although the forecast was for the old product. So now we deal with it and try and stop any orders that are in the system...”

Achievement of flexibility

2. How is flexibility achieved with suppliers?

“Generally a very good relationship with (Specific person from Supplier E1)...they understand this industry probably better than anybody else...they’ve been in the industry for a long time and (Specific person from Supplier E1)... also been there for a while now and they understand that the industry isn’t a constant injection moulding or... (*Inaudible part of recording*)...parts.”

Other

Ways to improve competitiveness

1. Can you describe any other areas not examined in the questions above that may improve competitiveness for the firm and its suppliers?

“I haven’t really thought in that direction at all...generally we...(*Inaudible part of recording*) on price...generally that’s a euro rands type of thing, so no, I haven’t really thought in that direction.”

Applicable to customer-firm unit of analysis (all questions below)

Classify a maximum of 3 customers to the firm that fulfil the following criteria:

- The customer is geographically distant (i.e. on another continent) from the firm

- The customer must receive a part of strategic importance from the firm. What makes that part strategically important?

Table I3: Customer details for Firm E

Customer name	Strategic part sent to customer. Why?	Location
Customer E1	UAV, "with landing gear, with everything, we build the complete structure, we just don't do the electronics" The UAV allows the exploration of other markets besides South Africa	Saudi Arabia

Speed

Better and timelier information

1. What type of information is shared between the firm and customers?

"Because they are paying for the design they have full access to what the design is, all that kind of stuff. We don't hold any information back from them."

2. How is Information Technology used in communicating with customers?

"There's an FTP site that we load everything on to, email and that FTP site…"

Lead time compression

3. How could the time between finished product in the firm and the delivery of the product to the customer be reduced?

"We haven't had problems with that yet. The guys that we use…they were blooming efficient. We really just packaged the

thing, dropped it off at their warehouse, and basically I think it was at the customer in 3 days…"

Synchronisation

4. *When* does the customer place a product order with the firm?

The ordering of the product was done through another South African company, who originally started the project but later pulled out and left it to Firm E.

5. Could you tell me how the *quantity* of product ordered by customers is determined?

"Depends on the customer, at the moment its development work, so its three or four things."

6. Could you tell me about any delays that have occurred when sending finished goods to customers as a result of capacity problems?

Not with the long supply chain customer, as very little has been sent to them.

Dependability

Processes and procedures to ensure dependability

1. Can you tell me about the processes and procedures that are in place with customers to achieve on time reliable delivery of goods?

"Basically I send a spreadsheet or project plan or whatever…"

Quality

Meaning of quality

1. Could you explain what quality means for the firm and its customers?

Talking about local customers: "Very important because my customers can't sell an inferior product..."

Talking about global customers: "We haven't had any specific requirements from them...because it's a development thing we are kind of writing the requirements as we go...I don't quite think they know what they want yet so that's why they are not making any requirements, well lets see what the first one looks like, this is the benchmark, where do we want to go from here."

Quality Planning

2. How are quality requirements determined with customers?

Asking whether the determination of quality requirements with overseas customers is still a work in progress: "With them, yes. With existing (local) customers...we generally have quality requirements on each product."

3. Can you describe the type of relationship that exists with your customers?

"In general, very good."

4. Would you say that the customer trusts the firm to deliver the required quality? How do you define trust?

"Ja. There's been a couple of issues on delivery times. But they keep on coming back to us."

Quality Control

5. How is poor quality controlled or prevented with customers?

This question was not asked, as the products are still in development stage and there are no specific requirements yet in place.

6. What type of performance measures are used in controlling or preventing poor quality with customers?

"Not really"

Asking what sort of performance measures would be put in place: "...do we deliver on time in the right quantities..."

Quality Improvement

7. How are quality improvements made in the long supply chain with customers?

"Not really"

Flexibility

Meaning of flexibility

3. Can you explain what flexibility means for the firm and its customers?

"...it is key because customers are constantly changing requirements, for example, the Saudi thing has changed so often that it's actually scary..."

Achievement of flexibility

4. How is flexibility achieved with customers?

Inaudible part of recording

Other

Ways to improve competitiveness

2. Can you describe any other areas not examined in the questions above that may improve competitiveness for the firm and its customers?

"I think we can all just work towards delivering, really delivering on time, and one thing, communication..."

Interview with participant 14

The supplier interviewee is herein referred to as participant 14. The firm in the unit of analysis is herein referred to as Firm E. The supplier is referred to as supplier E1.

The interview was recorded.

General

Table I4: Supplier details for Firm E

Firm	Supplier name	Strategic part supplied to firm. Why?	Location
Firm E	Supplier E1	Aerospace materials	South Africa

Speed

Better and timelier information

1. What type of information is shared between the firm and suppliers?

"Just about everything, if they've got projects that may become a reality they will speak to us about cost effective technologies that could be employed in it so I need to know that the project was there in the first place, um, they are potentially even showing me drawings of what the components that they are looking at making are like, bounce some ides around...obviously to us its to our advantage to make sure that they are successful on the project, if they get a project and fail, we don't get (sales? *Inaudible part of the recording*)...so we do a lot of technical support on the project."

2. How is Information Technology used in communicating with suppliers?

"Email, email orders and things like that...they on their side do do excel spreadsheets..."

Lead time compression

3. How could the time between the ordering of materials from suppliers and delivery of these materials to the firm be reduced?

“The logical answer is yes, it’s always possible to reduce times. In some cases I don’t know what they would be requiring. If it’s a project that’s ongoing, and its underway and it’s a mature project, because they are producing however many parts every month or close to it I can have stock for the next month here and ready to go to them, that’s typically what we would try and do. Sometimes along the way they maybe don’t buy from me this month, and I end up with extra stock, and I don’t reorder for instance, and the next month the project goes again, but I don’t know, and it goes again and all of a sudden the stock suddenly disappears and I haven’t got orders in place with suppliers, so… that could be improved. The fact that we all run on different systems and we don’t have enough money to pay…consultants to develop supply chain systems that they can enter information on their side and get delivery from us and use that in planning stock requirements for them…So stock planning could be improved.”

Synchronisation

4. How does the firm determine *when* orders are going to be placed with suppliers?

“About a week after its needed (*laughing*)…normally their customer gives them a job a week after it’s needed. And then it takes them a week to process that information, sometimes they do it the very day they get it and place an order a week to two weeks after the project was required…so depends in the job…

5. Could you tell me how the *quantity* of material ordered from suppliers is determined?

Explaining what the question means, in terms of whether the order volumes are the same each time or varying: “That can be a problem…for a phenolic glass pre-preg there’s a minimum order quantity from a supplier, they require that I order 400 meters at a time, I don’t have other customers that I’m selling the same product to, so I have to pass that minimum order quantity to Firm E. The way we deal with it with them…they only need one roll a

month, which is a hundred square metres, so I get from (person in Firm E) an order for four months. So he can give me those minimum order quantities but distribute the call off over four months...it helps them with their cash problems.

6. Could you tell me about any delays in receiving materials as a result of supplier capacity problems?

“Ja, if you go on the handrail project...they were manufacturing with (a specific resin)...production of the resin system is once every two months, they order product in the middle of that time somewhere, and there’s no stock on the shelf, there’s four to six weeks waiting time before it goes into manufacture, a week of manufacture and packaging, and then it can start getting shipped. So if the planning isn’t upfront, it gets stuffed up. Right now I’ve got 20 kits of the stuff sitting on my shelf and (specific person at Firm E) has got 4 sitting on his shelf because that was the material required for that project, and now they change to a different system, so...we plan for requirements on a project and materials change, and the reason we carry so much stock is problems with supply, so I initiate a two month buffer stock...”

Dependability

Processes and procedures to ensure dependability

1. Can you tell me about the processes and procedures that are in place with suppliers to achieve on time reliable delivery of goods?

“They give me some indication of a requirement going forward...I meet with them once a week...at worse it’s every second week, that’s required so I know what’s happening on the projects that they’re running. Ill have various materials they use that I must look at, shipping...it’s almost as if I work in the company, I wouldn’t call it a system.”

Quality

Meaning of quality

1. Could you explain what quality means for the firm and its suppliers?

“Quality, I don’t know, quality is one of those fuzzy things. Quality is getting the right product for the right job...and if its quality of the supply chain then at the right time too. In aerospace work it needs to have a certificate of compliance with it so that they can incorporate the product into an aircraft product...that should guarantee a certain quality...”

Quality Planning

2. How are quality requirements determined with suppliers?

“They’ll (Firm E) will tell me if there is one. If its (by? *Inaudible part of the recording*) the CFC its required...if they have problems on site they will call me out and have a look at the problem to do with the end product, typically we work together to try and get around me having to get more material or the resultant shortage that they have because the product is defective or doesn’t comply to what their quality level is...it happens.”

3. Can you describe the type of relationship that exists with your suppliers?

“Very good, they’re my best customer.”

4. Would you say that the firm trusts its suppliers to deliver the required quality? How do you define trust?

“Ja, they trust us to deliver the required quality or at least back our product up. If the quality is wrong they know we will sort it out.”

“When they order something from us they expect that it’s gonna meet the minimum requirements for them to go and produce whatever they are going to make...”

Quality Control

5. How is poor quality controlled or prevented with suppliers?

“We’ve got an ISO system in place so they can initiate corrective action with us. I think what we’ve done because ISO requires a certain cost per year, we’ve cancelled the ISO certification. (A customer) still audits us as a requirement of their ISO, but none of our customers require that we were ISO certified to be able to supply them. So we no longer ISO certified but in the case of (a

customer) they audit us to check that we comply with their requirements internally. But we got the systems of ISO here…"

"…whatever is required from Firm D's side actually happens…"

6. What type of performance measures are used in controlling or preventing poor quality with suppliers?

"There's no performance measures, they'll pick up quality on their side…typically ill know what batches have gone to them, if a CFC was issued with it, it was going to aerospace, then ill be able to check the batch, this is the batch that came from us, it definitely isn't ok. But there's no performance measure."

Quality Improvement

7. Can you explain how quality improvements are made in the long supply chain with suppliers?

"If a batch of material was supplied to us was found to be defective, if I have another batch available, it would be immediately be swapped around…the supplier would obviously be notified, we would try and get a credit from them on materials. If it was a Supplier E1 internal distributor problem then we would have to accept the loss. If the problem came from the suppliers then the next batch shouldn't have the same problems. Or if it was shipping problem that caused the problem to happen like the slow shipping of a pre-preg and it cured we would try and find the cause of the problem and then avoid it…"

Asking how constrained capacity on the supplier side is with these materials: "Depends on what the material is. Two years ago we had a carbon shortage in the world and (customers) had fully booked out a (specific material) for their new composite aircraft manufacture. The yarn production in the world was not high enough to meet…(demand)…especially on an aerospace approved product. If Firm E or one of their clients had specified a specific fabric type to use on a specific project…if that fabric is not available, then I can essentially not be able to do anything about it. Then we would initiate a notification to the client saying this fabric… (is not available)…here are alternatives that you could look at certifying to use as an interim on the project…"

Flexibility

Meaning of flexibility

1. Can you explain what flexibility means for the firm and its suppliers?

“Flexibility would be things like being able to work together to overcome material non-availability and find alternatives and change design to fit, and from our side the stocking of a product that we normally wouldn’t stock, to help them with their cash flow on the pre-preg...working out a way that makes it work for both sides, looking for win-win kind of scenarios, where maybe neither side gets what they want, but ultimately it makes it work. In Firm E’s case making do with a product that is not as good as it could be, but understanding where it comes from and the cost effectiveness of it and therefore making use of that product possible.”

Achievement of flexibility

2. How is flexibility achieved with suppliers?

In the answer above.

Other

Ways to improve competitiveness

1. Can you describe any other areas not examined in the questions above that may improve competitiveness for the firm and its suppliers?

“Ja, the government should spend money in the right places...developing the industry correctly. We...get funding for projects through the department of science and technology...but it doesn’t help industry at the end of the day, its theory, it’s got nothing to do with real supply chains, its got nothing to do with real product demand...the government does nothing to make us more cost effective.”

The South African government should spend money on the production of wind turbines in South Africa as we have the

ability to manufacture and export them. This would be far greater value adding as we could manufacture the whole unit, instead of only getting smaller aerospace OEM component manufacture. The dst and the dti should also ensure that the link between research and actual production is achieved. Regular meetings with the dti on what projects in specific areas could be done as well.

Interview with participant 15

The customer interviewee is herein referred to as participant 15. The firm in the unit of analysis is herein referred to as Firm E. The customer is referred to as customer E2.

The telephonic interview was not recorded. The telephonic connection with Participant 15 was inaudible at times.

General

Table I5: Customer details for Firm E

Firm	Customer name	Strategic part received from firm. Why?	Location
Firm E	Customer E2	Compression moulded composite turbine blades	California

Participant 15 says that the product received was a once off order, but Firm E may be used for future work.

Speed

Better and timelier information

1. What type of information is shared between the firm and customers?

An RFQ is sent to Firm E. With a successful quotation, a CAD model is then sent to Firm E. Manufacturing process options are discussed, together with feedback on the CAD model.

2. How is Information Technology used in communicating with customers?

Information technology is used “exclusively”. CAD models are electronically shared. Communication is by email and cell phone. No “physical interaction” with Firm E occurs due to the distances involved.

Lead time compression

3. How could the time between the ordering of materials from customers and delivery of these materials to the customers be reduced?

Import control in the USA adds a delay in receiving the product from Firm E. Firm E also had difficulty in procuring the necessary material for Customer E2's product in South Africa.

Synchronisation

4. How does the firm determine *when* orders are going to be placed with customers?

The order was a "once off product", and as such there is not really any scheduling in place.

5. Could you tell me how the *quantity* of material ordered from customers is determined?

Answered above.

6. Could you tell me about any delays in receiving materials as a result of firm capacity problems?

The CAD model sent to Firm E had a reference point that was out. A new model was then sent to Firm E.

Dependability

Processes and procedures to ensure dependability

1. Can you tell me about the processes and procedures that are in place with the firm to achieve on time reliable delivery of goods?

A date for delivery is given to Firm E, and Firm E is paid 30 days after parts are delivered.

Quality

Meaning of quality

1. Could you explain what quality means for the firm and its customers?

Customer E1 is a R&D company. As such, quality does not need to be certified as the product is not passenger carrying.

Quality Planning

2. How are quality requirements determined with customers?

The quality requirement from Firm E is that the product “fits” together and “does not break”.

3. Can you describe the type of relationship that exists with your customers?

Firm E was used due to “word of mouth” from someone within Customer E2 who is familiar with Firm E’s work.

4. Would you say that the customer trusts the firm to deliver the required quality? How do you define trust?

Quality Control

5. How is poor quality controlled or prevented with the firm?

6. What type of performance measures are used in controlling or preventing poor quality with the firm?

Quality Improvement

7. Can you explain how quality improvements are made in the long supply chain with the firm?

Flexibility

Meaning of flexibility

1. Can you explain what flexibility means for the firm and its customers?

Inaudible part of telephonic interview

Achievement of flexibility

2. How is flexibility achieved with the firm?

Other

Ways to improve competitiveness

1. Can you describe any other areas not examined in the questions above that may improve competitiveness for the firm and its customers?

Firm E was used because it has a “decent skill base” and lower operating costs compared to competitors.

Appendix J

Appendix J contains transcriptions of the audio interviews with participant 16, participant 17, participant 18 and participant 19 for Case F.

Case Study F

Interview with participant 16

The interviewee is herein referred to as participant 16. The firm in the unit of analysis is herein referred to as Firm F, supplier as Suppliers F1, Supplier F2 and Supplier F3, and customers as Customer F1.

The full interview was recorded.

General

Table J1: Firm F details

Firm	Total annual Sales (R)	No. of employees	Types of products	Number of direct suppliers		Number of direct customers	
				Local	Global	Local	Global
Firm F	-	Less than 1000, about 800	Maintenance, repair and overhaul of aircraft	-	-	99% of business is Customer F1	Some African countries

Applicable to supplier-firm unit of analysis (all questions below)

3. Classify a maximum of 3 suppliers to the firm that fulfil the following criteria:

    - The supplier is geographically distant (i.e. on another continent) from the firm
    - The supplier must provide a part with strategic importance to the firm. Why makes that part strategically important?

Table J2: Supplier details for Firm F

Supplier name	Strategic part supplied to firm. Why?	Location
Supplier F1	"Anything we need" for a specific aircraft "Very quiet at the moment"	America
Supplier F2	"Anything that we need" for a specific aircraft	United Kingdom
Supplier F3	"Everything French" Distributor of parts	South Africa

Speed

Better and timelier information

1. What type of information is shared between the firm and suppliers?

"This is an MRO, basically there's no planning...at this point, its ad hoc basically..."

2. How is Information Technology used in communicating with suppliers?

"Communication is email, phone, printed purchase orders, RFQ's."

Lead time compression

3. How could the time between the ordering of materials from suppliers and delivery of these materials to the firm be reduced?

"...how to reduce, not easy. You want to reduce it you fly it in. But the thing is with the old aircraft is the materials you require has got lead times some of them are 18 months..."

Synchronisation

4. How does the firm determine *when* orders are going to be placed with suppliers?

"First of all the aircraft comes in, it gets stripped down to see what's wrong, what needs to be replaced and from that the information we get from the planning office to say this is what we require, go source it...*The interviewer then asks if that also determines the quantities*...yes, they determine the quantities."

5. Could you tell me how the *quantity* of material ordered from suppliers is determined?

Asked above

6. Could you tell me about any delays in receiving materials as a result of supplier capacity problems?

Speak to Supplier F3.

Dependability

Processes and procedures to ensure dependability

1. Can you tell me about the processes and procedures that are in place with suppliers to achieve on time reliable delivery of goods?

"Our parts are always late... (A specific aircraft) being 90% of our business we are solely dependent on one agent of which we do have a service agreement, but due to the fact that we don't order the same parts regularly...its not a constant flow of the same type of thing, and the fact that the aircraft is that old."

Quality

Meaning of quality

1. Could you explain what quality means for the firm and its suppliers?

"In the aircraft industry it's very strict, they have to conform to the FIA quality standards, and ISO 9001...all the aircraft standards are applicable."

Quality Planning

2. How are quality requirements determined with suppliers?

“All the components that we bring into the country and use must have a certificate of conformance, and that’s basically what we rely on, CFC’s.”

3. Can you describe the type of relationship that exists with your suppliers?

Interviewer explains the meaning of the question: “Well, it fluctuates…Supplier F3 is picking up, it’s getting better…”

4. Would you say that the firm trusts its suppliers to deliver the required quality? How do you define trust?

“There must be…”

The interviewee asks another person in the office who deals with Supplier F1 and Supplier F2 what is meant by trust: “…Supplier F1, slow to quote, although we’ve got a service level agreement in place… (*Inaudible part of recording)*…”

Quality Control

5. How is poor quality controlled or prevented with suppliers?

“If components arrive and they are not up to standard, unfortunately that’s only found out when they hit the floor because goods receiving, they are not technically orientated to do quality control as such, that’s why we rely heavily on the CFC’s.”

6. What type of performance measures are used in controlling or preventing poor quality with suppliers?

Interviewer explains the meaning of the question: “You can talk delivery, you can talk price control and all that, we are not very concerned about it because we have no choice. We haven’t got suppliers that compete with one another, only on the RFQ basis when we go out on quotes and get quotes on two or three of them…if it conforms to the CFC then that’s it…we will never ever accept a part without it.”

Quality Improvement

7. Can you explain how quality improvements are made in the long supply chain with suppliers?

"When it doesn't conform we send it back, that's all we do, send it back and we tell them. It first of all goes to quality and they will have to give a write-up of what the problem is with that part and it's sent back, it's not acceptable. But that's few and far between."

Flexibility

Meaning of flexibility

1. Can you explain what flexibility means for the firm and its suppliers?

"...between suppliers you may have one's price is higher but the lead time is shorter...there's not a high degree of flexibility, no, very small."

Achievement of flexibility

2. How is flexibility achieved with suppliers?

Not asked

Other

Ways to improve competitiveness

1. Can you describe any other areas not examined in the questions above that may improve competitiveness for the firm and its suppliers?

"It's a money making business, that's what the suppliers are out for...how to improve competitiveness...not with the old products that we are dealing with. If we were in the game of new aircraft that would be a different ballgame...with an aircraft you are normally bound to the Original Equipment manufacturer who says that these components will be bought from those...suppliers, that's it, no comparison, you're bound by contract."

Applicable to customer-firm unit of analysis (all questions below)

Classify a maximum of 3 customers to the firm that fulfil the following criteria:

- The customer is geographically distant (i.e. on another continent) from the firm
- The customer must receive a part of strategic importance from the firm. What makes that part strategically important?

Table J3: Customer details for Firm F

Customer name	Strategic part sent to customer. Why?	Location
Customer F1	"Basically we've got one customer, that's Customer F1" "Component overhaul...different assemblies, maybe even parts."	South Africa

Speed

Better and timelier information

1. What type of information is shared between the firm and customers?

"Stock, do they have stock, do we have stock...their systems even on our site."

2. How is Information Technology used in communicating with customers?

"There is no link between our ERP and their ERP...email, reports...there's no electronic link so to speak."

Lead time compression

3. How could the time between finished product in the firm and the delivery of the product to the customer be reduced?

“I suppose it can...if the systems could be talking to one another it would be much quicker.”

Synchronisation

4. *When* does the customer place a product order with the firm?

“Ok, there’s a service level agreement...Customer F1 in terms of MRO, Maintenance, Repair and Overhaul, when we strip down the aircraft we find out what components are to be required. We first of all go to them and ask whether you have the spare, if not then we will order it via Supplier F3.”

5. Could you tell me how the *quantity* of product ordered by customers is determined?

Answered above.

6. Could you tell me about any delays that have occurred when sending finished goods to customers as a result of capacity problems?

“I suppose yes, because we’ve laid off a lot of people, a lot of knowledge went out the gate. Of course when we have to buy components it also takes a lot of time. And Customer F1 is restricted in their budget...”

Dependability

Processes and procedures to ensure dependability

1. Can you tell me about the processes and procedures that are in place with customers to achieve on time reliable delivery of goods?

“I don’t know”

Quality

Meaning of quality

1. Could you explain what quality means for the firm and its customers?

"...have to look at the vision statement..."

Quality Planning

2. How are quality requirements determined with customers?

"Well, the same as for us. The requirements we place on our suppliers are the same requirements that Customer F1 places on us."

3. Can you describe the type of relationship that exists with your customers?

"What relationship...it's a hand in the pocket relationship...the one can't go without the other. If this company would fold then Customer F1 is stuck, there would be nobody to do their work for them."

4. Would you say that the customer trusts the firm to deliver the required quality? How do you define trust?

"Yes I do believe they trust us...that the product that we deliver is up to their specification."

Quality Control

5. How is poor quality controlled or prevented with customers?

"The same CFC that we receive from our supplier goes back right through the system up to them, they are relying on the same CFC for quality."

6. What type of performance measures are used in controlling or preventing poor quality with customers?

"That would be with the sales department..."

Quality Improvement

7. How are quality improvements made in the long supply chain with customers?

"Oh yes, certainly there will be (feedback), but how that is done I done know."

Flexibility

Meaning of flexibility

1. Can you explain what flexibility means for the firm and its customers?

"Please give us more time (*interviewee laughing)*...the whole concept of your study is lead times, how long it takes, you need to be flexible...we must be able to tell them (Customer F1) sorry we can't make it because our suppliers are late."

Achievement of flexibility

2. How is flexibility achieved with customers?

Not asked.

Other

Ways to improve competitiveness

1. Can you describe any other areas not examined in the questions above that may improve competitiveness for the firm and its customers?

No.

Interview with participant 17

The interviewee is herein referred to as participant 17. The firm in the unit of analysis is herein referred to as Firm F, supplier as Supplier F1 and customers as Customer F1.

The interview for the supplier firm unit of analysis was recorded. Due to time constraints, the questions for the customer firm unit of analysis were not answered. A meeting was set up for a telephonic interview with participant 17 to complete the customer-firm unit, but this did not occur due to confusion over the telephone number given. Two subsequent telephonic meetings were set up with participant 17, but participant 17 was unavailable both times. In-between the setting up of these meetings, three unsuccessful attempts to get hold of participant 17 were made. The customer-firm unit of analysis data was therefore not obtained.

General

Table J4: Firm F details

Firm	Total annual Sales (R)	No. of employees	Types of products	No. of direct suppliers		No. of direct customers	
				Local	Global	Local	Global
Firm F	600M	About 600 in MRO	MRO	600; "Supplier F3 about 40% of that"	50	Customer F1 about 99% of that	Few in Africa, Middle East

Applicable to supplier-firm unit of analysis (all questions below)

1. Classify a maximum of 3 suppliers to the firm that fulfil the following criteria:

    - The supplier is geographically distant (i.e. on another continent) from the firm
    - The supplier must provide a part with strategic importance to the firm. Why makes that part strategically important?

Table J5: Supplier details for Firm F

Supplier name	Strategic part supplied to firm. Why?	Location
Supplier F3	Distributor of parts	South Africa

Speed

Better and timelier information

1. What type of information is shared between the firm and suppliers?

"At this point in time very little. What we are attempting to do is get a bigger horizon on our planning because currently the planning horizon is much too close...that's also partly because of the kind of business that were in, the clients send as an when he has equipment available to be repaired...so were a little bit at their mercy...we need to have better visibility on what is due as far in advance as possible. So one of the problems that we need to understand is the frequency of each and every aircraft, its use, so we can work out by when it is probably going to be available for some sort of maintenance, repair and overhaul...the big problem behind all this is very very long lead times, lead times are essentially 6 to 24 months...the aircraft that were running are no longer production line items, as a result of them no longer being production line items the availability of spares is also an issue...you have to break into somebody's production line...to have certain parts manufactured because you well aware that holding spares has become pretty much a no-no in the international community..."

2. How is Information Technology used in communicating with suppliers?

"What we're using at the moment is essentially spreadsheet, there is no e-procurement at the moment because you must also bear in mind the sensitivity in the military industry around data transfers. And you have two ERP systems taking to each other is a huge concern. It's not quite as simple as (the motor industry in terms of electronic data transfers)...unfortunately we are not in that, were unlikely to get to that point. However our intention is to at least get to another level, and there you get for example a

thing like Collaborative Exchange becomes a great option, because they become like a firewall between the two organisations…at the moment its really a question of weekly meetings, schedules by email…"

Lead time compression

3. How could the time between the ordering of materials from suppliers and delivery of these materials to the firm be reduced?

"I think there's only one clear answer to that is comprehensive and effective planning. Planning is the key to everything, your entire resource planning and material planning are key to the entire supply chain…"

Synchronisation

4. How does the firm determine *when* orders are going to be placed with suppliers?

"That is in relation to expected lead times. We know pretty much what the lead time is. Obviously we either have a catalogue of prices and delivery period or we go and say give us a price and lead time on this…generally however the lead times extend beyond the required by date, again…history has taught us maybe we can get it in 3 to 4 months, sorry this (*Inaudible part of the recording*) in 6 to 8 months. Next year it may be 10 to 12 months…that means really just being able to get a spare part for an aircraft that's currently supposed to be flying, again it comes to the age…essentially I think to try and reduce lead times the whole trick really is to say guys how can we integrate closer, how could I essentially look into (suppliers)…have a view on what spares do they have. I think that's really going to take forever to get that view. But what we have achieved is the local subsidiary of Supplier F3…the whole Supplier F3 organisation have got better visibility of all their subsidiaries around the world, and who carries what spares currently in stock to try and provide better customer service as well."

5. Could you tell me how the *quantity* of material ordered from suppliers is determined?

"…what were looking at is saying guys, we don't want to keep stock if we can help it. The only type of stock that we want to

keep is for a particular kind of project. We say this particular project for that particular aircraft requires the following equipment and requires supply there and then. We then have to look at the lead times and obviously an MRP type setting, order the stuff on time, to get here on time, with a safety lead time built in…"

6. Could you tell me about any delays in receiving materials as a result of supplier capacity problems?

"Yes, lots of. They might also be getting a whole bunch of bulk material from…another company. They bring it in on the master weigh bill. That master weigh bull has to be decanted. So they have to break up this big bulk…and that all takes a good deal of time. If it's a smaller organisation they invariably do not have enough personnel, and when they do not have enough personnel, then things will start lying around longer. Unless you put a lot of pressure on them, it could lie around for a while… So these are some of the challenges as well…"

Dependability

Processes and procedures to ensure dependability

1. Can you tell me about the processes and procedures that are in place with suppliers to achieve on time reliable delivery of goods?

"I think that at this point in time, what we do is in our quality assurance department, the guys actually go and do quality checks on…only on the local suppliers. The other thing is that in the aero industry you must understand that there's a lot of very frequent, very detailed quality checks by external organisations…then you've got all your different agreements like for example with a Supplier F3, they will come and inspect you and audit you in relation to the agreement. So on average we have some sort of audit taking place here every second month…we also look for example on the (*Inaudible part of recording*) models, we turn around and say guys, how many times have you oversupplied, how many times have you undersupplied, how many times have you supplied the wrong thing etc. So all the typical errors we try and monitor there…these are the problems that we've picked up, what are we, not you, we going to do about getting it right…"

Quality

Meaning of quality

1. Could you explain what quality means for the firm and its suppliers?

“Quality really in our mind is not only fit for use, for intended use, but it is also on time, correct quantity, correct descriptions, the documentation and items that arrive tie up, that the correct modifications of that part, because mod status is extremely important. If you get a mod status dash 1 and the latest mod status is dash 2 according to the bulletin, you can’t put that dash 1 in, you can only put the dash 2 in…which has a whole bunch of legal repercussions…while in the delivery period you have your lead time running, it changes from dash 1 to dash 2, and you order a dash 1 and get a dash 2…”

Quality Planning

2. How are quality requirements determined with suppliers?

“You see the other thing that comes with it is a certificate of conformance. Each part supplied by the supplier must have, aircraft related, (*Inaudible part of the recording*) a certificate of compliance supplied by that supplier, certificate of conformance. That basically says, this thing is correct in every detail, for the intended use. Unless you get this CFC, you don’t even accept the part. So at that level you have some recourse…”

3. Can you describe the type of relationship that exists with your suppliers?

“Look, I think the relationship really has to be one of mutual cooperation, you cannot work on an adversarial relationship…we’ve obviously also got very regular discussions…what’s the way forward…the usual kind of supplier discussions that you have. You also have your various agreements…very detailed agreements between a supplier and…Firm F, these are all forms of technical aid agreements, and these rule a lot about the relationships between two organisations…that also does not only mean for the parts but for knowledge, know-how, engineering, backup and all that type of stuff.”

4. Would you say that the firm trusts its suppliers to deliver the required quality? How do you define trust?

“Yes, when it comes with a CFC there’s a complete level of trust…Trust really in this case is we have to trust them to supply the right things, that is a level of trust. The trust however does go a little bit wonky when it comes to lead times and pricing (*Inaudible part of the recording*)…but that normally is taken care of in the normal service level agreement between supplier and customer.”

Quality Control

5. How is poor quality controlled or prevented with suppliers?

“Again, poor quality, there’s various quality considerations, poor quality can be wrong quantity, wrong part number, wrong mod number. But quantity can also be for example, sometimes, fitment to the aircraft is found to be faulty. That one happens very very rarely. It’s more the simple supply chain stuff that goes wrong, wrong part number, wrong quantities, late deliveries, late deliveries is a huge favourite in a non-production environment. Late can be up to 100% late”

6. What type of performance measures are used in controlling or preventing poor quality with suppliers?

“Again I think it’s very simple what we use here. Performance measures is really what are you delivering, when are you delivering, is it the right stuff that you are delivering, are you on time, what is your price variability, what is your response to tendering, what is your response to technical questions, how many issues have you got outstanding, what sort of quality issues are open, there’s a whole series of them.’

Quality Improvement

7. Can you explain how quality improvements are made in the long supply chain with suppliers?

I think there’s nothing active at the moment…we have to look at what we are going to do about that in the future, but right now we just have to stabilise relationships, stabilise suppliers, and

stabilise our own organisation, again a supplier can only supply as good as your planning is…"

Flexibility

Meaning of flexibility

1. Can you explain what flexibility means for the firm and its suppliers?

"…Flexibility can also be guys, we don't need the stuff now, we need it in six months time, or what stock do you have available, can I pull that forward by 3 months. I think the other flexibility is they have to give us quotations on changing requirements on a daily basis. Flexibility also means to us…the ability to assist us technically when technical questions arise."

Achievement of flexibility

2. How is flexibility achieved with suppliers?

"…flexibility comes with a cost, same thing as you look at for example your spares holding. What level of spares holding are you going to take, and if you look at your normal MAD calculation, then you very quickly start realising things like, if I want my customer satisfaction index to go up, get it closer to 100%, I'm going to have to hold more stock. But more stock costs more money, lower cash flow, all the other things that go with it. So you have to obviously play these things off against one another, and these are some of the things that you have to consider…"

Other

Ways to improve competitiveness

1. Can you describe any other areas not examined in the questions above that may improve competitiveness for the firm and its suppliers?

"I think flexibility and communication are really the two. And of the two if I had to pick one I would go communication. The better the communication throughout the organisation the better is going to be your supply capability. Internally, it always comes

back to this, the better your planning, the better your planning horizon is, the more accurate your planning horizon, the better your supplier is likely to support you. I really think those are the two fundamentals...accurate planning..."

Applicable to customer-firm unit of analysis (all questions below) (Not completed)

Classify a maximum of 3 customers to the firm that fulfil the following criteria:

- The customer is geographically distant (i.e. on another continent) from the firm
- The customer must receive a part of strategic importance from the firm. What makes that part strategically important?

Table J6: Customer details for Firm F

Customer name	Strategic part sent to customer. Why?	Location
Customer F1		

Speed

Better and timelier information

1. What type of information is shared between the firm and customers?
2. How is Information Technology used in communicating with customers?

Lead time compression

3. How could the time between finished product in the firm and the delivery of the product to the customer be reduced?

Synchronisation

4. *When* does the customer place a product order with the firm?

5. Could you tell me how the *quantity* of product ordered by customers is determined?

6. Could you tell me about any delays that have occurred when sending finished goods to customers as a result of capacity problems?

Dependability

Processes and procedures to ensure dependability

1. Can you tell me about the processes and procedures that are in place with customers to achieve on time reliable delivery of goods?

Quality

Meaning of quality

1. Could you explain what quality means for the firm and its customers?

Quality Planning

2. How are quality requirements determined with customers?

3. Can you describe the type of relationship that exists with your customers?

4. Would you say that the customer trusts the firm to deliver the required quality? How do you define trust?

Quality Control

5. How is poor quality controlled or prevented with customers?

6. What type of performance measures are used in controlling or preventing poor quality with customers?

Quality Improvement

7. How are quality improvements made in the long supply chain with customers?

Flexibility

Meaning of flexibility

1. Can you explain what flexibility means for the firm and its customers?

Achievement of flexibility

2. How is flexibility achieved with customers?

Other

Ways to improve competitiveness

1. Can you describe any other areas not examined in the questions above that may improve competitiveness for the firm and its customers?

Interview with participant 18 and participant 19

The supplier interviewees are herein referred to as participant 18 and participant 19. The firm in the unit of analysis is herein referred to as Firm F. The supplier is referred to as supplier F3.

The interview was recorded. As per request, Participant 18 and participant 19 were in the same interview.

General

Table J7: Supplier details for Firm F

Firm	Supplier name	Strategic part supplied to firm. Why?	Location
Firm F	Supplier F3	"All the related parts…you are looking at what type of aircraft they've got…" (Participant 18)	South Africa

Speed

Better and timelier information

1. What type of information is shared between the firm and suppliers?

"Well, basically the information that they require. It all starts with an RFQ, they will send us a RFQ, basically what's asked on the RFQ we will answer…" (Participant 18)

2. How is Information Technology used in communicating with suppliers?

"We all basically used to use faxes but that's fading out now. We normally scan and email all our information." (Participant 18)

Lead time compression

3. How could the time between the ordering of materials from suppliers and delivery of these materials to the firm be reduced?

"...I think we are doing quite good at the moment, there's no time difference between us and Firm F...and the same with us and France. So any information we give to Firm F is the quickest it can be..." (Participant 18)

Asking if the majority of goods are from France: "Yes, well in fact I would say 99% is from France" (Participant 18)

"...imagine, instead of working through (*fax? Inaudible*), we develop some kind of EDI with Firm F, where the computer system could interact directly with our system and our system is connected with the...France system...you would not really save in time, you would save in workload...in between we are planning to implement the customer website where they will be able to place a purchase order directly in the system, which will not be less work for them...but it would save time for us...that's on the information technology side. On the shipping side the only way we would is change the INCO terms, we can imagine that if we deliver to them instead of the parts arriving at Oliver Tambo...we inform them that it is ready, they are coming here and pick it up, so...they are maybe costing three or four days there...but most of the parts we are talking about is long lead times parts, they are not really talking to us on AOG's, it's long lead times, it's planned orders, they are old stock...so two or three days to get to them is not really a big deal...the transit time is nothing, compared to the manufacturing lead times..." (Participant 19)

Synchronisation

4. How does the firm determine *when* orders are going to be placed with suppliers?

"We place orders on a weekly basis" *Asking whether it is a regular type order:* "Obviously you get different types of orders, different types of spares, tools and stuff...we will do a quotation...for a tool, we know that Firm F on their procurement side, any tool more that R5000 rand you have to get approval...I

think they need six, seven signatures on that form…" (Participant 18)

"If you consider that its routine order, its replenishing, you can imagine that they would place an order once a month…or even if they place an order once a year, for the whole year…schedule deliveries, things like that, obviously…would be a lot better…a better vision in place, bigger but less often orders." (Participant 19)

"If you want to improve the flow, and I think that's what you want to do, improve the global supply chain, you have to integrate more from the customer, I'm not sure that Firm F has a clear picture of what would be the requirement in terms of flying hours in the coming years…so give Firm F a good forecast. When there's a good forecast on the operational requirements based on what they have in stock, discussion with the supplier, in that case would be us in terms of manufacturing lead time and things like that. If this is all well integrated we would be able to work a lot more efficient…now Firm F is sitting with big stock, they don't know exactly what the customer will need, they don't know how long it will take for us to supply the parts so they tend to overstock to make sure they will be able to deliver…the problem is more contractual…they need those gearboxes because they said they would deliver it even if the customer does not need them…probably the customer is doing like Firm F is doing, they don't know how long it takes to get the gearbox, so they put the contract in place saying I want one at that date, one at that date, one at that date, even if they don't really…" (Participant 19)

5. Could you tell me how the *quantity* of material ordered from suppliers is determined?

"…it varies…they are busy with a…project…that is now coming to an end, so obviously the amount they ordered last year and the year before will be less this year. Also looking at quantities, we've got a minimum order quantity as well…" (Participant 18)

6. Could you tell me about any delays in receiving materials as a result of supplier capacity problems?

"Bevel gears…it is a critical item, all over the world." (Participant 18) "The problem is a combination of production difficulties…the flow cannot be increased easily, and an

unexpected increase in demand...leads to the part being on the critical list...” (Participant 19)

Dependability

Processes and procedures to ensure dependability

1. Can you tell me about the processes and procedures that are in place with suppliers to achieve on time reliable delivery of goods?

“We’ve got a system in place now...with this system we try to save on time, we’ve got different platforms in Europe that we can place sales orders against. So we will save a day in shipping if we order something from Paris and not from the main hub in Marseille.” (Participant 18)

Talking about the computer program system in place: “...in terms of logistics process it’s a huge improvement in terms of workload. The savings in terms of days...is not critical for these types of orders, but we save a lot in terms of workload and in terms of possible mistakes and things like that.” (Participant 19)

“We’ve got a...progress meeting every second...week...” (Participant 18) “It gives us an opportunity to look at the order book and see the delivery date...and...review the items that are critical, the ones that are more urgent for Firm F...” (Participant 19)

Quality

Meaning of quality

1. Could you explain what quality means for the firm and its suppliers?

“The quality standards we deliver against is (*Some form of aerospace regulation body, inaudible part of recording*)...the quality is the best in the world. (Participant 18)...”

Quality Planning

2. How are quality requirements determined with suppliers?

"Well if you look at Firm F's purchase order, their first page has got a lot of conditions on there..." (Participant 18)

3. Can you describe the type of relationship that exists with your suppliers?

"I think it is a good relationship. We do have a lot of meetings on a regular basis..." (Participant 18)

"It more than a relationship, it's a partnership. We have a written agreement with Firm F, we are not just supplying parts, we are supporting them, with technical support agreements..." (Participant 19)

4. Would you say that the firm trusts its suppliers to deliver the required quality? How do you define trust?

"For the quality, I would say yes." (Participant 19)

"..they would trust us because their experiences show, in terms of quality...its not creating problems. There is some discussion sometimes in the past where...their complaint was more like our time to quote for example, or sometimes a list of parts waiting for quotes was a little bit long, so we had a lot of discussion and we try to improve...not delivering everything right now creates a little bit of tension on their side because they still have to deliver to the end customer...they understand we cannot deliver 100 percent, but trusting the fact that we give them the information. So they know we are not hiding anything from them...explain what type of problems we have. They also can trust us ... we can provide alternative solutions, we may not be able to provide new ones...we have demonstrated that if we have a problem, we are trying to help them with alternative solutions..." (Participant 19)

Quality Control

5. How is poor quality controlled or prevented with suppliers?

"Well firstly Firm F has their own rejection system within their own quality department. They will follow that they will send through a rejection note. We have our own quality system, we have a...form that needs to be filled in, obviously that will be sent back to Supplier F3 France, France will have a look at that, if they agree they will agree either to replace or repair that part." (Participant 18)

6. What type of performance measures are used in controlling or preventing poor quality with suppliers?

"Here we don't have KPI's to follow the level of quality of Firm F France. But the...(*Inaudible part of recording*)...all the suppliers are followed in terms of quality with a set of KPI's which we measure their on time delivery...the quality of the documentation for example...all the technical deficiencies...we don't have these types of systems here." (Participant 19)

Quality Improvement

7. Can you explain how quality improvements are made in the long supply chain with suppliers?

"We have a...department which is working on improving the quality of the work we are doing internally...as we are not manufacturing anything it's more working on improving our process...but not really on the quality of the product because the quality of the product is managed by some other company in Europe..." (Participant 19)

Flexibility

Meaning of flexibility

1. Can you explain what flexibility means for the firm and its suppliers?

"...we were flexible with the bevel gear sets that we managed to supply...the refurbished ones to them...flexibility, you see there's so many procedures and stuff that's in place, contracts, I cant really see that" (Participant 18)

Achievement of flexibility

2. How is flexibility achieved with suppliers?

"...right now, the setup, our global chain...with Firm F is not flexible...it's very rigid. We need to go back to what we were discussing earlier on having a more integrated chain, where if there's change in the operational requirements it will flow directly back to the production line...it will adjust...this is not really existing now..." (Participant 19)

"So yes flexibility is possible, but quality is not flexible." (Participant 18)

Other

Ways to improve competitiveness

1. Can you describe any other areas not examined in the questions above that may improve competitiveness for the firm and its suppliers?

"...the way for the future is by placing orders on the internet..." (Participant 18)

"...EDI could also be a way to improve, so we don't have to exchange paper...drop shipment could improve a little bit..." (Participant 19)

"...also the possibility for them to load...the purchase order on the internet on our system, that's a way to improve the relationship..." (Participant 18)

"...the big way forward is to integrate the needs of the final customer, go more into a relation between the operational needs and the production time." (Participant 19)

Appendix K

Complete Single Case Studies

Fully written up versions of Case A, Case C, Case D, Case E and Case F are found in Appendix K. These cases have not been included in the main report to help simplify reading. Case B can be found in the main report.

Case A

General

Firm A is a producer of interior aerospace products like seat coverings. The firm is a recent subsidiary of an automotive firm, which is also involved in the production of interior automotive products. Firm A has not yet begun to make any product, but will use the automotive manufacturing facilities, labour force and a selection of the automotive suppliers to draw raw material for aerospace product manufacture. Participant 1, the director of Firm A, says that production will be “Looking at the automotive perspective and applying it to aviation.” Because of this, Firm A cannot be discussed independently from its automotive background.

Suppliers and customers discussed within this case study, the product supplied and its strategic importance are given in the tables below. Whilst the criteria for long supply chain classification for this dissertation requires suppliers and customers to be geographically distant, generally on another continent, participant 1 has another definition in mind: “...for me a long supply chain is also a complex product or raw material that needs to go into my product...for example... (my product involves) a very timeous process...which makes it a complex supply chain, or a long supply chain.” A long supply chain in case A will not necessarily just involve suppliers and customers who are geographically distant. It may also be a supply chain that has a large number of steps or time length involved in processing a product.

Table K1: Suppliers identified by Firm A for analysis

Supplier	Strategic part supplied to firm. Why?	Location
Supplier A1	Main material needed for product manufacture from Supplier A1 (Participant 1)	Local and international
Supplier A2	"Scarce" material needed for product manufacture, as a result of infrequent production runs by Supplier A2 (Participant 1)	Local and international

Table K2: Customers identified by Firm A for analysis

Customer	Strategic part sent to customer. Why?	Location
Customer A1	Participant 1 says that Customer A1 receives a "Safety component" from Firm A, which holds an important function in aviation.	Local and international
Customer A2	Participant 1 says that Firm A product supplied to Customer A2 is a "Unique interior product" for aesthetic reasons.	Local and international

Speed

Better and timelier information

Communication

Participant 1 describes information sharing with suppliers as "...the more the supplier knows about...material we need and our manufacturing, the more he knows about our company, the better for the relationship." Participant 1 describes information sharing between Firm A and its customers as "To try and tell the customer that you are obviously the best...you would try to convince and maintain to your customer that the customer is

first...by giving him the best price, the best quality, and delivery when he wants it".

IT

Information Technology communication between Firm A, its suppliers and customers is facilitated through email, website, and an MRP system. Whilst IT does enable communication, it also has its problems, with participant 1 saying "...everything today is electronic which...has lost that personal touch...I'd rather quickly write an email then picking up the phone and phoning...every company basically has...an automatic...MRP system...the system is too often to blame." To try and counter IT system errors that may arise as a result of changes in demand, requirements and human error, electronic orders released electronically to suppliers must be verified before being sent. Face-to-face communication is regarded as an important communication mode above IT enabled communication, where participant 1 would go overseas "...once a year or every six months, scheduling one or two weeks depending on how many customers you want to see or suppliers...".

Lead time compression

Time reduction between the ordering of materials from suppliers and delivery of these materials to firm A is dependent on when customers place orders. Participant 1 says that ordering "...varies from daily, to weekly, to every three weeks, depending on how much stock you are prepared to carry. Stock carried is obviously of vital importance, everybody wants to carry as little stock as possible". With less stock that the firm is willing to carry, the more frequently orders have to be made to suppliers. JIT ordering of material from suppliers "...could be possible, but there are too many outside external factors" (participant 1). Lead time reduction between Firm A, its suppliers and customers requires an understanding of the cost competitive dimension. A mode of transport like air freight allows for greater reduction in lead time versus shipping the product, but results in increased costs. A balance therefore exists between lead time reduction and cost with respect to international transportation.

Synchronisation

Material order volume and frequency

Timing of placing material orders varies between suppliers, but in general ordering is done at the beginning of the week. A Material Requirements Planning (MRP) system is run at the end of the previous week, also accounting for the current stock levels at Firm A. Participant 1 says that material requirements are sent out "...even if a release of an order to a supplier hasn't changed...because it keeps that communication link going" Quantity of materials ordered is generally established at the onset of the relationship between Firm A and its suppliers, where supplier batch run sizes and packing quantities determine the size of Firm A's economic order quantities. The timing of customer orders placed with Firm A may be regular in the case of an ongoing aerospace project, but irregular for the once-off customer. Quantity of product ordered by customers from Firm A is often dependent on the interior size of the aircraft to be fitted, where "it could be a three seater, or it could be a five hundred seater, or something like that..." (Participant 1)

Capacity constraints

Internal supplier capacity problems give rise to Firm A production delays. These delays affect the supplier's customer based on a "...priority setting by the supplier..." (Participant 1) This means that if Firm A is high up on the suppliers list of prioritised customers, they will be receive their materials sooner than a customer lower on the list once supplier capacity problems have been corrected. Delays between Firm A and its customers may result from Firm A having internal manufacturing capacity constraints and quality problems, supplier problems, and late customer notification on which product to produce. Delays as a result of capacity constraints in the *links* between supply chain members also arise. This is seen in a transportation mode like air giving passengers first priority in peak season to aircraft capacity, possibly bumping off supplier or firm goods from the flight. Flights to the required destination may not be running when needed, or may be overbooked.

Dependability

Processes and procedures to ensure dependability

The verification and understanding of orders placed between suppliers and Firm A is required to achieve on time reliable delivery of product to Firm A. In addition to the delivery of product, the delivery of the required documentation, especially with overseas suppliers, is essential. Whilst ensuring dependable delivery to customers is largely about managing lead times, processes and procedures for dependable delivery are also something learnt from experience. Participant 1 says that contingency plans may be put in place in certain cases, but for the most part “there is no specific route that you can take…”

Quality

Meaning of Quality

A quality definition for Firm A and its suppliers is subjective, and dependent on what the customer requires. Customer requirements, together with technical inputs from Firm A, determine what material and quality levels would be needed from suppliers to complete the product. Participant 1 says that the ideal quality level for Firm A is to have a “0 ppm” (parts per million) quality defect level, and “to have no quality claims from the customer.” Participant 1 sums up what quality means by saying that “maybe in a nutshell, if you exceed your customer’s expectations, then you’ve achieved quality.”

Quality planning

Quality planning process

Quality requirements with suppliers are determined through documentation, and possible verification from customers on the suppliers inputs for their product. Quality requirements with customers are achieved again through documentation and a thorough understanding of what the customers want. Initial quality target setting of what the customer requires for their product is made (“is he happy with 100ppm?”). If the customer wants further quality target setting below that level, Firm A’s costs will have to increase to achieve that level. On top of the customer’s required quality levels, participant 1 says that Firm A

also adds an additional quality buffer to that level, “to make sure that we are always achieving the customer’s requirements”

Trust

Participant 1 says that a “partnership” type relationship exists between Firm A and its suppliers, where a “win-win situation” is required to be successful. Trust between Firm A and its suppliers is established “over time”. Participant 1 explains that indications that trust exists between Firm A and its suppliers could be seen in Firm A putting “unreasonable demands on the supplier, and yet he would be successful”, and professionalism and management of the supplier personnel. A relationship between Firm A and its customers must involve “mutual respect”. Participant 1 says that trust between Firm A and its customers is seen when the customer does not have to “worry” about Firm A, and when Firm A is “in the top 20 of my customers favourable suppliers”. Trust is also established with the “initial contact...the first impression...and the first communication you make” with your customers.

Quality control

Quality control process

Suppliers are expected to deliver the right material each time. Quality systems play an important part in controlling or preventing poor quality with suppliers. Participant 1 explains that once you “live” the system, you can be “70 or 80 percent sure that you are going to get good parts out of it”. The system however should not be implemented just for the purpose of having a system. Because “100 percent” inspection of incoming materials from suppliers is not possible, some “random sampling testing” and “inspection” by Firm A is required. Consistent quality problems with incoming materials from suppliers may call for stepped up quality inspections, “additional audits in process”, and supplier on-site inspections. Because quality needs to start with satisfying the customer, all means should be used in preventing poor quality parts from reaching the customer. If parts of poor quality do reach the customer, an overseas service centre corrects the quality issue.

Performance measurement

Performance data is collected within Firm A and on its suppliers. Participant 1 says that performance measures used depend on "...the processing of the material...there are vast things that you can do." A number of measures may be used with customers, it is important to "look at all possible options."

Quality improvement

For any quality improvements to be made with suppliers, a quality management system needs to be in place. Audits in the form of process audits, system audits and quality control audits may identify areas for supplier improvement. On the customer side, no active product quality improvements are made.

Flexibility

Meaning of flexibility

The meaning of flexibility for Firm A and its suppliers, according to participant 1, is the achievement of "unrealistic demands, or unreasonable demands" that are placed on the supplier by firm A. This can be seen in the firm changing the original order given to the supplier. A supplier initially shows flexibility by saying "Ill see what I can do." If the supplier follows through with what has been said, "Then he convinces me that he is more flexible". The meaning of flexibility with customers is a more "subjective" matter, and is dependent on where you are positioned in the supply chain.

Achievement of flexibility

For Firm A to try and achieve greater flexibility with its suppliers, an understanding of the suppliers' processes is required. The "buying-in" of suppliers into improving levels of flexibility with Firm A is also a requirement. Whilst the customer expects flexibility from Firm A, an understanding of what is required to achieve that flexibility is often missing. Participant 1 says that flexibility for the customer requires not only Firm A to be flexible, but also the supply chain members below Firm A to be flexible, as a result of the "ripple effect that exists". Achievement of greater flexibility with customers generally also has a cost attached to it: By increasing stock

levels at Firm A, an added inventory cost, quicker response to customer needs can be achieved; faster delivery of goods to the customer is possible using a more expensive mode of transport like overnight air freight versus slower ship freight; and increasing internal production capacity levels, possibly through incurring the cost of more machines and labour, allow for more flexibility.

Other

Ways to improve competitiveness

The cost dimension is important for increasing the competitiveness of Firm A and its suppliers. Participant 1 says that payment of goods in South Africa generally works on a 30 day cycle, “Yet the norm in Europe is 90 days” By having longer payment terms to suppliers, the cash flow cycle is improved, which “leads to regularly getting in more funds…” In increasing competitiveness for Firm A and its customers, organisational efficiency within Firm A is important. This may be achieved through increasing labour efficiencies, possibly through multi-skilling. The automation of the MRP function between supply chain members, where systems communicate with one another, may also aid in improving efficiency.

Case C

General

Firm C is a distributor of aircraft components, paints and materials utilised in the aircraft maintenance and manufacture sector. A "semi" long supply chain exists from Firm C to its customers, who are found in Africa or off the coast of Africa. Suppliers and customers discussed within this case study, the product supplied and its strategic importance are given in the tables below.

Table K3: Suppliers identified by Firm C for analysis

Supplier name	Strategic part supplied to firm. Why?	Location
Supplier C1	Paint Participant 3 says that Supplier C1 product "...represents about 20% of our annual turnover at the moment..."	Germany
Supplier C2	Filters Participant 3 says that Supplier C2's product is "...strategic because it's a very common replacement item during aircraft maintenance"	USA
Supplier C3	Windshields for aircraft Participant 3 says that Supplier C3's windscreen product is needed as it is "...an item that an aircraft could get grounded if a bird strikes it, so the urgency and access to stock is probably quite imperative to an airline"	France

Table K4: Customers identified by Firm C for analysis

Customer name	Strategic part sent to customer. Why?	Location
Customer C1	Paint, to aircraft hardware, to aircraft components Product supplied to customer is strategic for financial reasons	Mauritius

Speed

Better and timelier information

Communication

Participant 3 says that Firm C and Supplier C1 share a "lot of information" between themselves. Rough order details like material types, delivery times, amounts, and costs are given. Monthly invoicing reports are shared, as well as information on activity in the South African marketplace for new products. Supplier C1 shares new technologies and project details with Firm C. This allows Firm C to then share the relevant information with its customers. Participant 3 views information sharing with suppliers as a "...open two way channel." Information sharing with customers is important from "...a sales point of view..." Once the sale has taken place Firm C needs to notify the customer about shipping details so the customer can "track" or trace their goods shipment. Customer C1 shares spare part numbers, quantity of material requirements and material usage frequency information with Firm C.

IT

Modes of communication used for sharing information between Firm C and its suppliers include phone, email, fax and vendor reports. Firm C uses specific software tailored for distribution activities in the aerospace industry. This allows Firm C to draw information about supplier and customer activity. Participant 3 explains that this allows Firm C to find out "...who we've quoted, how many times have we quoted, volume of potential sales, what sales we did get orders for, so in that way the

primary information that they want to know." Communication between Firm C and its customers is done through "telephone, fax, email" and aerospace specific software. Quotations, order acknowledgement, and shipping and order status "...is done on software and electronically transmitted via email."

Lead time compression

Firm C generally places orders in advance with Supplier C1 to aid in timely shipping of goods. Air freight instead of shipping freight is used when orders need to be sent quickly to Firm C. Lead time compression between Firm C and its customers is aided by the use of aerospace specific software. Participant 3 explains that the software "...is almost like a one entry point...all, the processes are quite a straight line." Participant 4 says the software has allowed Firm C to have "...shrunk our complete cycle..." of administrative activities. Firm C keeps on hand safety stock for Customer C1 for fast moving stock.

Synchronisation

Material order volume and frequency

For known projects, material order frequency from suppliers is based on Firm C's customers consumption forecast; stock levels held at Firm C; and sea or air transportation times. Participant 5 says that Firm C orders paint from Supplier C1 on a "regular basis" But if an AOG or Aircraft on Ground occurs, when an aircraft needs parts as soon as possible, Supplier C1 can airfreight goods to Firm C within 48 hours. Participant 3 says that "...we would be ordering at least 3 months consumption..." of goods from suppliers. A three month order covers about two months of shipping time, and provides a month of buffer stock. The quantity of material ordered by Firm C is "fluid", as the aerospace "market (is) not so regular." (Participant 5) Unforeseen customer product reworks may result in Firm C having to airfreight in a product like paint when buffer stock is inadequate. Customers order goods from Firm C based on price, delivery conditions and the "...situation they find themselves in" (Participant 3). If a customer finds themselves in a situation like AOG where they need to obtain parts as quickly as possible and Firm C has the part, the customer will order as soon as possible. Customer order volumes are based on "min/maximum levels", where the "reorder process" is the customer's responsibility.

Participant 3 says that “We at times prescribe minimum order quantities or price break quantities…” for certain products.

Capacity constraints

Delays as a result of supplier capacity constraints occur when Firm C orders large batches of paint from Supplier C1. Participant 3 says that “…when I order 10 kg’s of paint from the manufacturer, generally that would be on the shelf. If I order 300 kg’s of that same paint from the manufacturer then obviously the production time is a bit different.” It is important to know how long it takes suppliers to produce the larger batches, but participant 3 does say that the ordering of larger batches “…isn’t a regular occurrence.” Delays from external capacity problems between Firm C and its customers may result from “flight availabilities” as airlines do not fly out of Johannesburg “…to each and every country.”

Dependability

Processes and procedures to ensure dependability

From Firm C’s supplier purchasing point of view, processes and procedures are embedded within their aerospace specific software. Purchase orders are generated using this software. Regulatory requirements of paints first need to be met before they can be sent to Firm C. Paints, according to Participant 3, “…are classified as dangerous goods, you can’t just catch the first available flight and it will come out to Africa.” Other supplier products sent to Firm C “…are more straightforward because they are not dangerous goods, they are just physical boxes containing the parts.” (Participant 3) From Supplier C1’s point of view, there are no specific processes and procedures in place to achieve on time reliable delivery of goods. The process involves getting the order, defining the lead time required for that order, and then trying to meet the lead time. To achieve reliable delivery, participant 3 says that an understanding of supplier “standard lead times” is required. A “written procedure” exists between Firm C and customer, from material dispatch out of store to freight forwarder. But aspects like flight availability are out of Firm C’s control and cannot be put into a written procedure to ensure reliable delivery. Tracking information from Firm C allows Customer C1 to monitor order progress.

Quality

Meaning of Quality

Quality to Firm C and its suppliers means “lead time control” through monitoring the requested delivery date versus actual delivery date of product from suppliers; and “product control” of incoming material from suppliers. Quality may also include documentation or a “certificate” associated with the material. Quality to Firm C and its customers means “product quality” and delivery of goods to customers on time. Participant 3 says that even though supplying a quality product is important, customers “...always like to gauge your quality by delivering your material on time...”

Quality planning

Quality planning process

Planning for quality with suppliers is generally controlled by prescribed product specifications, product standards or defined part product numbers as per the OEM, airline or maintenance firm. Planning of quality requirements with customers is dependent on “International aviation regulation...” (Participant 4) standards, as well as “...other criteria that each airline or each customer will have that isn’t necessarily prescribed specifically...” (Participant 3)

Trust

A “positive relationship” exists between Firm C and its suppliers. Participant 3 says that if “...you have a good relationship, you can be able to get credit terms for (from) a supplier, and then you also help yourself to have a positive cash flow.” Participant 5 says that it is “nearly a friendship” between Firm C and Supplier C1. A “high level of trust” (Participant 5) exists between Firm C and Supplier C1. Participant 4 in Firm C says that trust does exist, but this is because a “...qualification system of each supplier...” is in place and “...we follow up on the quality system on a monthly basis.” A “pretty good relationship” (participant 3) exists between Firm C and its customers, with participant 6 going so far as to call it a “partnership”. Relationships with customers are highly dependent on specific people within a firm. If a specific contact person moves out of

that customer firm, participant 3 says that "...you start all over again." Trust between Firm C and its customers exist because the links between supplier and customer are "pretty transparent." This is seen in the customer being able to audit Firm C by arrangement. Firm C is also a distributor of a known OEM product, and if the customer has confidence in the OEM, the customer will have confidence in the distributor. This is provided product traceability on Firm C's behalf is evident.

Quality control

Quality control process

Full traceability of the product from supplier to Firm C is "...an extremely important factor" (Participant 4) in quality control. A quality system needs to be in place to ensure traceability of both product and the "...certificate associated with it..." (Participant 3) A discrepancy reporting system contained in Firm C's software and monthly management system meetings helps control quality. If Firm C is first unable to rectify the quality problem, the reclaim is sent back to Supplier C1 in Germany. An average overall lead time from suppliers is generally used for this measurement. Quality control between Firm C and its customers is achieved using the customer complain system found in the quality management system. Customer complaints are addressed at monthly quality meetings, where action is taken according to the severity of the problem. Participant 3 says that in quality control "...communication to and from the customer is very important. And has to be timeous as well..."

Performance measurement

Supplier product quality performance measures are taken, but "...delivery times required versus actual..." (Participant 3) measures from suppliers are not. Instead average delivery lead times are taken, as it is difficult to calculate the components of transhipment times due to lack of visibility. Performance measures are used with Firm C and its customers. Participant 3 explains that one measure is "...the number of customer complaints versus the number of line items delivered to the customer..." Customer satisfaction questionnaires supply "very simple" responses (Participant 3). Performance measures need to identify quality problems at the receiving point of the process from suppliers. Because of this "...the volume of discrepancies

associated to deliveries from suppliers to us is significantly higher to what we then have to the customer and us."

Quality improvement

Firm C gives "specific feedback" on performance and product quality to its distributorships or main suppliers on a monthly and annualised basis. Firm C gives "widespread feedback" to its non-distributorships or ad-hoc suppliers. Quality improvements with customers are made through the customer complaint process in the quality management system. Participant 3 says that the customer complaint process allows you "...to create a preventative action request or a corrective action request which in itself will create improvements in the quality system."

Flexibility

Meaning of flexibility

Participant 3 says that "Flexibility of payment terms are (sic) probably one of the key aspects" with suppliers. Flexibility between Firm C and customers means flexibility in "payment terms". The size of the customer market in Africa in relation to the customer market in Europe and North America is small. With Firm C supplying the African market (except North Africa), it needs to be flexible with customer payment terms to keep volume. If customers in Africa do not pay on time, Firm C is lenient, with participant 3 saying that "...you let these customers go a bit beyond their payment terms and accommodate that in your prices..."

Achievement of flexibility

The placing of supplier stock with Firm C on consignment would allow Firm C to deliver product to customers as "...efficiently as possible." (Participant 3) But some manufacturers do not like placing stock with Firm C, as they "...don't feel that they have control over the material anymore once it's somewhere else." If the placement of products on consignment with Firm C is not an option for a supplier, an increase in "payment terms", where you "...sell the product before you actually have to pay for it..." (Participant 3) may help achieve flexibility. Firm C can locally customise certain products from supplier C1 in Germany, allowing it to respond quicker to local customer needs. Achieving

flexibility between Firm C and its customers depends on flexibility in payment terms. A “win-win” payment situation must be in place between Firm C and its customers.

Other

Ways to improve competitiveness

Freight costs from goods transportation between supplier and Firm C add “...a huge impact to the bottom line price of a product...” (Participant 3) Participant 4 says on freight costs that “...there’s not much that can be done, except increasing volumes to get better price...and consolidation.” Costs associated with bank charges and payment to suppliers in foreign currency do not aid in improving Firm C competitiveness. Participant 5 says that to improve competitiveness “it is important to know who is speaking on the other side of the relationship.” The development of a local supplier base and a support base “...where in the long term everyone would benefit...” (Participant 3) would help improve competitiveness in the local aerospace industry. A defined code of conduct in the aerospace industry “...in which companies and individuals could register themselves and some simple mechanism to avoid corruption...” is missing from our local aerospace industry.

Case D

General

Firm D produces interior and exterior components for the aerospace industry. Suppliers and customers discussed within this case study, the product supplied and its strategic importance are given in the tables below.

Table K5: Suppliers identified by Firm D for analysis

Supplier name	Strategic part supplied to firm. Why?	Location
Supplier D1	Specialised materials Supplier D1's materials "provide half of our total expenditure" (Participant 7)	USA
Supplier D2	Precision formed sheet metal components Supplier D2 is strategic "in terms of money expended" (Participant 7)	UK
Supplier D3	Aircraft components-Rod ends and fork ends Supplier D3 is strategic "in terms of money expended" (Participant 7)	France
Supplier D4	AGS (Aircraft General Spares). Bolts, washers. Supplier D4 is a stockist for Firm D, with a Service Level Agreement (SLA) in place that has reduced lead time for delivery of goods. (Participant 8)	UK, but administration done in Germany
Supplier D5	Sheets and billets. Supplier D5 product is supplied to Firm D based on Customer D3's negotiated amounts and prices (Participant 8)	France

Table K6: Customers identified by Firm D for analysis

Customer name	Strategic part sent to customer. Why?	Location
Customer D1	Sole supplier for certain interior panels for an OEM aircraft Product supplied to customer is strategic for cost reasons	USA
Customer D2	Avionic racks for an OEM aircraft Product supplied to customer is strategic for cost reasons	France
Customer D3	Manufacture of the wingtip for an OEM aircraft Product supplied to customer is strategic for cost reasons	UK

Speed

Better and timelier information

Communication

Engineering, demand and supplier performance is shared between Firm D and its suppliers. A long term agreement is in place between Firm D and Supplier D1 to facilitate ongoing communication. A greater amount of communication occurs between Firm D and its suppliers compared to that with customers. Participant 7 explains that this is "...because it is much more frequent...we are following up on orders every single day...in terms of sheer frequency and volume...its not a good or a bad thing, it's the way the business works". Information sharing between Firm D and its customers includes "Almost everything from our systems, manufacturing capacity, resource capacity, financial aspects of the business, procedures and policies...quality audits." (Participant 7) Participant 7 from Firm D says that customers "...look at our business right from the front end right to the back, they know probably as much about us as well know about ourselves." Participant 12 says "A lot of information" is shared between customer D1 and Firm D.

IT

Communication between Firm D and some of its suppliers is "...C2C, or system to system..." (Participant 7) But not all suppliers are willing to participate in electronic communications. Email communication is used between Firm D and other suppliers. The communication link between Firm D and its customers is "...highly technical, and formalised", with "...a variety of electronic interfaces" (Participant 7) Firm D is "Obliged to use" (Participant 7) certain online IT applications with Customer D1 and Customer D3 for purchase orders and advanced shipping notices. The type of IT communication used in Firm D is also department dependent, with purchasing and quality having different ways of accessing the customer. Participant 12 says that daily communication between Firm D and Customer D1 is done "old-school" through the use of phone calls and email, but data placement is done through online information exchange portals, where both parties can securely connect and get data. Commercial applications are also used for communication between Firm D and Customer D1.

Lead time compression

Participant 8 says that lead time compression between Firm D and its suppliers is only possible "...if they become stockists for us". Participant 7 says that the possibility of lead time compression with suppliers "varies enormously, there are some suppliers where you can basically order off the shelf, you place an order, they get it prepared and send it..." Other components like Aircraft General Spares "...where there are shortages on the market as a whole..." require intervention by the higher OEM customer to the supplier for Firm D to obtain the part. Participant 10 highlights the importance of strategic relationships with suppliers in lead time reduction, where if you "...are buying bits and pieces from different suppliers, whenever you need something, then you have to wait for the normal period for the lead time, but if you're strategic you contribute maybe 10 to 15 percent of the profit then obviously they will regard you as an important...customer" Lead time reduction with Supplier D4 is achieved by establishing forecasts and putting Service Level Agreements (SLA's) in place. The use of air freight instead of ocean freight is important in achieving lead time reduction. Participant 7 says that "There is always a balancing act to be made between cost and lead time" when considering transhipment modes. Lead time compression between Firm D and Supplier D1

is enabled by Supplier D1 producing a quarterly run of materials all at once for Firm D. The material from these quarterly runs is released based on Firm D's actual orders to Supplier D1, eliminating the time taken for production each time. This allows Supplier D1 to achieve efficiencies of scale by manufacture of the whole batch at once.

Choice of transhipment mode between Firm D and its customers is important in lead time compression. In addition to the actual costs of transhipment choice, product characteristics and cash flow must also be understood. Participant 7 says that a large amount of aerospace product cannot be "...put out on the sea, there's all sorts of dangers, product being affected by damp air, ...corrosion plays a big part, packaging plays a big part, and cash flow plays a big part...if you order something now that you are only going to receive in 6 weeks time, you've gotta pay in 30 days, so you actually paying for the product long before you receive it..." Participant 7 says that their consolidation of shipments from logistics hubs "...is cost effective, but not lead time effective." Participant 12 from Customer D1 says that Firm D keeps a large on hand stock of material to ensure JIT delivery to them in the USA. This is done as Customer D1 does not want to stock inventory. Participant 8 says that lead time can be reduced from Firm D to the customer by improving internal capacity at Firm D.

Synchronisation

Material order volume and frequency

Frequency of materials ordered from suppliers is done according to the MRP system, which takes into account customer demand, stock levels and lead times. Shipping times for input into the MRP system are taken "at the extreme", where an assumption is made that a shipping consolidation of goods has been missed. Quantity of material ordered from suppliers is based on Economic Batch Quantities (EBQ's) from the MRP system, which accounts for customer demand and current stock levels. But EBQ's do not apply to all product lines, as some suppliers apply minimum order quantities or price breaks for certain products. A long term agreement is in place between Supplier D1 and Firm D, to ensure "security of supply." Quantity of material ordered by Firm D from Supplier D1 is determined by quarterly forecast order amounts plus a possible 25% increase above that amount. The frequency of material orders placed by Customer D1 with Firm D

is based on their master schedule from the ERP system. These orders must be placed within Firm D's available number of manufacturing days. The quantity of material ordered by customers is generally based on a schedule. Participant 7 says that "We generally know from past experience that we've got stable contracts…we know what we producing every month…it's a drumbeat".

Capacity constraints

Delays as a result of supplier capacity problems are different for certain product categories. Raw material delays may occur if a mill breaks down. Participant 7 says that Firm D deals with these breakdowns "…on a one to one basis." Delays in Firm D receiving paint may occur due to interaction between the paint supplier and OEM, where the paint supplier must send material samples to the OEM customer for checking before shipping to Firm D. Participant 9 says that the biggest delays are due to the high levels of material testing in the aerospace industry. Delays from certain suppliers may be dealt with by getting the OEM customer involved "on the rare occasion" to ensure Firm D receives material. Delays in sending products to customers from Firm D may result from "…bottlenecks in the process…" (Participant 7) Bottlenecks may arise from inaccurate inventory counts; buyers slipping up; incorrect min/max levels; changes in schedule; scrapping of parts; and shortage in material supply leading to build up of work in process. Participant 12 from Customer D1 says that Firm D does a good job in mitigating delays, as "they are willing to hold stock for us."

Dependability

Processes and procedures to ensure dependability

A system at Firm D is in place to help "place orders timeously" (participant 7) with suppliers. A 60 day report is sent out to every supplier "…every month, continually on a two month window…" (participant 7) for the supplier to confirm that orders on the report are still on schedule. Quarterly supplier performance feedback allows suppliers to raise issues. Participant 11 says that a change to quarterly production runs at Supplier D1 allows for "flux" in the system, where spikes in demand from Firm D can be covered by "backfill" of orders. Processes and procedures between Firm D and its customers exist

"...in all parts of the business, that's part of the requirements of Customer D1 and Customer D3...they want to see that you've got it documented, and not only documented,...you must show them, not tell them" (Participant 7) Customer D1 holds weekly or even bi-weekly telephonic discussions with Firm D to ensure that processes and procedures are followed. Participant 7 says that main reasons for late delivery to the customer are "a combination of...late deliveries from the supplier, for whatever reason, and probably just production planning."

Quality

Meaning of Quality

Quality between Firm D and its supplier's means that suppliers "...deliver on time...they deliver the right stuff to the right quality, and...accompanied by test reports or certificates of conformance..." (Participant 7) Participant 8 breaks down quality into two parts. Firstly, quality is concerned with documentation like the certificate of conformance (CFC). Secondly, quality is concerned with physical characteristics like material size, dimensions and shelf life for products like paints. Participant 10 describes quality as a supplier delivering a conforming product with the correct quality with all completed correct relevant documentation. Quality between Firm D and its customers is "...a broad focus..." which means delivering the right goods, at the right time, in the right quantities, to an acceptable quality" (participant 7). Participant 12 says that quality is one of the "highest priorities".

Quality planning

Quality planning process

Quality requirements set with suppliers are dependent on the customer's specifications. OEM customers are generally involved in determining stringent initial part or component specifications. Once specifications are determined, manufacturing processes at both supplier and Firm D are kept standard as per customer requirements. Delivery of the product from suppliers to Firm D requires a certificate of conformance to state that the product conforms to the required customer specification. Quality requirements set with customers look at "delivery and quality"

(participant 7) criteria. These criteria are determined by the customer.

Trust

Participant 7 explains the relationship between Firm D and it's suppliers as "...arm's distance, for no other reason but that we are probably separated by ten to twenty thousand kilometres." This means that the relationship with suppliers is not what Firm D would like it to be, as the ability to visit a supplier and "...look in someone's eyes...develops much more personal relationships." Even so, the relationship with suppliers is generally "...pretty cordial, knowing that we do not have too much leverage of ourselves with the suppliers..." This is because Firm D represents a fractional part of most of the big supplier's turnover. Participant 8 identifies language as a barrier in relationships between Firm D and especially French suppliers. This has been addressed by identifying "...a certain supplier that is quite clued up" in France as a middleman, who liaise with French suppliers on Firm D's behalf. Participant 11 says that "Partnership models" are highly important when setting quality requirements with suppliers. On trust with suppliers, participant 7 from Firm D says that "...there's no such thing as trust when you get to the aircraft industry, guys have got to perform to a certain standard...you want documentation..." Participant 8 says that trust depends "...on the commodity". If the product is an AGS like a bolt from Supplier D4, not every bolt is checked. But metal sheets from Supplier D5 are frequently checked.

Participant 7 from Firm D says that the relationship with Customer D1 is "very good" and the relationship with Customer D3 is "good". Participant 12 from Customer D1 says that the relationship with Firm D is "judged on the basis of merit", with a good relationship dependent on Firm D's performance to a set of stipulated criteria. Trust between Firm D and customers "is earned", based on Firm D's historical performance. Participant 12 says that trust has an "expectation" to it, where because Firm D has historically met Customer D1's requirements, they will maintain so in the future relationship.

Quality control

Quality control process

Supplier quality issues are picked up on inspection at Firm D. A level one basic inspection examines whether the product is "...the right stuff... (In) the right quantities..." A level two inspection may require "...further testing...." of the product (Participant 7). If a supplier quality issue is found, it is registered. The buyer then takes the issue up with the supplier. Quality personnel are involved if required and corrective action reports are sent to the supplier to ensure the quality issue is rectified. Quality control is required of both supplier product and documentation, with participant 7 saying that "In the aircraft industry the general rule is that everything on the aircraft should be traceable back to origin". Participant 9 says that an issue with quality control is that checking of approved suppliers and their approved materials is done in receiving, whereas "...that should actually be a check with procurement..." before goods arrive at Firm D. Participant 10 says that a problem in quality control may occur when purchasing a defective product from a distributor in South Africa, who purchases from a distributor overseas who then purchases from a manufacturer overseas. In trying to rectify the problem and "...somebody in-between there is not cooperating its going to impact your production..."

A "multilayered approach" (participant 12) is taken to quality control between Firm D and Customer D1. Customer D1 monitors Firm D's incoming quality and documents quality trends. If a non-conformance is found, Firm D does a root cause analysis and possibly a "5 why" (participant 7) analysis to address the cause. If the quality problem is not found in this way, Customer D1 field personnel are sent to Firm D to determine where the problem lies. Customer D1 uses the "carrot and stick approach" in achieving quality, where a financial reward is given for required and above quality levels and penalties are imposed for poor quality levels.

Performance measurement

Performance feedback on quality and delivery criteria is given to suppliers once a quarter. Suppliers are notified of immediate problems on a daily basis by buyers in Firm D if required. Customer D1 personnel again take a "multilayered approach" in measuring Firm D performance. Customer D1 gives monthly and

quarterly feedback, and a yearly on site “production readiness review” (participant 12) of Firm D’s facilities. Shop floor data collection at Firm D monitors internal performance.

Quality improvement

Quality improvements are not made between Firm D and its suppliers, with participant 7 saying that “...quality is taken care of via the OEM’s”, as most suppliers that Firm D uses have already been quality rated by the OEM’s. But participant 8 from Firm D says that quality improvements are made with suppliers via performance feedback, non conformance reports and interaction with suppliers. Participant 11 from Supplier D1 says that “Any quality changes originate from trust” and two methods exist in trying to improve quality. First, interactions with Firm D can determine whether beneficial changes can be made. Second, internal systems and performance measures in place at Supplier D1 monitor outgoing product quality to Firm D.

Quality improvements between Firm D and its customers “basically come...from the OEM” (participant 7) Firm D produces the OEM customer product to plan, and any changes made to the standard plan, such as materials used, is determined by the customer. Participant 12 from Customer D1 says that quality improvements made are dependent on relationships, and whether firms want to improve themselves.

Flexibility

Meaning of flexibility

Flexibility between Firm D and its suppliers “...means being able to change...delivery schedules, or delivery quantities, or react to...Aircraft on Ground, which is the highest priority of requirement...” (Participant 7) Participant 8 says that flexibility “...means a lot to me, but not so much to suppliers”, where some suppliers are not willing to make beneficial changes for Firm D. Participant 8 also gives forward that “Flexibility is a matter of perception” and there is “no generic statement for all suppliers” to explain flexibility. Participant 11 says that “Limited flexibility in product quality” exists in the aerospace industry.

Flexibility between Firm D and Customer D1 and Customer D3 is “...really a flexibility with regard to adapting the changes that

they want, and it could be in terms of materials, it could be in terms of design... the initiative is in the OEM's camp." (Participant 7) Flexibility is required from Firm D when the customer asks for shorter lead times for product delivery, sometimes in the expediting of supplies, a cost "...which you cannot pass onto the customer." (Participant 7) Participant 12 says that "There's not much flexibility" between Customer D1 and Firm D in meeting delivery and quality criteria, as the programme that Firm D supplies for is highly constrained. For other suppliers supplying for other programmes there is "greater flexibility because the (delivery) rate is slower." Participant 8 says that flexibility with customers means that if the customer has an unforeseen event, "...we need to cater for that..."

Achievement of flexibility

Participant 7 says that "...mutual communication...that's all we can do from this distance" is required to achieve flexibility between Firm D and its suppliers. Participant 8 says that "It is a matter of communication" to achieve flexibility with suppliers. Participant 11 says that the number one thing for flexibility is "visibility" into the OEM customer's demand, which would help limit "fluctuation in demand for our product." Participant 11 says that the move to quarterly forecasts between Firm D and Supplier D1 aids flexibility. Participant 8 says that achieving flexibility with customers is based on "...the culture of the (customers) company" Participant 7 says that Firm D's "design office needs to be extremely flexible..." with regard to product design changes for customers.

Other

Ways to improve competitiveness

Participant 8 says that establishing Service Level Agreements (SLA's) between Firm D and its suppliers would lead to improved competitiveness. SLA's would be established with the top ten suppliers "in terms of the value that we spend" and "strategic value that they add to our supply chain". But suppliers do not want to get into an SLA, possibly because "we make up such a small percentage of their turnover". Participant 8 says that supplier audits may improve competitiveness.

Participant 8 says that the crux of improving competitiveness between Firm D, its suppliers and customers lies in accurate forecasts and SLA's. Participant 12 says that improving competitiveness with customers is more of an "issue of marketing than performance." Because of South Africa's geographic location, the countries aerospace industry is relatively unknown. "Active marketing" is therefore required. Participant 12 also says that South African aerospace should "offering a certain service and technology" to differentiate ourselves in the aerospace market.

Case E

General

Firm E produces interior and exterior components for the aerospace industry. Suppliers and customers discussed within this case study, the product supplied and its strategic importance are given in the tables below.

Table K7: Suppliers identified by Firm E for analysis

Supplier name	Strategic part supplied to firm. Why?	Location
Supplier E1	Participant 13 says that Supplier E1 supplies "All my aerospace materials..."	South Africa

Table K8: Customers identified by Firm E for analysis

Customer name	Strategic part sent to customer. Why?	Location
Customer E1	UAV, "with landing gear, with everything, we build the complete structure, we just don't do the electronics" (Participant 13) The UAV allows the exploration of other markets besides South Africa	Saudi Arabia
Customer E2	Compression moulded composite turbine blades Product supplied to customer is strategic for cost reasons	USA

Speed

Better and timelier information

Communication

Participant 13 says that information sharing between Firm E and Supplier E1 is "...down to detail level..." with "Just about everything" (Participant 14) being discussed. Participant 14 says that Supplier E1 "forms a big part of product development" with Firm E, even sitting in on initial project meetings to help determine material choices. Participant 13 says that because Customer E1 is paying Firm E for design, "...they have full access..." to the design, and no information is held back from them. Information sharing between Firm E and Customer E2 consists of RFQ's, electronic sending of a CAD model to Firm E, feedback on the model, and discussion on what manufacturing processes could be used for product manufacture.

IT

Email and telephone is used in communicating between Firm E and Supplier E1. Email and an FTP (File Transfer Protocol) internet site are used in communicating between Firm E and Customer E1. Information technology is "exclusively" used in communicating between Firm E and Customer E2, with email, phone and electronic CAD model transfer. With the large distance between Firm E and Customer E2, no "physical interaction" occurs.

Lead time compression

Participant 14 from Supplier E1 says that Firm E does not always convey project progress and material requirements to them. This can result in Supplier E1 not reordering materials from their suppliers in time, delaying the project. The use of different systems between supply chain members that do not link together to enable information flow leads to lack of stock visibility. This problem is cost based, as supply chain systems and consultants are too costly for Supplier E1 to use. Participant 14 says that lead time compression between Firm E and Supplier E1 can be achieved by improving "stock planning". Participant 13 says that long lead times may occur with some "pre-preg" composite materials, "...because the supplier overseas manufacture(s) the

material for us specifically...” Therefore planning ahead and holding stock is essential to ensure that production does not stand still.

Few problems with regard to slow lead times have been experienced between Firm E and Customer E1. This is attributed to the use of an “efficient” logistic provider. Participant 15 says that lead time delays between Firm E and Customer E2 may result from import control delays of goods going into the USA from South Africa; and difficulty in procuring the necessary material for Customer E2’s product in South Africa.

Synchronisation

Material order volume and frequency

Participant 13 says that a set amount of “pre-preg” material is ordered from Supplier E1 every month based on the Bill of Materials, scrap rates and current production levels at Firm E. A three month production forecast is then given to Supplier E1 based on Firm E’s current production. If a “ramp up or ramp down” of production is required, Supplier E1 is notified three months in advance. But participant 14 says that normally Firm E places an order “...a week after its needed...” with Supplier E1, as Firm E’s customer may place a late order with them. Participant 14 from Supplier E1 says that minimum order quantities for certain of Firm E’s materials are imposed by their suppliers. Because Firm E may be the only customer requiring that material, the minimum order quantity is passed onto Firm E. This is done incrementally, where if Supplier E1 orders a minimum order quantity of 400 meters, then Firm E purchases 100 metres of material over four months. This helps Firm E with their “cash problems.” Participant 13 from Firm E says that order quantities depend on who the customer is. Development work between Firm E and Customer E1 resulted in “...three or four things” being ordered from Firm E. The order placed by Customer E2 with Firm E was a “once off product”, and as such there is not really any form of scheduling in place.

Capacity constraints

Participant 13 says that a “manufacturing delay” with the “pre-preg” material manufacturer has occurred in the past. Because of lengthy production and transportation times to receive the material, Firm E used another brand of “pre-preg” material which

was not a fully qualified product. Firm E had to therefore qualify the new brand of material, "...which is a bit of a schlep..." Participant 14 says that production of specific resins by overseas suppliers is only done periodically. If Firm E orders product in the middle of the period where no resin manufacture occurs and no stock is on the shelf at Supplier E1, Firm E has to wait for both production and transhipment time for delivery. Participant 14 says that "...if the planning isn't upfront, it gets stuffed up." There have been no delays in sending materials from Firm E to Customer E1 as little product has so far been sent. A delay in sending material between Firm E and Customer E2 occurred due to an error in the CAD model design.

Dependability

Processes and procedures to ensure dependability

Participant 13 says that "...the forecasts are sufficient" to ensure on time reliable delivery of goods between Supplier E1 and Firm E. Participant 14 from Supplier E1 says that they meet once or every second week to see what is happening on the projects that are running. Participant 14 says that "...it's almost as if I work in the company..." Firm E sends a "...spreadsheet or project plan..." to Customer E1 to aid on time reliable delivery of goods (Participant 13) A date is given to Firm E for delivery of goods to Customer E2.

Quality

Meaning of Quality

Participant 13 says that quality is a combination of "...material quality, to my product quality, to my service quality to the customer..." Participant 14 says that a certificate of compliance "...that should guarantee a certain quality..." is necessary in aerospace work. Participant 13 says that there are no "specific requirements" for quality with Customer E1. This is because the product that Firm E manufactures for Customer E1 is still in development, and requirements will be set with development progress. With Customer E2 being a R&D company, product quality from Firm E does not need to be certified. This is because the product is not required to carry people as would be so in aerospace.

Quality planning

Quality planning process

Participant 14 from Supplier E1 says that Firm E "...will tell me..." if any quality requirements exist. The manufacturer's Certificate of Conformance (CFC) is needed for Firm E to accept incoming material. Quality planning with Customer E1 is still a work in progress as the product is still in the development phase. Customer E2 quality requires that the product "fits" together and "does not break" (Participant 15)

Trust

A "...good working relationship..." (Participant 13) exists between Firm E and Supplier E1. Participant 14 from Supplier E1 says that the relationship with Firm E is "Very good, they're my best customer." Participant 13 from Firm D says that trust exists with a specific person in Supplier E1, who "...knows our requirements..." Participant 14 from Supplier E1 says that Firm E trusts us to "...deliver the required quality or at least back our product up. If the quality is wrong they know we will sort it out." Participant 13 says the relationship with Customer E1 is "In general, very good." Participant 13 says that whilst there have been "...a couple of issues on delivery times", Customer E1 does trust Firm E to deliver the required quality. Participant 13 says that trust is shown with Firm E because Customer E1 "...keep(s) on coming back to us." The relationship between Firm E and Customer E2 started as a result of "word of mouth" from someone within Customer E2 who is familiar with Firm E's work.

Quality control

Quality control process

Incoming product to Firm E is not accepted unless the manufacturers Certificate of Conformance is present. An incoming inspection is then performed. If the product fails incoming inspection, the buyer phones Supplier E1, and the product is replaced or a refund is issued. Participant 14 from Supplier E1 says that "...whatever is required from Firm E's side actually happens..." As Customer E1 is still in the product development phase, there are no set quality control requirements with Firm E as yet.

Performance measurement

There are no performance measures in place at Firm E, but Participant 13 says that they are in the process of implementing an ISO system. Participant 14 says that there are no performance measures in place at Supplier E1 either, but quality issues are tracked using batch numbers and CFC's. There are currently no performance measures in place with Customer E1. Participant 13 says that in future performance measures with Customer E1 would look at whether Firm E delivers "...on time in the right quantities..."

Quality improvement

If a defective material batch form the manufacturer is supplied to Supplier E1 or Firm E, the manufacturer is notified. If a defect like the curing of a "pre-preg" material due to slow shipping occurs, Supplier E1 would try and correct the cause of the problem. No quality improvements are made with Customer E1.

Flexibility

Meaning of flexibility

Participant 13 says that "Flexibility is key in this industry..." Flexibility in the relationship between Firm E and Supplier E1 is seen in the ability for Firm E to change orders from the original forecast sent to Supplier E1. Participant 14 says that flexibility between Firm E and Supplier E1 is seen in the ability to: work together to find alternative materials and fit designs if specific materials are not available; and the stocking of specific product by Supplier E1 for Firm E to aid cash flow. Flexibility may also mean that Firm E may make do with a product from Supplier E1 "...that is not as good as it could be...", but understanding its origin and the cost benefits of using that product. Firm E must be flexible because Customer E1 is "...constantly changing requirements..." (Participant 13)

Achievement of flexibility

Flexibility between Firm E and Supplier E1 is achieved by having "...a very good relationship..." Participant 14 says that it is necessary to make the relationship "...work for both sides,

looking for win-win kind of scenarios…" Supplier E1 is also knowledgeable about the aerospace industry, "…they understand this industry probably better than anyone else…" (Participant 13)

Other

Ways to improve competitiveness

Participant 14 says that "…the government should spend money in the right places…developing the industry correctly…make us (the aerospace industry) more cost effective." Participant 14 also suggests that the South African government should spend money on the production of wind turbines in South Africa as we have the ability to manufacture and export them. This would be far greater value adding as we could manufacture the whole unit, instead of only getting smaller aerospace OEM component manufacture. The Department of Science and Technology (dst) and the Department of Trade and Industry (dti) should also ensure that the link between research and actual production is achieved. Regular meetings with the dti on projects in specific focus areas should be done. Participant 13 says that improving competitiveness between Firm E and Customer E1 requires working together to "…deliver on time…" and "communication".

Case F

General

Firm F performs Maintenance, Repair and Overhaul (MRO) services for the aerospace industry. Suppliers and customers discussed within this case study, the product supplied and its strategic importance are given in the tables below.

Table K9: Suppliers identified by Firm F for analysis

Supplier name	Strategic part supplied to firm. Why?	Location
Supplier F1	Participant 16 says Supplier F1 provides "Anything we need" for a specific aircraft	USA
Supplier F2	Participant 16 says Supplier F2 provides "Anything we need" for a specific aircraft	UK
Supplier F3	Supplier F3 makes up about 40% of supply by cost (Participant 17)	South Africa

Table K10: Customers identified by Firm F for analysis

Customer name	Strategic part sent to customer. Why?	Location
Customer F1	"Component overhaul...different assemblies, maybe even parts." (Participant 16) Participant 16 says that "Basically we've got one customer, that's Customer F1"	South Africa

Speed

Better and timelier information

Communication

Participant 16 says that information sharing with suppliers is on an “ad hoc” basis. Participant 17 says that “At this point in time very little” information is shared with suppliers, but in the future the planning horizon is to be extended to “...have better visibility on what is due as far in advance as possible.” Information on stock levels is shared between Firm F and customers.

IT

Information sharing between Firm F and suppliers is in the form of email, phone, printed purchase orders, RFQ’s and spreadsheet. Participant 17 explains that “...there is no e-procurement at the moment because you must also bear in mind the sensitivity in the military industry around data transfers...two ERP systems taking to each other is a huge concern.” Whilst complete integration is not possible, “another level” of IT above what is currently in place is needed. Participant 16 says that “...there’s no electronic link so to speak” that is used for communication between Firm F and customers.

Lead time compression

Participant 16 says that lead time reduction is possible with suppliers if “...you fly it in.” Participant 17 says that “...comprehensive and effective planning...” and the need to “...integrate closer...” with suppliers is required for lead time compression. Participant 18 from Supplier F3 suggests the use of a website, where customers “...will be able to place a purchase order directly into the system...” to reduce lead time. Participant 16 says that lead time reduction between Firm F and its customers may be possible if computer systems “...could be talking to one another...”

Synchronisation

Material order volume and frequency

Material order frequency from suppliers is based on the customer's aircraft needs. This can only be determined when the aircraft is stripped down at Firm F to discover what components need replaced. Lead times from suppliers may vary when ordering components due to supplier production schedules. Material order volumes are based on "...lead times and obviously an MRP type setting..." (Participant 17) Stock is kept at Firm F only if a particular project is running with customers, otherwise participant 17 says that "...we don't want to keep stock if we can help it." Material order volume and frequency of parts from Firm F by Customer F1 is based on a service level agreement. Customer aircraft are stripped down by Firm F and required parts are ordered.

Capacity constraints

Delay between Firm F and its suppliers may result from the supplier having to split incoming larger batches into smaller ones, and not enough personnel to do so in a timely manner. Participant 19 from Supplier F3 points out that Bevel gear production from its suppliers is constrained as a result of "...production difficulties...and an unexpected increase in demand..."

Dependability

Processes and procedures to ensure dependability

Frequent audits and quality checks based on agreements are performed between Firm F and its local suppliers. Firm F also monitors the "typical errors" (Participant 17) that its suppliers may make, such as the frequency of oversupply, undersupply, and supplying the wrong goods. A progress meeting every second week between Firm F and Supplier F3 allows for review of specified delivery dates and critical items required by Firm F.

Quality

Meaning of Quality

Participant 17 from Firm F describes quality with suppliers as being "...not only fit for use...but is also on time, correct quantity, correct descriptions, the documentation and items that arrive tie up,...the correct modifications of that part..."

Quality planning

Quality planning process

Quality requirements set with suppliers require a Certificate of Conformance (CFC) to be sent with all components. Participant 17 says that this is to ensure the sent component "...is correct in every detail, for the intended use." Participant 16 says that the quality requirements "...we place on our suppliers are the same requirements that Customer F1 places on us."

Trust

Participant 17 says that the relationship between Firm F and its suppliers "...has to be one of mutual cooperation, you cannot work on an adversarial relationship..." Participant 19 says that a "partnership" exists between Firm F and Supplier F3. Participant 17 says that a technical aid agreement between Firm F and its suppliers "...rule a lot about the relationships between two organisations...not only...for the parts but for knowledge, know-how, engineering, backup..." Participant 16 says that the relationship between Firm F and Customer F1 is a "...hand in the pocket relationship...the one can't go without the other." This is because Firm F and Customer F1 are heavily reliant on each other for business.

Trust exists between Firm F and its suppliers on component quality, subject to a CFC being sent with the component. Trust is less clear on lead times and pricing, but Participant 17 says that this is "...normally taken care of in the normal service level agreement between supplier and customer." Participant 19 says that trust between Firm F and Supplier F3 is based on past experience, and Supplier F3 providing alternative solutions to

problems if required. Participant 16 says that he does believe that Customer F1 trusts Firm F, where "...the product that we deliver is up to their specification."

Quality control

Quality control process

Participant 16 says that quality problems at Firm F are often only picked up on the shop floor "...because goods receiving...are not technically orientated to do quality control as such, that's why we rely heavily on the CFC's." Quality control needs to consider both component quality and supply chain factors such as late delivery, wrong quantities, and wrong part numbers. Participant 16 says that quality control with customers relies "...on the same CFC for quality" that is received from the supplier.

Performance measurement

Participant 17 says that "...a whole series..." of "very simple" performance measures are used with suppliers, looking at things such as "...what are you delivering, when are you delivering, is it the right stuff... on time...price variability...response to technical questions..." etc.

Quality improvement

No "active" quality improvements are made between Firm F and its suppliers. Participant 17 says that quality improvements with suppliers will be looked at in the future, but Firm F first needs to "stabilise" Firm F internally as well as its relationships with suppliers before this happens.

Flexibility

Meaning of flexibility

Flexibility between Firm F and its suppliers means that Firm F can alter the delivery dates of stock based on their needs. Participant 17 from Firm F says that flexibility means suppliers have "...the ability to assist us technically when technical questions arise", and suppliers "...give us quotations on changing requirements on a daily basis." Participant 16 and participant 18

say that little flexibility exists between Firm F and suppliers. Participant 18 says that "...procedures and...contracts..." limit flexibility. Participant 16 says that flexibility with customers is time based, where the customer may need to be flexible with Firm F if "...we can't make it because our suppliers are late."

Achievement of flexibility

Participant 17 says that "...flexibility comes with a cost..." An increase in spares holding allows for greater flexibility with customers, but also lowers cash flow. Participant 18 says that supply chain flexibility requires "...a more integrated chain..." where changes in customer operational requirements "...will flow directly back to the production line..." Participant 19 says that achieving flexibility through a more integrated chain is possible, "...but quality is not flexible."

Other

Ways to improve competitiveness

Participant 17 says that "communication" throughout the organisation is important for supply capability, as well as "...accurate planning..." where "...the better your planning horizon is, the more accurate your planning horizon...the better your supplier is likely to support you." Participant 16 says that trying to improve competitiveness through cost is difficult, as you are normally "bound" to the OEM manufacturer "...who says that these components will be bought from those...suppliers..." Participant 18 says that improving competitiveness between Firm F and Supplier F3 can be achieved "...by placing orders on the internet..." Participant 19 suggests EDI as a way to improve by not having to exchange paper, and "...the big way forward is to integrate the needs of the final customer..." with suppliers.

Appendix L

Single Case Analysis Tabular Results

Appendix L contains the single case tabular results for Case A, Case C, Case D, Case E and Case F. Case B is included in the main report.

Summary of Case A data

Competitive dimension	Second-Order Measurement	Third-Order Measurement	Case A (supplier-firm unit)
Speed	Better and timelier information	Communication	Information sharing important
		IT	Email, website and MRP, but IT "has lost that personal touch" (participant 1) Cannot completely rely on systems Face-to-face communication essential
	Lead time compression	-	"Stock carried is obviously of vital importance, everybody wants to carry as little stock as possible." (Participant 1) Lead time reduction using air instead of ship freight, but costs must be considered
	Synchronisation	Material order volume and frequency	MRP generally establishes material order volumes and frequencies. Material order frequency varies between suppliers. Material EOQ's generally determined at onset with suppliers, accounting for supplier batch and packaging sizes
		Capacity constraints	Suppliers prioritize specific customer orders based on importance if internal capacity issues arise Transhipment capacity as well as internal firm capacity important
Dependability	Processes and procedures	-	Verification and understanding of supplier orders. Delivery of documentation equally important to the physical product

Summary of Case A data (continued)

Competitive dimension	Second-Order Measurement	Third-Order Measurement	Case A (supplier-firm unit)
Quality	Meaning of quality	-	Subjective, dependent on customer requirements
	Quality planning	Quality planning process	Documentation of quality requirements, and possible customer verification of requirements
		Trust	"Partnership" type relationship (Participant 1) Trust in the relationship is established "over time" (Participant 1)
	Quality control	Quality control process	Firm A does "random sampling testing" and "inspection" with suppliers Consistent quality problems result in stepped up quality inspections, "additional audits in process", and supplier on-site inspections (Participant 1)
		Performance measurement	Performance data is collected within Firm A and on its suppliers. Participant 1 says that performance measures used depend on "…the processing of the material…there are vast things that you can do."
	Quality improvement	-	A quality management system has to be in place. Supplier audits performed to identify quality improvements

Summary of Case A data (continued)

Competitive dimension	Second-Order Measurement	Third-Order Measurement	Case A (supplier-firm unit)
Flexibility	Meaning of flexibility	-	Flexibility is the achievement of "unrealistic demands, or unreasonable demands" that are placed on the supplier by Firm A, possibly in the firm changing the original order given to the supplier (Participant 1)
	Achievement of flexibility	-	Understanding of supplier processes The "buying-in" of suppliers into improving levels of flexibility with Firm A (Participant 1)
Other	Ways to improve competitiveness	-	Having longer payment terms with suppliers leads to an improved cash flow, which "leads to regularly getting in more funds…" (Participant 1)

Summary of Case A data (continued)

Competitive dimension	Second-Order Measurement	Third-Order Measurement	Case A (customer-firm unit)
Speed	Better and timelier information	Communication	"To try and tell the customer that you are obviously the best…you would try to convince and maintain to your customer that the customer is first…by giving him the best price, the best quality, and delivery when he wants it". (Participant 1)
		IT	IT communication through email, website and an MRP system Face-to-face communication still essential, where participant 1 would go overseas "…once a year or every six months, scheduling one or two weeks depending on how many customers you want to see…"
	Lead time compression	-	Lead times for transportation modes requires an understanding of associated costs
	Synchronisation	Material order volume and frequency	Timing of orders irregular for once off customer projects, but may be regular for other customer projects. Order sizes dependent on the interior size of an aircraft
		Capacity constraints	Internal firm capacity problems relating to manufacturing; supplier issues; late customer notification on which product to produce External (transhipment) capacity as well as internal firm capacity important

Summary of Case A data (continued)

Competitive dimension	Second-Order Measurement	Third-Order Measurement	Case A (customer-firm unit)
Dependability	Processes and procedures	-	Management of lead times. Contingency plans and reaction to issues as they arise are important, but learning from past experience is vital
Quality	Meaning of quality	-	"Maybe in a nutshell, if you exceed your customer's expectations, then you've achieved quality" (Participant 1)
	Quality planning	Quality planning process	Documentation and an understanding of customers needs. Product quality targets initially set and fixed by customer, costs associated with increasing quality targets
		Trust	"Mutual respect" required in the relationship (Participant 1) Trust is established with the "initial contact…the first impression…and the first communication you make" with your customers (Participant 1)
	Quality control	Quality control process	All means should be used in preventing poor quality parts from reaching the customer. If poor quality parts reach the customer, an overseas service centre corrects the quality issue.
		Performance measurement	A failures modes and effects analysis (FMEA) may be performed to find reasons for poor quality with customers. A number of measures may be used, and participant 1 says that it is important to "look at all possible options."
	Quality improvement	-	No active quality improvements made, quality target initially set is kept

Summary of Case A data (continued)

Competitive dimension	Second-Order Measurement	Third-Order Measurement	Case A (customer-firm unit)
Flexibility	Meaning of flexibility	-	Flexibility with customers is a more "subjective" matter, and depends on where you are positioned in the supply chain (Participant 1)
	Achievement of flexibility	-	Achieving flexibility with customers may increase cash expenditure for Firm A through holding extra stock, alternate transportation modes, or internal production costs
Other	Ways to improve competitiveness	-	Increasing Firm A organisational efficiency, possibly through multi-skilling labour and MRP automation

Summary of Case C data

Competitive dimension	Sub-Measurement	Sub-sub Measurement	Case C (supplier-firm unit)
Speed	Better and timelier information	Communication	Information sharing with suppliers is a "…open two way channel" and a "lot of information" is shared (Participant 3)
		IT	Email and vendor reports. Specific software tailored for distribution activities in the aerospace industry
	Lead time compression	-	Firm C generally places orders in advance with Supplier C1 to aid in timely shipping of goods. Lead time reduction using air instead of ship freight, but costs must be considered
	Synchronisation	Material order volume and frequency	For known projects, material order frequency from suppliers is done on a "regular basis" (Participant 5). But if an AOG, material is air freighted within 48 hours to Firm C. The volume of material ordered by Firm C is "fluid", as the aerospace "market (is) not so regular." (Participant 5)
		Capacity constraints	Delays when Firm C orders large batches of paint from Supplier C1. Not a "regular occurrence" (Participant 5)

Summary of Case C data (continued)

Competitive dimension	Sub-Measurement	Sub-sub Measurement	Case C (supplier-firm unit)
Dependability	Processes and procedures	-	Supplier "standard lead times" and product regulatory requirements must be understood (Participant 3) From Firm C's purchasing point of view, processes and procedures are embedded within their aerospace specific software
Quality	Meaning of quality	-	"Lead time control" through monitoring the requested delivery date versus actual delivery date of product from suppliers; and "product control" of incoming material from suppliers (Participant 3) Documentation important
	Quality planning	Quality planning process	Planning for quality with suppliers generally controlled by prescribed product specifications, product standards or defined part product numbers as per the OEM, airline or maintenance firm
		Trust	A "Positive relationship" exists between Firm C and suppliers. Trust exists, because a "…qualification system of each supplier…" is in place and "…we follow up on the quality system on a monthly basis." (Participant 4)

Summary of Case C data (continued)

Competitive dimension	Sub-Measurement	Sub-sub Measurement	Case C (supplier-firm unit)
Quality	Quality control	Quality control process	A quality system needs to be in place to ensure traceability of both product and the "…certificate associated with it…" (Participant 3) Full traceability is "…an extremely important factor" (Participant 4)
		Performance measurement	Supplier average delivery lead times and product quality performance measured
	Quality improvement	-	Firm C gives "specific feedback" on performance and product quality to its distributorships or main suppliers on a monthly and annualised basis. Firm C gives "widespread feedback" to its non-distributorships or ad-hoc suppliers (Participant 3)
Flexibility	Meaning of flexibility	-	Participant 3 says that "Flexibility of payment terms are (sic) probably one of the key aspects" with suppliers
	Achievement of flexibility	-	Suppliers placing stock on consignment with Firm C would allow for delivery of product to customers as "…efficiently as possible." (Participant 3) Local customisation of some overseas supplier products
Other	Ways to improve competitiveness	-	Increasing material volumes and consolidation to reduce freight costs Bank charges and foreign currency payments problematic Relationships are important

Summary of Case C data (continued)

Competitive dimension	Sub-Measurement	Sub-sub Measurement	Case C (customer-firm unit)
Speed	Better and timelier information	Communication	Information sharing with customers is important from "…a sales point of view…" (Participant 3, Case C) Information sharing in the form of shipping details, spare part numbers, material quantities and usage frequencies
		IT	Communication with customers done using aerospace specific software and email
	Lead time compression	-	Lead time compression aided by the use of aerospace specific software to shrink administrative cycle between Firm C and customers Firm C keeps on hand safety stock for Customer C1 for fast moving stock
	Synchronisation	Material order volume and frequency	Customers order goods from Firm C based on price, delivery conditions and the "…situation they find themselves in" Customer order volumes are based on "min/maximum levels", where the "reorder process" is the customer's responsibility. Firm C prescribes "…minimum order quantities or price break quantities…" for certain products (Participant 3)

Summary of Case C data (continued)

Competitive dimension	Sub-Measurement	Sub-sub Measurement	Case C (customer-firm unit)
Speed	Synchronisation	Capacity constraints	External capacity delays because of flight availability to customers
Dependability	Processes and procedures	-	A "written procedure" exists, but aspects like flight availability are out of Firm C control. Tracking information from Firm C allows Customer C1 to monitor order progress.
Quality	Meaning of quality	-	"product quality" and on time delivery to customers (Participant 3)
	Quality planning	Quality planning process	Depends on ""International aviation regulation…" (Participant 4) and "…other criteria that each airline or each customer will have that isn't necessarily prescribed specifically…" (Participant 3)
		Trust	A "pretty good relationship" exists between Firm C and its customers (Participant 3). Relationships with customers are highly dependent on specific people within a firm. Trust between Firm C and its customers exist because of transparency; the customer can audit Firm C. Customer's trust the product distributed by Firm C because it is a reputable OEM product.

Summary of Case C data (continued)

Competitive dimension	Sub-Measurement	Sub-sub Measurement	Case C (customer-firm unit)
Quality	Quality control	Quality control process	Quality complaint system in the quality management system identifies customer quality problems. Customer quality problems addressed at Firm C monthly meetings. "…communication to and from the customer is very important. And has to be timeous as well…" (Participant 3)
		Performance measurement	Performance measures used. Customer satisfaction questionnaires supply "very simple" responses. Performance measures need to identify quality problems at the receiving point of the process from suppliers (Participant 3)
	Quality improvement	-	Quality improvements made through the customer complaint process in the quality management system
Flexibility	Meaning of flexibility	-	Flexibility of "payment terms" with customers (Participant 3)
	Achievement of flexibility	-	Flexibility of "payment terms" with customers, with a "win-win" payment situation for both parties involved (Participant 3)
Other	Ways to improve competitiveness	-	The development of a local supplier base and a support base "…where in the long term everyone would benefit…" (Participant 3) A defined code of conduct in the aerospace industry "…in which companies and individuals could register themselves and some simple mechanism to avoid corruption…" (Participant 3)

Summary of Case D data

Competitive dimension	Sub-Measurement	Sub-sub Measurement	Case D (supplier-firm unit)
Speed	Better and timelier information	Communication	Engineering, demand and supplier performance information shared. A long term agreement is in place between Firm D and Supplier D1 to facilitate ongoing communication
		IT	"…C2C, or system to system…" (Participant 7) Not all suppliers are willing to participate in electronic communications. Email used in communicating with other suppliers
	Lead time compression	-	Lead time compression with suppliers possible "…if they become stockists for us" (Participant 8) Being strategically important to a supplier Forecasts and SLA's Full quarterly runs of material released by Supplier D1 when needed, eliminates production time Lead time reduction using air instead of ship freight, but costs must be considered

Summary of Case D data (continued)

Competitive dimension	Sub-Measurement	Sub-sub Measurement	Case D (supplier-firm unit)
Speed	Synchronisation	Order volume and frequency	MRP determines material order frequency. Some material order volumes based on EBQ's, others on minimum order quantities or price breaks
		Capacity constraints	Delays are different for various product categories. Delays may occur due to material testing by OEM's
Dependability	Processes and procedures	-	A system at Firm D is in place to help "place orders timeously" (participant 7) with suppliers A 60 day order confirmation report is sent out to suppliers "…every month, continually on a two month window…" (Participant 7) Quarterly supplier performance feedback allows suppliers to raise issues. Quarterly production runs at Supplier D1 allows for "flux" in the system, controlling spikes in demand with Firm D through "backfill" of orders (Participant 11)

Summary of Case D data (continued)

Competitive dimension	Second-Order Measurement	Third-Order Measurement	Case D (supplier-firm unit)
Quality	Meaning of quality	-	Suppliers "…deliver on time…they deliver the right stuff to the right quality, and…accompanied by test reports or certificates of conformance…" (Participant 7)
	Quality planning	Quality planning process	Quality requirements set with suppliers are dependent on the customer's specifications. OEM customers are generally involved in determining stringent initial part or component specifications. Delivery of the product from suppliers to Firm D requires a certificate of conformance to state that the product conforms to the required customer specification
		Trust	"Partnership models" (Participant 11) are important when setting quality requirements with suppliers. The relationship with suppliers is "…arms distance, for no other reason but that we are probably separated by ten to twenty thousand kilometres." Even so, relationships are generally "…pretty cordial…" (Participant 7) "…there's no such thing as trust when you get to the aircraft industry, guys have got to perform to a certain standard…you want documentation…" (Participant 7)

Summary of Case D data (continued)

Competitive dimension	Second-Order Measurement	Third-Order Measurement	Case D (supplier-firm unit)
Quality	Quality control	Quality control process	Incoming product inspection Quality control of supplier product and documentation, "In the aircraft industry the general rule is that everything on the aircraft should be traceable back to origin" (Participant 7) Checking of approved suppliers and materials is done in receiving, whereas "…that should actually be a check with procurement…" before goods arrive at Firm D (Participant 9) Procurement of defective international products from distributors in South Africa may be difficult to rectify, if "…somebody in-between there is not cooperating its going to impact your production…" (Participant 10)
		Performance measurement	Performance feedback on quality and delivery criteria is given to suppliers once a quarter. Suppliers are notified of immediate problems on a daily basis by buyers in Firm D if required.

Summary of Case D data (continued)

Competitive dimension	Second-Order Measurement	Third-Order Measurement	Case D (supplier-firm unit)
Quality	Quality improvement	-	Active quality improvements are not made with suppliers, "…quality is taken care of via the OEM's" (Participant 7) Quality improvements are made with suppliers via performance feedback, non conformance reports and interaction with suppliers (Participant 8) "Any quality changes originate from trust" (Participant 11).
Flexibility	Meaning of flexibility	-	Flexibility between Firm D and its suppliers "…means being able to change…delivery schedules, or delivery quantities, or react to…Aircraft on Ground, which is the highest priority of requirement…" (Participant 7) "Flexibility is a matter of perception" and there is "no generic statement for all suppliers" (Participant 8) "Limited flexibility in product quality" exists in the aerospace industry (Participant 11)
	Achievement of flexibility	-	"…mutual communication…that's all we can do from this distance" (Participant 7). "It is a matter of communication" (Participant 8) "Visibility" into the OEM customer's demand (Participant 11) Quarterly forecasts between Firm D and Supplier D1
Other	Ways to improve competitiveness	-	Establishing Service Level Agreements (SLA's) between Firm D and its suppliers

Summary of Case D data (continued)

Competitive dimension	Sub-Measurement	Sub-sub Measurement	Case D (customer-firm unit)
Speed	Better and timelier information	Communication	"Almost everything…" Customers "…look at our business right from the front end right to the back, they know probably as much about us as we know about ourselves." (Participant 7, Case D)
		IT	"…highly technical, and formalised", with "…a variety of electronic interfaces" (Participant 7) "Obliged to use" certain online IT applications with customers (Participant 7)
	Lead time compression	-	Choice of transhipment modes, considering costs, product characteristics and cash flow Consolidation "…is cost effective, but not lead time effective." (Participant 7) Firm D keeps a large on-hand stock of material to ensure JIT delivery to Customer D1 in the USA Improve internal capacity at Firm D.

Summary of Case D data (continued)

Competitive dimension	Sub-Measurement	Sub-sub Measurement	Case D (customer-firm unit)
Speed	Synchronisation	Order volume and frequency	Material quantities ordered by customers are generally based on a schedule. Participant 7 says that "We generally know from past experience that we've got stable contracts…we know what we producing every month…it's a drumbeat"
		Capacity constraints	Internal firm capacity problems like "…bottlenecks in the process…" (Participant 7, Case D) Firm D mitigates delays with Customer D1 because "they are willing to hold stock for us."
Dependability	Processes and procedures	-	Processes and procedures between Firm D and Customer D1 and Customer D3 exist "…in all parts of the business, that's part of the requirements…" (Participant 7) Telephonic discussions are held between Firm D and Customer D1 to ensure that processes and procedures are followed Main reasons for late delivery to the customer are "a combination of…late deliveries from the supplier…and probably just production planning." (Participant 7)

Summary of Case D data (continued)

Competitive dimension	Second-Order Measurement	Third-Order Measurement	Case D (customer-firm unit)
Quality	Meaning of quality	-	Quality between Firm D and its customers is "…a broad focus…" (Participant 7) "Quality means delivering the right goods, at the right time, in the right quantities, to an acceptable quality" (Participant 7)
	Quality planning	Quality planning process	Quality requirements set with customers look at "delivery and quality" criteria. Criteria determined by the customer (Participant 7)
		Trust	The relationship with Customer D1 is "very good", and "good" with Customer D3 (Participant 7) Customer D1's relationship with Firm D is "judged on the basis of merit" (Participant 12) Trust between Firm D and customers "is earned", based on Firm D's historical performance (Participant 7). Trust has an "expectation" to it, where Firm D has met Customer D1's requirements, and will maintain so in the future (Participant 12)

Summary of Case D data (continued)

Competitive dimension	Second-Order Measurement	Third-Order Measurement	Case D (customer-firm unit)
Quality	Quality control	Quality control process	Customer D1 monitors Firm D's incoming quality and documents quality trends. Firm D addresses non-conformance found by Customer D1 through root cause analysis and possibly a "5 why" (Participant 7). If Firm D cannot find the quality problem, Customer D1 field personnel are sent to Firm D to determine the problem. Customer D1 uses the "carrot and stick approach" to achieve quality (Participant 12). Financial rewards are given for required and above quality levels and penalties are imposed for poor quality levels
		Performance measurement	Customer D1 personnel take a "multilayered approach" in measuring Firm D performance. Customer D1 gives monthly and quarterly feedback, and a yearly on site "production readiness review" (participant 12) of Firm D's facilities. Shop floor data collection at Firm D monitors internal performance.
	Quality improvement	-	Quality improvements "basically come…from the OEM" (Participant 7, Case D)

Summary of Case D data (continued)

Competitive dimension	Second-Order Measurement	Third-Order Measurement	Case D (customer-firm unit)
Flexibility	Meaning of flexibility	-	Flexibility between Firm D, Customer D1 and Customer D3 is "…really a flexibility with regard to adapting the changes that they want…" (Participant 7) Flexibility with customers means if the customer has an unforeseen event, "…we need to cater for that…" (Participant 8) Shorter lead times for product delivery to customers, sometimes through the expediting of supplies, a cost "…which you cannot pass onto the customer." (Participant 7) "There's not much flexibility" between Customer D1 and Firm D in meeting delivery and quality criteria (Participant 12)
	Achievement of flexibility	-	Achieving flexibility with customers has a basis in "…the culture of the (customers) company." (Participant 8) Participant 7 says that Firm D's "design office needs to be extremely flexible…" with regard to product design changes for customers

Summary of Case D data (continued)

Competitive dimension	Second-Order Measurement	Third-Order Measurement	Case D (customer-firm unit)
Other	Ways to improve competitiveness	-	Accurate forecasts and SLA's Improving competitiveness with customers is more of an "issue of marketing than performance", as South Africa's aerospace industry is relatively unknown due to its geographic location (Participant 12) South African aerospace should "offering a certain service and technology" to differentiate ourselves in the aerospace market (Participant 12)

Summary of Case E data

Competitive dimension	Sub-Measurement	Sub-sub Measurement	Case E (supplier-firm unit)
Speed	Better and timelier information	Communication	Information sharing between Firm E and Supplier E1 is "…down to detail level…" (Participant 13) and "Just about everything" (Participant 14) is discussed.
		IT	Email
	Lead time compression	-	Project progress and material requirements not always conveyed to Supplier E1 on time, resulting in ordering delays. Lead time compression between Firm E and Supplier E1 can be achieved by improving "stock planning" (Participant 14). Lack of stock visibility due to information systems not linking together. Costs of improving visibility prohibitive
	Synchronisation	Material order volume and frequency	A fixed material volume is ordered from Supplier E1 each month, based on a three month production forecast. Minimum order quantities are imposed by Supplier E1's suppliers. These quantities are incrementally passed on to Firm E

Summary of Case E data (continued)

Competitive dimension	Sub-Measurement	Sub-sub Measurement	Case E (supplier-firm unit)
Speed	-	Capacity constraints	Production of specific resins by overseas suppliers is done periodically
Dependability	Processes and procedures	-	"…the forecasts are sufficient" to ensure dependable delivery from Supplier E1 Supplier E1 meets with Firm E to discuss current projects, participant 14 says that "…it's almost as if I work in the company…"
Quality	Meaning of quality	-	Quality is a combination of "…material quality, to my product quality, to my service quality to the customer…" (Participant 13) A certificate of compliance "…that should guarantee a certain quality…" is necessary in aerospace work (Participant 14)
	Quality planning	Quality planning process	Participant 14 from Supplier E1 says that Firm E "…will tell me…" if any quality requirements exist. The manufacturer's Certificate of Conformance (CFC) is needed for Firm E to accept incoming material

Summary of Case E data (continued)

Competitive dimension	Sub-Measurement	Sub-sub Measurement	Case E (supplier-firm unit)
Quality	Quality planning	Trust	A "…good working relationship…" exists between Firm E and Supplier E1 (Participant 13) Participant 14 from Supplier E1 says that Firm E trusts us to "…deliver the required quality or at least back our product up. If the quality is wrong they know we will sort it out."
	Quality control	Quality control process	Incoming inspection. If the product fails incoming inspection, the buyer phones Supplier E1, and the product is replaced or a refund is issued A CFC is required to accept incoming product from suppliers
		Performance measures	No performance measures yet in place at Firm E or Supplier E1. Quality issues tracked using batch numbers and CFC's
	Quality improvement	-	Manufacturer notified if a material batch is found defective. Supplier D1 tries to correct other problems with incoming material

Summary of Case E data (continued)

Competitive dimension	Sub-Measurement	Sub-sub Measurement	Case E (supplier-firm unit)
Flexibility	Meaning of flexibility	-	"Flexibility is key in this industry…" (Participant 13) Ability of Firm E to change orders from the original forecast sent to Supplier E1 Firm E and Supplier E1 working together to find alternative materials and fit designs if specific materials are not available Supplier E1 stocking specific product for Firm E to help Firm E with cash flow
	Achievement of flexibility	-	Flexibility between Firm E and Supplier E1 is achieved by having "…a very good relationship…" It is necessary to make the relationship "...work for both sides, looking for win-win kind of scenarios…" (Participant 14)
Other	Ways to improve competitiveness	-	"…the government should spend money in the right places…developing the industry correctly…make us (the aerospace industry) more cost effective." (Participant 14)

Summary of Case E data (continued)

Competitive dimension	Sub-Measurement	Sub-sub Measurement	Case E (customer-firm unit)
Speed	Better and timelier information	Communication	Because Customer E1 pays Firm E for design, "…they have full access…" to the design, and no information is held back from them (Participant 13) Information sharing between Firm E and Customer E2 consists of RFQ's, CAD models, feedback and manufacturing processes information
		IT	Email and an FTP (File Transfer Protocol) internet site are used in communicating between Firm E and Customer E1
	Lead time compression	-	Few problems with slow lead times between Firm E and Customer E1, an "efficient" logistic provider is used. Lead time delays between Firm E and Customer E2 due to import control delays and difficulty in procuring the necessary materials in South Africa

Summary of Case E data (continued)

Competitive dimension	Sub-Measurement	Sub-sub Measurement	Case E (customer-firm unit)
Speed	Synchronisation	Material order volume and frequency	Development work between Firm E and Customer E1 resulted in "…three or four…" orders with Firm E. The order placed by Customer E2 was a "once off product", and as such there is not really any form of scheduling in place (Participant 13)
		Capacity constraints	There have been no delays in sending materials from Firm E to Customer E1 as little product has so far been delivered
Dependability	Processes and procedures	-	Firm E sends a "…spreadsheet or project plan…" to Customer E1 to aid on time reliable delivery of goods (Participant 13) A date is given to Firm E for delivery of goods to Customer E2.

Summary of Case E data (continued)

Competitive dimension	Sub-Measurement	Sub-sub Measurement	Case E (customer-firm unit)
Quality	Meaning of quality	-	No "specific requirements" for quality with Customer E1, requirements still to be set (Participant 13)
	Quality planning	Quality planning process	Quality planning with Customer E1 is still a work in progress as the product is still in the development phase. Customer E2 quality requires that the product "fits" together and "does not break" (Participant 15)
		Trust	The relationship with Customer E1 is "In general, very good." (Participant 13) Trust is shown with between Firm E and Customer E1 because they "...keep on coming back to us."
	Quality control	Quality control process	As Customer E1 is still in the product development phase, there are no set quality control requirements with Firm E as yet.
		Performance measures	There are currently no performance measures in place in Customer E1. Participant 13 says that in future performance measures would look at whether Firm E delivers "…on time in the right quantities…"
	Quality improvement	-	No quality improvements are made with Customer E1

Summary of Case E data (continued)

Competitive dimension	Sub-Measurement	Sub-sub Measurement	Case E (customer-firm unit)
Flexibility	Meaning of flexibility	-	Firm E must be flexible because Customer E1 is "…constantly changing requirements…" (Participant 13)
	Achievement of flexibility	-	_
Other	Ways to improve competitiveness	-	Improving competitiveness between Firm E and Customer E1 requires working together to "…deliver on time…" and "communication" (Participant 13)

Summary of Case F data

Competitive dimension	Sub-Measurement	Sub-sub Measurement	Case F (supplier-firm unit)
Speed	Better and timelier information	Communication	Information sharing with suppliers is on an "ad hoc" basis. (Participant 16) "At this point in time very little" information is shared with suppliers, but in the future the planning horizon is to be extended to "…have better visibility…" (Participant 17)
		IT	Email, phone, printed purchase orders, RFQ's and spreadsheet. "…there is no e-procurement at the moment because you must also bear in mind the sensitivity in the military industry around data transfers..." Whilst complete integration is not possible, "another level" of IT above what is currently in place is needed. (Participant 17)

Summary of Case F data (continued)

Competitive dimension	Sub-Measurement	Sub-sub Measurement	Case F (supplier-firm unit)
Speed	Lead time compression	-	Lead time reduction possible if "…you fly it in." (Participant 16) "…comprehensive and effective planning…" and the need to "…integrate closer…" with suppliers (Participant 17) A website "…to place a purchase order directly into the system…" (Participant 18)
	Synchronisation	Material order volume and frequency	Material order frequency from suppliers based on the customer's aircraft needs, determined by stripping down the aircraft. Lead times from suppliers may vary when ordering components due to supplier production schedules. Material order volumes are based on "…lead times and obviously an MRP type setting…" (Participant 17) Stock only kept for ongoing projects

Summary of Case F data (continued)

Competitive dimension	**Sub-Measurement**	**Sub-sub Measurement**	**Case F (supplier-firm unit)**
Speed	Synchronisation	Capacity constraints	Suppliers having to split incoming larger batches into smaller ones, and not enough personnel to do so in a timely manner. Bevel gear production from suppliers is constrained as a result of "…production difficulties…and an unexpected increase in demand…" (Participant 19)
Dependability	Processes and procedures	-	Frequent audits and quality checks based on agreements Firm F monitors the "typical errors" (Participant 17) that its suppliers may make A progress meeting between Firm F and Supplier F3 allows for the review of specified delivery dates and critical items

Summary of Case F data (continued)

Competitive dimension	Sub-Measurement	Sub-sub Measurement	Case F (supplier-firm unit)
Quality	Meaning of quality	-	Quality with suppliers is "…not only fit for use…but is also on time, correct quantity, correct descriptions, the documentation and items that arrive tie up,…the correct modifications of that part…" (Participant 17)
	Quality planning	Quality planning process	Quality requirements set with suppliers require a Certificate of Conformance (CFC) to be sent with all components. Participant 17 says that this is to ensure the sent component "…is correct in every detail, for the intended use."
		Trust	A relationship "…has to be one of mutual cooperation, you cannot work on an adversarial relationship…" (Participant 17) Technical aid agreements with suppliers "…rule a lot about the relationships between two organisations…not only…for the parts but for knowledge, know-how, engineering, backup…" (Participant 17) Trust exists between Firm F and its suppliers on component quality, subject to a CFC being sent with the component. Trust is less clear on lead times and pricing, but Participant 17 says that this is "…normally taken care of in the normal service level agreement between supplier and customer." Trust between Firm F and Supplier F3 is based on past experience, and Supplier F3 providing alternative solutions to problems if required.

Summary of Case F data (continued)

Competitive dimension	Sub-Measurement	Sub-sub Measurement	Case F (supplier-firm unit)
Quality	Quality control	Quality control process	Quality problems are often only picked up on the shop floor, "…because goods receiving…are not technically orientated to do quality control as such, that's why we rely heavily on the CFC's." (Participant 16) Quality control needs to consider component quality and supply chain factors like late delivery, wrong quantities, and wrong part numbers.
		Performance measures	"…a whole series…" of "very simple" performance measures are used with suppliers (Participant 17)
	Quality improvement	-	No "active" quality improvements are made between Firm F and its suppliers, but will be examined in the future (Participant 17)
Flexibility	Meaning of flexibility	-	Suppliers changing stock delivery dates to the firm based on the firm's requirements Suppliers have "…the ability to assist us technically when technical questions arise", and suppliers "…give us quotations on changing requirements on a daily basis." (Participant 17) "…procedures and…contracts…" limit flexibility (Participant 18)

Summary of Case F data (continued)

Competitive dimension	Sub-Measurement	Sub-sub Measurement	Case F (supplier-firm unit)
Flexibility	Achievement of flexibility	-	"…flexibility comes with a cost…" (Participant 17) "…quality is not flexible." (Participant 19) Supply chain flexibility requires "…a more integrated chain…" (Participant 18)
Other	Ways to improve competitiveness	-	"communication" throughout the organisation is important for supply capability (Participant 17) "…accurate planning…" (Participant 17) Improving competitiveness through cost is difficult, as you are normally "bound" to the OEM manufacturer "…who says that these components will be bought from those…suppliers…" (Participant 16) Improving competitiveness between Firm F and Supplier F3 can be achieved "…by placing orders on the internet…" (Participant 18) EDI "…the big way forward is to integrate the needs of the final customer…" with suppliers (Participant 19)

Summary of Case F data (continued)

Competitive dimension	Sub-Measurement	Sub-sub Measurement	Case F (customer-firm unit)
Speed	Better and timelier information	Communication	Information on stock levels
		IT	Participant 16 says that "…there's no electronic link so to speak" that is used for communication between Firm F and suppliers
	Lead time compression	-	Lead time reduction may be possible if computer systems "…could be talking to one another…" (Participant 16)
	Synchronisation	Material order volume and frequency	Material order volume and frequency of parts from Firm F by Customer F1 is based on a service level agreement. Customer aircraft are stripped down by Firm F and required parts are ordered
		Capacity constraints	-
Dependability	Processes and procedures	-	-

Summary of Case F data (continued)

Competitive dimension	Sub-Measurement	Sub-sub Measurement	Case E (customer-firm unit)
Quality	Meaning of quality	-	-
	Quality planning	Quality planning process	Participant 16 says that the quality requirements "…we place on our suppliers are the same requirements that Customer F1 places on us."
		Trust	The relationship between Firm F and Customer F1 is a "…hand in the pocket relationship…the one can't go without the other." (Participant 16) Participant 16 says that he does believe that Customer F1 trusts Firm F, as "…the product that we deliver is up to their specification."
	Quality control	Quality control process	Participant 16 says that quality control with customers relies "...on the same CFC for quality" that is received from the supplier.
		Performance measures	-
	Quality improvement	-	-

Summary of Case F data (continued)

Competitive dimension	Sub-Measurement	Sub-sub Measurement	Case E (customer-firm unit)
Flexibility	Meaning of flexibility	-	Flexibility with customers is time based, where the customer may need to be flexible with Firm F if "…we can't make it because our suppliers are late." (Participant 16)
	Achievement of flexibility	-	-
Other	Ways to improve competitiveness	-	-

END