



University of Southern Queensland

**Critical success factors in supply chain management
at high technology companies.**

A Dissertation submitted by

Sarvnandan S. Soin

For the award of

Doctor of Business Administration

ABSTRACT

In today's turbulent economic environment, firms are striving for ways to achieve competitive advantage. One of the approaches is to manage the entire supply chain to reduce costs and improve performance to create competitive advantage and business success.

This dissertation explores and investigates how high technology firms use supply chain management to gain competitive advantage and increase business success. The research objective is to determine the critical success factors in supply chain management at high technology companies. This dissertation provides a theoretical framework to understand a firm's performance and argues that supply chain management will help a firm to be competitive and successful. To this end, the critical success factors that make a company more competitive are identified.

The research design is based on the established and recommended procedures of multiple case study research methodology; and this methodology is used to gather data from five companies in California, USA. The analysis is based primarily on cross-case analysis for the purpose of theoretical generalization about the research issues.

The results identify two clusters of company behavior and characteristics, specifically traditional 'old style' manufacturing companies and progressive manufacturing companies. Each cluster of company behaves differently. At the traditional manufacturing companies, the selection of critical supply chain management factors is internally focused on factors that are manufacturing and quality focused, while at the progressive manufacturing companies the selection of critical supply chain management factors is externally focused on factors that are directed to customers and information systems.

There are differences between critical supply chain management factors at high technology companies and benchmark (or commodity) companies that were selected in this study. The benchmark companies select supply chain management factors that focus on customer services and quality. This approach is, possibly, due to the fact that the benchmark companies deal in

commodity type products and hence they have to focus on differentiating themselves through strong customer services and quality products.

Additionally, with the help of supply chain metrics, financial performance data, and understanding the various companies, it is possible to determine which critical supply chain factors best can contribute to business performance. At the case study companies, an external focus on supply chain management factors such as a strong focus on customer relationship and management, gives better business results.

Finally, this study has proposed a novel and new approach to improving customer satisfaction by using QFD methodology to identify performance gaps (and opportunities) from the customer's viewpoint in supply chain management. If the companies wish to increase customer satisfaction, they have to use the QFD methodology to identify critical supply chain factors. The reason is primarily because performance gaps derived from customer needs emphasize what the customer wants and that is different from the internal perceptions of a company's managers. The initiatives that provide the greatest opportunity have been identified in this analysis.

Overall, these findings can be used by high technology firms to select supply chain strategies that will lead to sustainable competitive advantage and hence improve their brand and business performance.

CERTIFICATION OF DISSERTATION

I certify that the ideas, experimental work, results, analyses, software and conclusions reported in this dissertation are entirely my own effort, except where otherwise acknowledged. I also certify that the work is original and has not been previously submitted for any other award, except where otherwise acknowledged.

Candidate : Sarvnandan S. Soin

Student Number D 99313828

Signature of Candidate

Date

ENDORSEMENT

Supervisor: Dr. Latif Al-Hakim

Signature of Supervisor

Date

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CHAPTER 1

INTRODUCTION

The genesis of this dissertation was a request from a high technology company to investigate the company's supply chain system and identify factors affecting the successful implementation of supply chain management. This chapter serves as an introduction to the dissertation. It comprises eight sections, which cover the background to the research, objective of the research and the research questions, justification and significance of the research, a brief description of the methodology, an outline of the structure of the study, key definitions, delimitations of this research, and the chapter's conclusion.

1.1 Background

A firm's strategies, innovations, and well-planned activities will lead to sustainable competitive advantage and hence improve its brand and business performance. As firms strive for ways to achieve competitive advantage, they are looking for new ideas and solutions. This dissertation addresses the topic of competitive advantage, reviews how firm's attempt to achieve it, and focuses on one aspect of competitive advantage – managing the supply chain to increase competitive advantage and business success.

The early understanding of competitive advantage is based on Leon Walras (1874, 1984) theory of perfect competition. In perfect competition products are homogenous, consumers and producers have perfect information, prices will reach equilibrium, and as a result profits are zero in the long run. A later approach is the Industrial Organization approach (Tirole, 1988), which argues that success comes from market power and a firm's efficiency. However, the proponents of this approach agree that in the long term there would be industry equilibrium and little profit.

One of the first researchers to propose a theoretical framework for understanding a firm's performance is Michael Porter (1980). He takes a strategic and analytical approach to understanding competitive strategy, and argues that, "*Every firm competing in an industry has a*

competitive strategy, whether explicit or implicit.” Porter asserts that, except for microeconomic theory, the strategy field and literature had offered few analytical techniques for gaining this understanding. Porter (1980) argues that with the right approach it is possible to break away from the economic equilibrium situation and achieve superior performance. Therefore he proposes a framework for analyzing industries and competitors and describes three generic strategies – cost leadership, differentiation, and focus. He postulates that to be successful, the firm has to do well in one or more of these strategies.

Porter’s (1980) ideas and proposals on achieving competitive advantage have influenced many other researchers to propose complementary theories on achieving competitive advantage. All the theories proposed by researchers are supported with examples of winning strategies implemented at renowned companies. The theories include an emphasis on planning (Porter, 1980, 1985), strategic approach (Hamel and Prahalad, 1990, 1998; Porter, 1985, 1990, 1991), marketing strategies (Day, 1994, 1999), value chain management (Porter, 1985), and supply chain management (Christopher, 1998; Poirier, 1999; Tyndall et al., 1998).

A theory that has gained momentum in the last few years is the concept of supply chain management. In recent years, there have been numerous advances and developments in supply chain techniques and management. One of the reasons is that as trade barriers drop and markets open, competition has become more intense – hence companies need to be more competitive and cost effective. An initiative to help achieve this is a supply chain management program. Supply chain management is the management of upstream and downstream activities, resources, and relationships with suppliers and customers, which is required to deliver products or services. In theory, if this is done well it will lead to competitive advantage through differentiation and lower costs as suggested by Porter (1980). Moreover, some researchers claim that effective supply chain management can reduce costs by several percentage points of revenue (Boyson, et. al, 1999). Furthermore, there has been little verification or research done on measuring competitive advantage gained through supply chain management.

Supply chain management is not a static concept or solution. Instead, new advances and techniques for supply chain management continue to mushroom. This tremendous growth in new

ideas and processes is starting to influence and change the business processes and models of companies. Hence companies have many choices in selecting programs in supply chain management. In making their choices, companies need to plan for effective supply chain management, in order to gain competitive advantage.

However, to ensure that effective supply chain management can provide business success, this study must determine the critical success factors in supply chain management that can provide competitive advantage. Furthermore, these critical success factors must be identified and conveyed to senior management in firms that want to have an effective supply chain management program.

1.2 Objective of this research

The objective of this dissertation is to explore and investigate how firms scope, design, and implement supply chain management in order to gain competitive advantage. Most importantly, this dissertation endeavors to determine the critical success factors in supply chain management that can provide competitive advantage. It also explores and investigates the advances and new ideas in supply chain management and examines how firms scope, design, and implement supply chain management in order to gain competitive advantage.

The genesis of this dissertation was a request from a high technology company to investigate the company's supply chain system and propose improvements to help make it more competitive. The company is headquartered in California USA, and this author works for one of the company's business unit as General Manager for Distribution. The request was to investigate the company's supply chain management system and to propose improvements that would make it more competitive

This dissertation provides a theoretical framework to understand a firm's performance and argues that supply chain management is an approach that will help a firm to be competitive and successful. Furthermore, in using supply chain management, firms are faced with choices on what supply chain techniques and developments to adopt for their businesses. This dissertation will

review the choices that high technology companies have today, and will make recommendations to select the best choices, or critical success factors, based on business and customer needs. Therefore, the research objective is to:

Determine the critical success factors in supply chain management at high technology companies.

In fulfilling this objective, this dissertation also addresses the following research issues:

1. Are there differences between critical supply chain management factors at various high technology companies?
2. Are there differences between critical supply chain management factors at high technology companies and non high technology (or benchmark commodity) companies?
3. Will a focus on external supply chain management factors give better business results?
4. Are perceived critical gaps (and opportunities) in performance derived from traditional methodology similar to those deployed from customer needs?

In this study, the critical success factors to make a company more competitive are identified. To ensure a robust analysis and conclusion, the expectations and perceptions of respondents, involved in this study, are taken into consideration as well as customer requirements.

1.3 Significance of the research

There are many theories and empirical studies on competitive advantage. However, the empirical studies, using mathematical models, tend to be limited in scope (Porter, 1991; Buzzel and Gale, 1990), and do not include supply chain management parameters. While there has been much research on activities that can provide competitive advantage, there is little knowledge on the process of selection and impact of supply chain management on the competitive position and business performance of a high technology firm. Firms need to understand how supply chain management can help them achieve competitive advantage. Furthermore, there is an expectation that high technology companies will use leading edge technology and invest heavily in supply chain management. This dissertation makes the following contributions:

1. Fulfills a request from a high technology company: The author of this study works for a high technology company, head-quartered in California USA, and was requested to investigate the company's (business unit) supply chain system and propose improvements to help make it more competitive.
2. Identifies the critical success factors in supply chain management from a high technology company's viewpoint. Often when reviewing critical success factors, only the perception of respondents is taken into account. However, in this analysis both the perceptions and expectations of respondents are taken into consideration. Such an analysis will be more robust and will allow performance gaps to be analyzed and understood.
3. Identifies the critical success factors in supply chain management from customers of high technology companies. To enhance the relevance of the conclusions, customer requirements are also taken into consideration by using the quality function deployment (QFD) methodology and these are compared to the high technology companies' performance gaps. Such an analysis will allow performance gaps to be analyzed and understood from the viewpoint of customers of high technology companies.
4. Contributes to the understanding of how high technology companies scope, design, and develop their supply chain management system.

1.4 Research Methodology

This study employs the qualitative research process using multiple case studies. There are several reasons for this: Since the focus of this research is on high technology companies operating in California, USA, there is a concern that there will be a small number of companies willing to participate in a large (sample size) quantitative survey. Furthermore face-to-face meetings with respondents can help provide understanding and information on several qualitative areas, such as: reasons for implementing specific supply chain factors (or strategies), customer needs data, and discussions and feedback on the questionnaire. Also, cases can be viewed and studied alone and across cases to provide comparison and contrast and richer details and insights regarding the research issues (Eisenhardt 1989; Stake 1994; Yin 1994). Hence this research will be done via a multiple case study approach using structured interviews with a questionnaire (Yin, 1994).

1.5 Structure of the dissertation

In addition to this introductory chapter, this dissertation consists of four chapters (Figure 1.1). Chapter 2 reviews the relevant literature, addresses the disciplines under investigation, and provides an overview of competitive advantage. The chapter then provides a detailed review of the current literature and practices of supply chain management. With that as the background, chapter 2 continues into identifying gaps in the literature and provides the rationale for selecting the research topic and issues.

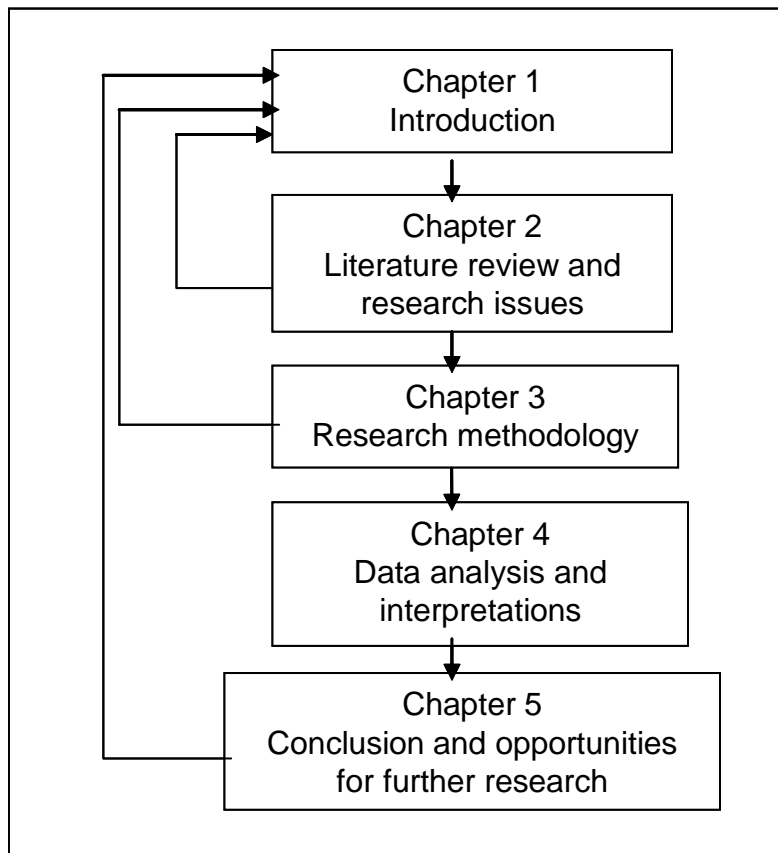


Figure 1.1 Structure and flow of the dissertation

Chapter 3 discusses the research methodology used for this study and it includes: the justification of the research methodology, a discussion on preparation of the questionnaire and the data gathering process, the process used for data analysis and determining gaps, the process used to

generate recommendations from the data, and concludes with a discussion on the limitations of case study research.

Chapter 4 summarizes the data collected from the selected companies and respondents and aims to interpret the data in relation to the research objective. Each of the four research issues is analyzed, interpreted, and the detailed findings are presented. The chapter concludes with a summary of the research findings.

Chapter 5 provides a summary of the findings and conclusions of the research objective and issues, discusses the contribution of the research findings to the literature and theory, reviews the implications of the findings, discusses the limitations of the research, and concludes with suggested direction for future research.

1.6 Key definitions

Definitions adopted by researchers are often not uniform; hence key terms are defined to establish positions taken for this dissertation (Perry 1998). This will ensure that subsequent research, undertaken at a later stage, will better measure and compare what this dissertation has set out to do.

- *Logistics*: The management and movement of product and services, including storage and warehousing, and their transport via air, land, and water (Coyle, Bardi, and Langley, 1988).
- *Supply chain*: Consists of all inter-linked resources and activities needed to create and deliver products and services to customers (Hakanson, 1999).
- *Supply chain management*: This includes managing supply and demand, sourcing raw materials and parts, manufacturing and assembly, distribution across all channels, and delivery to the customer (Supply Chain Council, 2001).
- *Supply chain agility or agile supply chain*: An agile supply chain is one that is flexible and has a business-wide capability that embraces organizational structures, information systems, and logistics processes. (Christopher, 2000)

- *Critical success factors (CSF)*: Critical success factors are those few things that must go well to ensure success for a manager or organization, and therefore may represent those managerial or enterprise areas that must be given continual attention. CSFs include issues vital to an organization's current operating activities and to its future success (Boynton and Zmud, 1984).
- *Customer relationship management (CRM)*: CRM is the management of technology, processes, information, and people in order to maximize each customer contact by obtaining a 360-degree view of the customer (Galbreath and Rogers, 1999).
- *Performance gap*: This is a gap between the perceived performance and the expected importance of a factor (in this dissertation it is a supply chain factor). The performance gap provides an indication as to whether executives and managers are successful in translating their vision to their employees and hence such perception may give an indication regarding the degree of employees' alignment with the organization's vision. If a factor is critical and has a negative value of factor alignment (perceived performance is less than the expectation), then the organization may have a potential problem with that factor. Information on factor alignment allows executives to develop a strategy to overcome the challenges associated with the gaps between importance and performance. (Martilla and James, 1977).
- *Quality Function Deployment (QFD)*: QFD is a comprehensive quality tool that can be used to uncover customers spoken and unspoken needs, and convert these needs to product or service design targets and processes (Akao, 1990).

1.7 Delimitation

There are several delimitations in this dissertation.

- The theoretical model derived from this dissertation is only applicable to the high technology companies.
- The dissertation is focused on companies operating geographically in California, United States of America, where there is a concentration of high technology companies.
- This dissertation is an exploratory research and will have to be tested for generalizability in later, more extensive, quantitative research (Perry, 1998).
- There is no scientific basis for choosing the number of cases in this dissertation. The number selected is based on the experiences and recommendations of the research and academic community (Eisenhardt, 1989; Perry, 1998).

1.8 Conclusion

This chapter provides an overview of the dissertation. The aim, objectives, and justification of the research topic were discussed. The dissertation is an investigation on the impact of a supply chain management system on the competitive position of high technology business firms. It explores and investigates new ideas in supply chain management and examines how high technology firms manage and improve their supply chain management system. Furthermore, this dissertation will analyze the gaps and opportunities for supply chain management in high technology companies and give a set of recommendations. The methodology was briefly described, key definitions were explained, delimitations of this research were addressed, and the structure of the dissertation was outlined. With all the important areas of the research briefly introduced in this chapter, the following four chapters of this dissertation will present detailed description and findings of the research topic.

CHAPTER 2

LITERATURE REVIEW AND RESEARCH ISSUES

The previous chapter provided an overview of the dissertation and listed the objective, issues, and significance of the research topic.

This chapter reviews the relevant literature and comprises of six sections. The review starts with a discussion on early approaches to understanding a firm's performance and its competitive advantage. This is followed by the development of a theoretical framework and a discussion on contemporary approaches to competitive advantage. Next there is a discussion on supply chain management, followed by an overview of advanced supply chain management systems. The last two sections conclude with a discussion on gaps in the literature, identification of areas for further research, and the summary.

2.1 Early approaches to understanding a firm's performance and competitive advantage

One of the earliest (chronologically) approaches to competitive advantage is the microeconomic approach, or the idea of perfect competition (Walras, 1874, 1969). In perfect competition products are homogenous, consumers and producers have perfect information, prices will reach equilibrium, and as a result profits are negligible or low in the long run. However, according to Gill (1991), such a perfect economy is an abstraction, because there are monopolies, oligopolies, and perfect competition. Furthermore, there are also two kinds of competition: spatial and monopolistic. Spatial differentiation pertains to oligopolistic competition (Hotelling, 1929), and it meets consumer's different tastes. Monopolistic competition assumes that small firms produce a variety of differentiated products (Chamberlin, 1933; in Gill, 1991). All these situations allow for profit maximization and higher profits (Gill, 1991).

The industrial organization (IO) approach takes a richer approach to understanding a firm's successful performance. IO differs from the microeconomic approach by introducing variables that explain real-world economic behavior. In IO, there are two competing hypothesis that lead to higher profits and success - market power and a firm's efficiency (Scherer, 1990; Tirole, 1988). Nevertheless, the IO approach assumes that markets and firms will reach equilibrium, and in equilibrium profits differences will not exist (Tirole, 1988).

Both the microeconomic approach and the industrial organization approach assume that all firms would reach equilibrium and have equal profit and success. However, we know from a daily look at many firms' performance on the stock market that profit and performance vary across firms, even when they are in the same business. Eaton and Lipsey (1978) have verified that differences in performance and profit exist between firms.

2.2 Contemporary approaches to achieving competitive advantage

2.2.1 Framework to understanding a firm's performance

One of the first researchers to propose a theoretical framework for understanding a firm's performance is Porter (1980). He takes a strategic and analytical approach to understanding competitive strategy, and argued that, "*Every firm competing in an industry has a competitive strategy, whether explicit or implicit*" (Porter, 1980, p. xiii). He proposes a framework for analyzing industries and competitors and describes three generic strategies – cost leadership, differentiation, and focus. He postulates that if a firm is able to do well in any of these strategies, it will gain competitive advantage. Porter's concept is illustrated in figure 2-1.

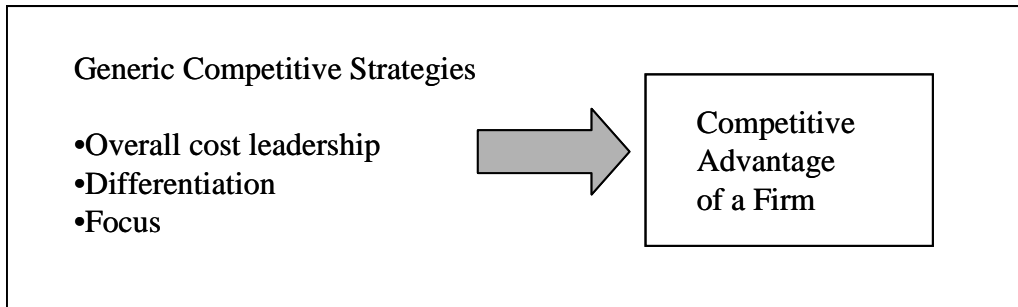


Figure: 2-1: Strategies to achieve competitive advantage
Source: Porter (1980)

- Cost leadership requires efficient-scale facilities, pursuit of cost reductions, and cost minimization in all areas of the firm. This will give more profit.
- Differentiation of product or service requires industry-wide differentiation, including design and brand image, customer service, and distribution or dealer network. Product or service differentiation will help increase customer loyalty and ensure repurchase.
- Focus on markets, buyers, or product lines can maximize profits.

The framework, in figure 2-1, shows that the right strategies can provide competitive advantage. Porter (1985) also argues that competitive advantage come from the many discrete activities a firm performs in designing, producing, marketing, delivering, and supporting its product. Each of these activities contributes to a firm's relative cost position and creates a basis for differentiation. This is the value chain, and a firm has to disaggregate its strategically relevant activities in order to understand the behavior of costs and the existing and potential sources of differentiation. A firm gains competitive advantage by performing these strategically important activities cheaper or better than its competitors (Porter, 1985), and this can lead to a higher profit margin. The value chain concept is illustrated in figure 2-2.

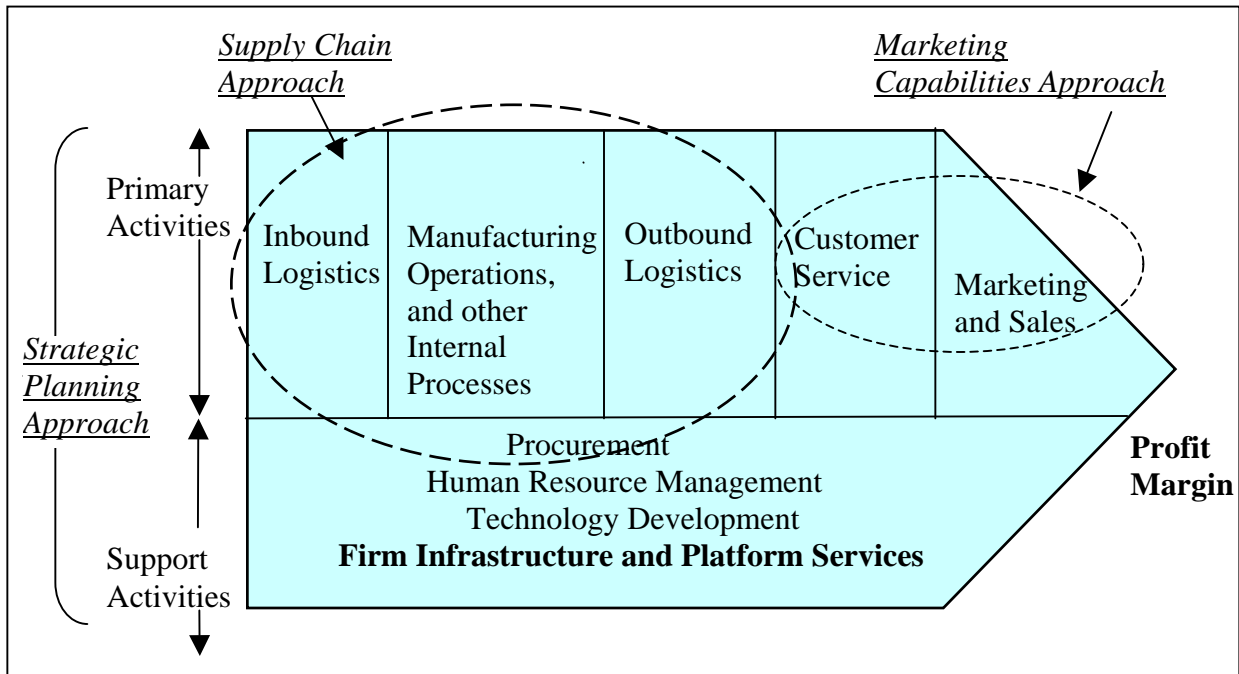


Figure 2.2: The Value Chain and Theoretical Framework to Achieve Competitive Advantage

Adapted from Porter (1985) and this literature review.

Note 1: Key approaches to competitive advantage are highlighted with underlined Characters

Note 2: The definition of supply chain implies all activities necessary to deliver a product (Hakanson, 1999). Therefore sales, marketing, and customer service activities can be construed as part of the supply chain approach shown in the figure. In this study, sales and marketing processes, such as demand management, order processing, and customer relationship management are included in the internal processes shown in the figure and in the supply chain literature review. However, sales and marketing activity, such as sales calls, advertising, product positioning, market research, and some post delivery support processes are excluded from supply chain activity. This is consistent with the approach taken by the Supply Chain Council and the SCOR (Supply Chain Operational Reference) model it uses to measure supply chain activity (Supply Chain Council, 2001).

2.2.2 Summary of contemporary approaches to competitive advantage

Porter's approach presents new thinking to competitive advantage (Rumelt, Schendel, and Teece, 1991) and has influenced other approaches to creating competitive

advantage. Many of the other approaches to competitive advantage are summarized in Table 2-1. From the table, it can be seen that all the approaches to increasing competitive advantage, except for the early microeconomic and industrial organization approaches, fit the theoretical framework in figure 2-2. However, all these approaches to competitive advantage are complementary and not alternatives or conflicting theories – they basically propose various segments of the theoretical framework shown in figure 2-2.

The various approaches are discussed very briefly below, but the last approach (in Table 2-1), Supply Chain Management, is discussed in greater detail.

2.2.3 The strategic planning approach

In essence, Porter's (1980, 1985) approaches are *strategic planning* approaches, i.e. a firm's competitive advantage can be planned for. This includes planning for differentiation in the value chain, low cost leadership, and focus.

Nations can also be competitive (Porter, 1990). Nations need four conditions to gain competitive advantage and be successful. The four conditions are: factor conditions (education and skill levels), demand conditions (or market size), related and supporting industries, and company strategy and rivalry (Porter, 1990).

Strategy is “lucky foresight...Strategy is always the product of a complex and unexpected interplay between ideas, information, personalities, and desire...” according to Hamel (1998). What this implies is that one does not settle for obvious solutions and strategies but should look at alternatives, challenge assumptions, and look at new ways of delivering superior customer value and firm performance.

Table 2-1 Summary of early and contemporary approaches to competitive advantage

Approach	Proponent	Main idea/postulate	Comments
Microeconomic	Walras (1874, 1984)	Perfect competition results in negligible profits	Ideas ignore monopolies, oligopolies, and product differentiation. Profit does vary across firms according to Eaton and Lipsey (1978).
Industrial Organization	Scherer (1990), Tirole (1988)	Success comes from market power and a firm's efficiency.	All proponents agree that in the long term there will be industry equilibrium and little profit.
The Strategic Approach and its Variations	Porter (1980)	Provides a framework for achieving competitive advantage. Every firm has a generic competitive strategy in cost leadership, market focus, or differentiation.	Challenges the stereotype approach of perfect competition and industry equilibrium.
Value Chain Approach	Porter (1985)	The value chain disaggregates a firm into its strategically relevant activities. A firm gains competitive advantage by performing these important activities better than its competitors.	Provides a prescriptive approach to achieve competitive advantage, but the ideas and solutions are essentially conceptual.
Strategic Approach	Hamel (1998)	Strategy is the product of a complex and unexpected interplay between ideas, information, personalities, and desire.	A firm has to seek alternatives and new ways of delivering superior customer value and firm performance.
Resource Based Approach	Wernerfelt (1984), Barney (1991), Rumelt, Schendel, and Teece (1991).	A firm has to identify specific, or rare, resources that lead to higher profits. Long-term superior performance comes from building product market positions that effectively utilize and maintain these resources. Examples of such resources include customer loyalty, and technological leads.	If the resources are unique and difficult to duplicate, then the firm achieves competitive advantage.

Table 2-1 (Continued) Summary of early and contemporary approaches to competitive advantage

Approach	Proponent	Main idea/postulate	Comments
Market Strategy Marketing Capabilities Approach	Day (1994,1999), Cool and Dierickx (1989), Aaker (1989), Caves and Ghemawat (1986).	A firm's competitive advantage comes from two sources: Assets or resource endowments and distinct capabilities, which are the glue that holds these assets together. Examples are Honda's fuel-efficient engines, Wal-Mart's logistics systems. Day proposes a 'market driven' organization, which will have a superior ability to understand, attract, and keep valuable customers	Assets and distinct capabilities provide competitive advantage and strong market position
	Also, Buzzell and Gale (1987), Jacobsen (1990), Erickson and Jacobson (1992), Boulding, Lee, and Staelin (1994).		
	Hamel and Prahalad (1990, 1998)	The concept of core competencies, or bundle of skills, that provides access to a wide variety of markets, provides customer benefits, and is difficult to imitate. An example is Federal Expresses' packaging, routing and delivery process	The firm's profitability is determined by its relative costs and differentiation advantages in an industry
Resource-Advantage Theory	Hunt and Morgan (1995, 1996)	The firm's endowments are its resources, both tangible and intangible assets, which allow it to produce products that are perceived to have superior value.	The right combination of resources will improve marketplace position and lead to competitive advantage and superior financial performance.
Product Differentiation	Trout (2000).	The concept of tangible product differentiation, which the customer can appreciate – tangibles such as heritage (of product), product leadership, first mover advantage, and latest technology.	Only differentiation will provide competitive advantage
Supply Chain Management	Christopher (1998), Poirier and Reiter (1999), Tyndall et al. (1998)	This approach is a subset of the value chain approach and is focused on one section of the value chain. Refer to Figure 2.2. The management of internal, upstream, and downstream relationships with suppliers and customers will deliver superior value at lower cost.	Provides a prescriptive and detailed approach. The approach results in an efficient supply chain, which can deliver goods at lower costs, high efficiency, and maximum customer satisfaction.

Source: Developed for this study

Another approach from the strategy-based literature comes from Wernerfelt (1984). He proposes the Resource-Based approach for a firm. He analyzes the firm from the resource side rather than product or market power side. He has a 2-prong argument: A need for some specific resources that lead to higher profits and strong or rare resources, which can impose an entry barrier for other firms. Attractive resources that provide such barriers can be identified, implemented, and managed to make it difficult for others to catch up. Examples of resources include customer loyalty and production or technological leads. This is a prevalent theme throughout the literature – competitive advantage strategies cannot be bought they need to be developed. Barney (1991) and Rumelt, Schendel, and Teece (1991) also support this resource-based view.

2.2.4 Marketing strategy approach

The marketing capabilities approach introduces the concept of capabilities of a market-driven organization and explores the links between capabilities and a firm's performance and market success (Day, 1994, 1999). A firm's competitive advantage comes from two sources: Assets or resource endowments (image, quality perceptions, brand equity, etc.), which are acquired over time, and distinct capabilities, which are the glue that holds these assets together. Examples are Honda's fuel-efficient engines and Wal-Mart's logistics systems. Such capabilities provide competitive advantage resulting in better business performance (Day, 1994, 1999). Other proponents of the marketing capability approach are Cool and Derrick (1989), Aaker (1989), Caves and Ghemawat (1986), Buzzell and Gale (1987), Jacobsen (1990), Erickson and Jacobson (1992), and Bounding, Lee, and Staelin (1994).

The concept of core capabilities is not new and was proposed much earlier by Penrose (1959). However, this has been popularized as the concept of *core competencies* of the corporation that can lead to a firm's success by Hamel and Prahalad (1990). They actually propose some tests to measure the strength and success of core competencies – they must provide access to a wide variety of markets, they must provide customer benefits, and are difficult to imitate. An example is Federal Expresses' packaging, routing and delivery process. These researchers go on to argue (Hamel and Prahalad,

1998) that a firm's actual profitability is determined by its relative costs and differentiation advantages in an industry. This approach is almost identical to the theoretical framework for competitive advantage based on Porter (1980). Therefore it can be concluded that Porter's approach, postulated in 1980, is still valid in 1998.

The resource-advantage approach takes a similar vein as the marketing capabilities approach. The proponents (Hunt and Morgan, 1995, 1996) postulate that the firm's endowments are its resources, both tangible and intangible assets, which allow it to produce products that are perceived to have superior value. One of the resource-advantage examples quoted is the productivity, quality, and reliability of Japanese (Toyota) cars Vs General Motors cars. Hence, the right combination of resources will improve marketplace position and lead to competitive advantage and superior financial performance (Hunt and Morgan, 1995, 1996).

The product differentiation approach by Trout (2000) states that what matters is differentiation of product or service. Trout (2000) states that there are too many choices in today's world, and only differentiation provides competitive advantage.

Verification of marketing capabilities approach with the PIMS database.

Most theories mentioned in this review have not been tested empirically. However, there is literature that discusses cause and effect in the marketing environment. One of the arguments uses the Profit Impact of Marketing Strategies or PIMS database for its analysis and conclusions. The study by Buzzell and Gale (1987) looks at the affect of business and marketing strategies on the profitability of firms, and concludes that a firm's performance, measured by profits and ROI (Return On Investment) is driven by 3 factors: high market share, product quality, and low capital investments. This assertion is supported by Austin and Peters (1985), who argue that a firm can start with quality and then achieve lower costs, and hence higher profits. Later empirical research, using the PIMS database by Boulding, Lee, and Staelin (1994), also supports the assertion that differentiation (via advertising and sales force expenditures increase) can provide higher profits.

2.2.5 The advent of the supply chain approach

In the competitive environment of the 1990s, there has been a change in management thinking, resulting in a search for strategies that provide superior value. As a result, the supply chain approach to gaining competitive advantage has moved into the mainstream of business strategies. This approach has its roots from historical military campaigns (Britannica, 1994-1999) and more recently from Porter's (1985) value chain, with its emphasis on inbound and outbound logistics, and manufacturing operations. Kotler and Armstrong (1996), in a discussion on *marketing logistics thinking* argue that logistics (a key sub-set of supply chain management) has major impact on customer satisfaction, success, and costs. They recommend that a firm manage its entire supply chain and that such an approach will create competitive advantage and success.

2.3 Supply chain management categories and factors

2.3.1 A historical perspective of supply chain management

Before the term supply chain was coined, the term used for management and movement of product and services was logistics. The development of logistics was originally undertaken by the military in ancient times (Britannica, 1994-1999). For example, the Roman legions used a flexible system consisting of supplies, storage depots, and magazines stocked with supplies and arms, superb road systems, mobile repair shops, service corps of engineers and armourers, and extensive coordination and planning. This resulted in an efficient, fast, and formidable army that won many battles and conquered much of Europe and Asia, and held it for many hundreds of years (Britannica, 1994-1999). The vast Roman Empire finally declined, not because it lost control of its empire due to poor logistics, but because of moral decay and despotism (Durant, 1944).

2.3.2 Definition of supply chain and supply chain management

It will be useful to look at some definitions of supply chain and supply chain management:

- *Supply chain* is all inter-linked resources and activities needed to create and deliver products and services to customers (Hakanson, 1999, p. 254).
- *Supply chain management* goes further and includes managing supply and demand, sourcing raw materials and parts, manufacturing and assembly, distribution across all channels, and delivery to the customer (Supply Chain Council, 2001).
- A more eloquent definition of *Supply Chain Management* is a network of relationships, with the goal to deliver superior value, i.e., “The management of upstream and downstream relationships with suppliers and customers to deliver superior value (in manufacturing products and services) at less cost to the supply chain as a whole” (Christopher, 1998).

2.3.3 Key categories the Supply Chain Management System

While the value chain and marketing approaches propose generic ideas and capabilities, proponents of the supply chain approach go a step further and identify specific activities, backed by detailed processes that can improve a firm’s competitive advantage and success. Supply chain management encompasses end-to-end management of a product or service, and includes the items shown below in Figure 2-3. Note that when all the supply chain categories are linked together they form The Supply Chain Management System.

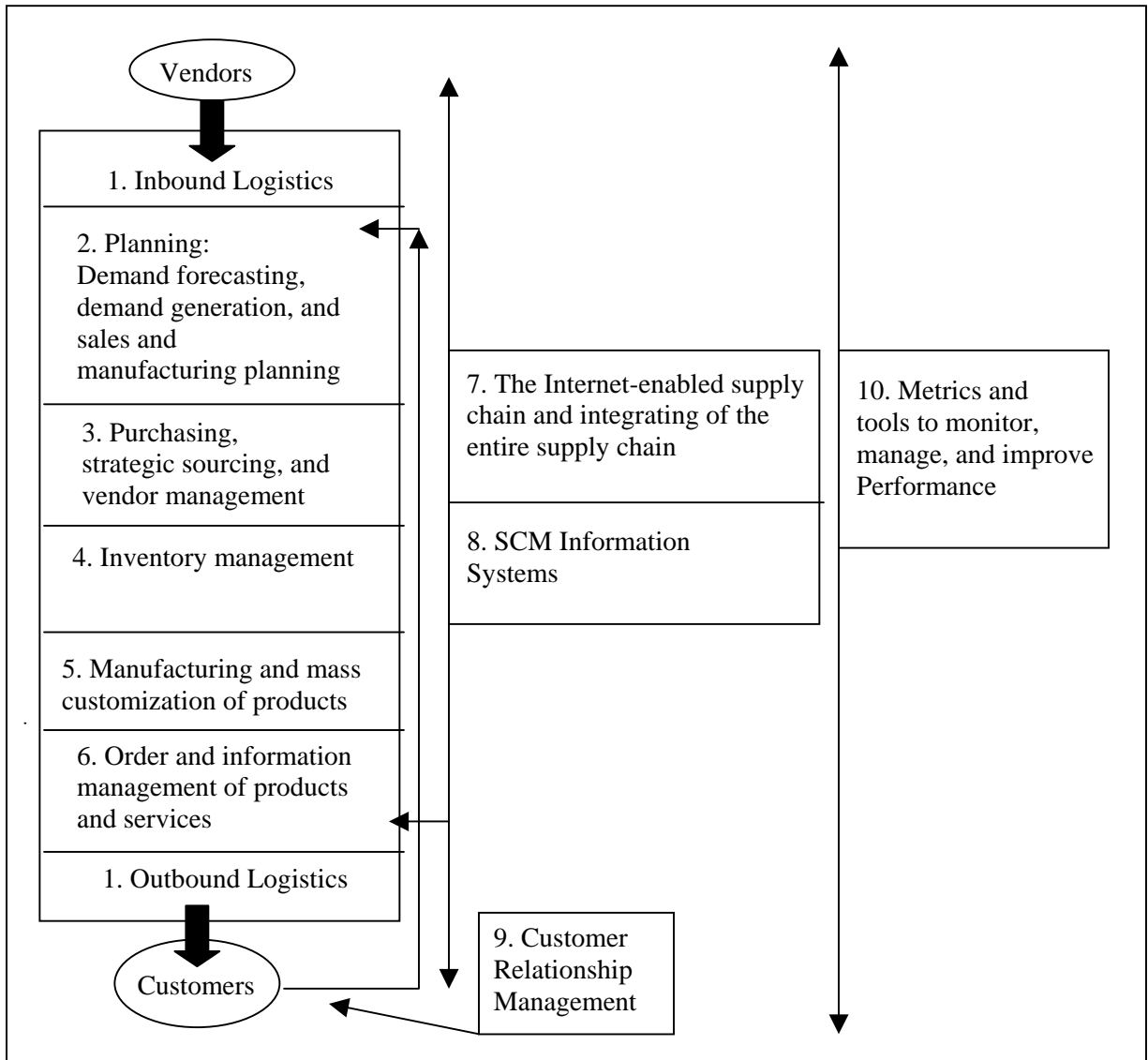


Figure 2.3: Key categories of the supply chain: Together they form the Supply Chain Management System

Note: The factors include physical activities, transactions, information systems, and tools

Source: Adapted and compiled from: Al-Hakim (2002), Anderson and Lee (1999), Britannica (1994-1999), Banfield (1999), Bradshaw and Bash (2001), Christopher (1998), Coyle, Bardi, and Langley (1998), Galbreath and Rogers (1999), Poirier (1999), Poirier and Reiter (1999), Poirier and Bauer (2000), Riggs and Robbins (1998), Tyndall et al. (1998).

A summary of the supply chain categories and factors and their benefits is given below in Table 2-2, and a detailed discussion of each element is given in detail in the next section.

Table 2.2 Supply Chain Categories, Factors, and their Benefits

	Categories	Factors	Benefit
1	Logistics (Transportation only)	<ul style="list-style-type: none"> • Inbound transportation into company • Outbound transportation to customers • Company wide logistics coordination and management • Reverse logistics 	<ul style="list-style-type: none"> • Lower costs • Faster deliveries of parts and products • Customer satisfaction
2	Planning	<ul style="list-style-type: none"> • Collaborative planning • Demand generation (of products) 	<ul style="list-style-type: none"> • Provides better forecast process, resulting in less inventory, stable manufacturing, and less stock-outs
3	Purchasing	<ul style="list-style-type: none"> • Strategic sourcing and centralized purchasing • Consolidate and reduce number of suppliers • Collaborative bidding 	<ul style="list-style-type: none"> • Lowers costs of purchased parts and cost reduction
4	Inventory management	<ul style="list-style-type: none"> • Inventory management and reduction 	<ul style="list-style-type: none"> • Reduces inventory, assets, and better availability
5	Manufacturing techniques and mass customization	<ul style="list-style-type: none"> • Lean manufacturing • Late product differentiation and customization • Outsourcing of non-core activities 	<ul style="list-style-type: none"> • Lean inventories and minimum waste in production • Reduces number of product options and better availability • Increases productivity via lower costs
6	Order management	<ul style="list-style-type: none"> • Electronic order management, with electronic transactions and payments 	<ul style="list-style-type: none"> • Increases speed of order transactions, with better and quicker information to customers

Table 2.2 (Continued) Supply Chain Categories, Factors, and their Benefits

	Categories	Factors	Benefit
7	The Internet enabled supply chain and integration of the entire supply chain	<ul style="list-style-type: none"> • SCM systems to link the supply chain • Efficient Consumer Response (ECR) • Internet as the basic engine for e-commerce • Inter-organizational level coordination • Rebuilding, or disinter-mediation, of the supply chain 	<ul style="list-style-type: none"> • End-to-end visibility of the supply chain, with faster transactions, lower costs and inventory, higher customer satisfaction • Reduction of cash to cash cycle • Enables Electronic product information and pricing, faster customer and supplier and financial transactions, real time order management, and electronic delivery of products and services • Optimization of supply chain • Shorter and more efficient supply chain
8	SCM Information Systems	<ul style="list-style-type: none"> • Supply Chain Management information systems • Customers access into a firm's supply chain 	<ul style="list-style-type: none"> • Faster information flow internally and with customers and suppliers • Increased customer satisfaction
9	Customer Relationship Management (CRM)	<ul style="list-style-type: none"> • Management of technology, processes, information, and people (to get a 360-degree view of the customer) 	<ul style="list-style-type: none"> • Higher customer satisfaction and loyalty
10	Metrics and tools to manage and improve performance	<ul style="list-style-type: none"> • Metrics to track key factors of supply chain performance • SCOR (Supply Chain Operations Reference) model • Competitive benchmarking process • Computer modeling for SCM optimization 	<ul style="list-style-type: none"> • Better monitoring and management of performance • --As above-- • Adoption of best practices • Lower supply chain costs

Source: Summary from Literature Review, adapted and compiled from: Al-Hakim (2002), Anderson and Lee (1999), Bakos, (1991), Britannica (1994-1999), Banfield (1999), Barret and Oliveira (2001), Bradshaw and Bash (2001), Christopher (1998), Coyle, Bardi, and Langley (1998), Galbreath and Rogers (1999), Handfield and Nichols (1999), Poirier (1999), Poirier and Reiter (1999), Poirier and Bauer (2000), Riggs and Robbins (1998), Tibben-Lembke (2002), Tyndall et al. (1998).

2.3.4 Applications of supply chain management factors

1. Inbound and outbound logistics

All parts and products within the supply chain have to be delivered to factories, distributors, and customers. The choice of the transport mode (air, sea, or land) affects all other areas of supply chain management, such as warehousing, production, packaging, planning, location (of suppliers, manufacturing, and customers), inventory control, and information management (Coyle, Bardi, Langley, 1998). Therefore factors such as transit time, reliability, accessibility, security, impact on inventory, product degradation or obsolescence, trace-ability, and so on are important. Once the carrier is selected, computer models are used to optimize routing. The overall effectiveness of the shipping function is a major way to reduce costs (Britannica, 1994-1999; Council Of Logistics Management, 2001; Coyle, Bardi, Langley, 1998).

More recently, managing the reverse flow of products has become an important ability. *Reverse Logistics* is the management of the reverse flow of products. This includes customer dissatisfaction with the product or at the end of the product life cycle, when the product is returned for recycling. This concept of reverse logistics has become an important strategic advantage for companies, and is driven by losses from customer dissatisfaction returns, or the cost and challenges of recycling (Tibben-Lembke, 2002). Both activities if managed well can increase customer satisfaction.

2. Planning: Sales and production planning: collaborative planning and generating demand

All manufacturing or supply of services starts with a forecast of demand. The problem is that forecast errors can result in lost business (if forecast is low) or high inventories (if forecast is too high). Forecast errors lead to the "bullwhip" effect and can cause excessive inventories, poor customer service, lost revenues, misguided capacity plans, and missed production schedules (Lee, Padmanabhan, and Whang, 1997). Furthermore suppliers often push products to market, but more recently the retailers are interested in stocking only what the consumer will buy.

The solution to the “bullwhip” effect is supply chain collaboration – an activity requiring two or more companies to share the responsibility of exchanging common planning, management, execution, and performance measurement information (Anthony, 2000). Such a collaborative relationship transforms how information is shared between companies and drives change to the underlying business processes. Typically, the process is to get data from POS (point of sales) systems, which is sent back to the warehouse or manufacturer, who arranges for quick replenishment (Lee, Padmanabhan, and Whang, 1997; Poirier, 1999; Poirier and Reiter, 1999). Consequently, production volumes and subsequent sales to retailers are based on sell-through information, planned promotions, and seasonal forecasts using statistical models. The sell-through data are used to replenish products at a retailer through a process called *continuous replenishment*. Hence, if a firm has the ability to understand real-time market demand and respond quickly it is possible to manufacture only what sells in the market (Lee, Padmanabhan, and Whang, 1997). This continuous replenishment process, or the *synchronized supply chain* as it is often called, has spread from the supermarket sector to the automobile industry, but barriers remain including lack of scalability and critical mass, managing exceptions, and managing promotions (Barret and Oliveira, 2001).

3. Purchasing, strategic sourcing, vendor management, collaboration and bidding via the supply chain

With accurate dynamic forecasts made from customer demand and promotions, the correct raw material inventory can be stocked. Furthermore, purchasing becomes a strategic function – hence strategic sourcing is initiated to reorganize the company’s supply base for materials and services in order to reduce external expenditures and internal processing costs (Banfield, 1999). Aggressive companies have partnered with suppliers to reduce the number of suppliers by 40 % to 85% (Banfield, 1999; Poirier and Reiter, 1999). This supplier reduction program also reduces internal processing costs as larger orders go to fewer suppliers. In addition, aggressive companies review their supplier’s cost structure and technical capabilities in order to select the best supplier. They also set up internal supply management teams to manage the supply

process (Riggs and Robbins, 1998). These initiatives result in higher volumes with better prices and quality from the short-listed suppliers (Banfield, 1999; Riggs and Robbins, 1998).

Costs can be reduced through industry collaboration and bidding via the supply chain. For example, increasing political pressure to cut defense budgets in the late 1990s and early 2000 has caused a major restructuring of the defense industry and led to consolidation, mergers, acquisitions, and strategic alliances. This has led to extensive collaboration between defense firms, and included collaborative bidding (Graham, Hardakar, and Sharp, 2001). Research into the collaborative bidding process has shown that bidders use Porter's (1980, 1985) competitive approach, and attempt to position themselves as a low cost or differentiated (value added) supplier.

4. Inventory Management

There was a strong emphasis on asset management via lower inventories and warehouse space. Companies recognize that product inventories are expensive to hold. Therefore many companies have implemented just-in-time (JIT) deliveries of parts, a methodology initially implemented by Toyota Motor Company (Shingo, 1981). Some companies have been more aggressive and have implemented vendor-managed inventory (VMI). For example Apple Computer Inc. has set up a partnering deal with suppliers. A supplier keeps inventory in the warehouse on consignment and moves it to the factory on demand – only then is it considered sold (Bleakley, 1995).

Moreover, inventory occupies warehouse space, which is costly – therefore there is a drive to reduce multiple warehouses. Hence, regional distribution centers (RDCs), instead of a warehouse in every big city, have become popular (Coyle, Bardi, and Langley, 1998). For example, Philips has reduced its warehouses for consumer products from 22 to 4 in Europe (Christopher, 1998). The RDCs are typically located within or near major markets. This can often result in longer delivery cycles, but can be compensated with supply chain programs like continuous replenishment. The next step is to manage inventory by a centralized information system, to facilitate shipping

across and within regions. The information systems are critical in providing availability information and create a virtual inventory that is accessible to all involved parties (Poirier, 1999).

5. Manufacturing techniques, mass customization of products, and outsourcing

Japanese companies led by the automobile industry have implemented lean manufacturing techniques. For example *kanban* manufacturing and just in time (JIT) delivery of parts. (Note: *Kanban* is a system that emphasizes manufacturing in small lots with minimum inventory build-up in the production process). This results in lower inventories, better deliveries, and lower costs compared to US (automobile) competitors (Liker and Wu, 2000). Another activity to lower costs is outsourcing of manufacturing and manufacturing closer to the customers and large markets. The reason for this is that in every industry customers are expecting greater customization of products and services to meet their individual needs (Anderson and Lee, 1999; Schonfeld, 1998). To meet these needs, companies are pursuing *a supply chain compression* strategy (Anderson and Lee, 1999). Some of the strategies pursued by companies are: (adapted from Anderson and Lee, 1999; Bagozzi, et al., 1998; Rockford, Lee, and Hall, 1998; Feitzinger and Lee, 1997):

- *Intra-company postponement*: moving final product configuration from factory to distribution centers in selected markets. This solution requires a modular product design, which allows last minute customization, to meet customer, at a distribution center near the customer. The Hewlett-Packard Company pioneered this program from 1992 onwards. Note: the term postponement is the last stage of manufacturing, which was postponed until the last possible moment.
- *Inter-company postponement*, i.e. moving final product configuration downstream to a channel partner, intermediary, or retailer
- *Sales agent model*: moving all inventory to the assembler, and allowing the channel and reseller to focus on sales.
- *Direct model*: the assembler is responsible for order processing and delivery, thereby eliminating the distributor and reseller, and sales channel.

- *Outsourcing*: companies are realizing that manufacturing (especially of low-value added activity) is not a core competency. Outsourcing of such activity can reduce costs and increase productivity per employee.

Any one of these strategies is able to save costs and improve return on investment. Depending on which strategy is used, some companies have shown an increase in EVA (Economic Value Added) of 70 to 470 million dollars (Anderson and Lee, 1999).

6. Order and information management of products and services

Since 1995, many companies have started to convey information, transmit orders, and purchase parts and products via Electronic Data Interchange (EDI) or the Internet (Poirier and Reiter, 1999). EDI has been available for many years, but is limited to big producers and is too costly for small manufacturers or retailers (Kerstetter, 2001). However with the advent of the Internet, almost any firm is able to become an electronic commerce player. Activities provided via the Internet include inventory information, catalogs and prices, order management, shipping information, and product-returns management (Sedlak, 2001). The benefits of electronic commerce to a firm include quicker and more accurate capture of orders, quicker verification and transmission of orders, better communications, and quicker payments.

7. The Internet enabled supply chain and integration of the entire supply chain

The disparate factors of the supply chain (such as planning, purchasing, manufacturing, order and management, warehouse management, and logistics) have resulted in a formidable challenge because many activities were adopted and introduced ad-hoc in a company. However, with the advent of more powerful information technology systems, many solutions towards better integration have been introduced:

Integrating the entire supply chain via a computer network: The separate factors of the supply chain grew and evolved over the years. These factors have to be linked together to ensure optimization of resources and costs. As a result, software vendors have come up with solutions to provide this synergy, synchronization, and

optimization of the supply chain. In 1999, there were at least 14 enterprise-wide (supply chain) software solutions available (Shepherd and Lapide, 1999). The linkages span the supply chain from the consumer to the supplier. Good integration involves coordination of the following: demand information, inventory status, capacity plans, production schedules, promotion plans, demand forecasts, shipment schedules and replenishment processes (Lee, 2000). The benefit of integration is the creation of supply chain that reads customer demand and responds quickly to customer and market needs. Such a lean and responsive system is, in theory, able to shorten time to do anything and have a shorter cash to cash cycle (Poirier, 1999; Tyndall et al. 1998). Note: The cash to cash cycle is the time taken to convert an order into cash and is a key measure of financial performance – refer to figure 2.2.

With SCM integration it is possible to improve inter-organizational level coordination and hence move towards optimization of the supply chain (Bakos, 1991).

Successful integration via Efficient Consumer Response (ECR) process: One of the most effective integration solutions is Efficient Consumer Response (ECR) - it enables the integration of factory or vendor supply and customer demand. Specifically, it focuses on demand management, supply management, and enabling technologies that links these activities (Christopher, 1998; Poirier and Reiter, 1999). ECR can coordinate new product introductions, consumer promotions, product range/variety, and replenishment. This is the standard in large grocery chains in the US and Europe and is moving into department and other retail outlets (Poirier and Reiter, 1999). The benefit of ECR is lower cost, less inventory, and improved product availability (Christopher, 1998; Poirier and Reiter, 1999). ECR can result in extensive collaboration between suppliers, logistics service providers, and retailers. Hence, supply chains can become *demand chains*, resulting in the optimum quantity of products in the market, with little or no stock-outs in the retail outlets.

Rebuilding the supply chain: The convergence of the Supply Chain with the Internet has resulted in a rebuilding of the supply chain. The Internet makes it possible to dispense with many activities in the supply chain (The Economist, 2000a). This dis-

intermediation has reduced the role of many wholesalers and retailers as consumers have started to buy direct from manufacturers or wholesalers. However, early predictions that this dis-intermediation will eliminate wholesalers and retailers has not happened - instead what has emerged is a change in the function of intermediaries, for example the need to add value and decrease high price mark-ups (Hagel and Singer, 1999).

The Internet-enabled supply chain: Further coordination and integration of the factors of supply chain is possible with the advent of the Internet. Several visionaries and researchers have made predictions on how the Internet will impact the supply chain. The Internet provides the basic engine to initiate, propagate, support e-commerce, and synchronize the entire supply chain. In the future, with e-commerce and the Internet, companies will sell only what they can deliver. This will put a high dependency on supply chain management (Drucker, 2000). Some of the activities that are possible via the Internet are (Christopher, 1998; Hagel and Singer, 1999; Johnson, 2000; The Economist, 2000a; Tyndall et al. 1998.):

- Product and marketing information, catalogues, and pricing data.
- Customer communication, order management, acknowledgement, and service.
- Supplier communication, data interchange, and purchase orders
- Financial transactions between the firm and its suppliers and customers
- Electronic delivery of products and services (discussed below)
- Rebuilding the supply chain

However, the Internet is only a tool to better synchronize and facilitate supply chain management and cannot replace it - the outcome will be lower costs, higher speed, and increased customer satisfaction (Anderson and Lee, 2000).

The E-supply chain: The Internet enabled supply chain becomes an E (or Electronic) supply chain. The E-supply chain connects the entire organization from raw material vendors, purchasing, planning, manufacturing, logistics, marketing, customer care and service, and human resources. Such a system is able to meet the customer's changing demand quickly able and meet very aggressive goals in economic added value, EVA,

(Poirier and Bauer, 2000). The E-supply chain forms a network, which, allows for collaboration with all the partners of a firm and links all the important information in a firm, including cash flow and order management, to those members of the supply chain that most need it. The greatest challenge is good information exchange and better integration to create a truly virtual E-supply chain. If this is achieved, the result will be lower costs and enhanced performance (Van Hoek, 2001). Nevertheless, the E-supply chain dimension of E-business is largely neglected and under-practiced, and hence it is difficult to make E-business into a reality. In fact one researcher argues that the E-supply chain is virtually non-existing (Van Hoek, 2001).

Electronic delivery of products and services: The convergence of the Supply Chain with the Internet allows immediate delivery of certain products and services, which can be transmitted electronically. These include music, documents and books (via data files), software, event and travel tickets, stock transactions, on-line diagnosis of computers and their peripherals, and banking services, e.g. loans and payments (The Economist, 2000a).

8. Supply Chain Management (SCM) Information Systems

The linkages of supply chain factors via computer systems using enterprise resource planning (ERP) systems or the Internet also provide another benefit - access to information throughout the supply chain. Some of the benefits and advances are:

Visibility across the entire supply chain: Supply Chain Management information systems are able to provide complete visibility across the entire supply chain. Available information includes (Christopher, 1998; Hagel and Singer, 1999; Johnson, 2000; The Economist, 2000b; Tyndall et al. 1998; Bakos, 1991):

- Product and marketing information, catalogues, and pricing data.
- Customer communication, order management, acknowledgement, and service.
- Supplier communication, data interchange, and purchase orders
- Provide complete visibility across entire chain
- Ability to track specific projects, production runs and cycle times

- Inventory buckets at suppliers, in transit, receiving docks, work-in-process, finished goods, and at distributors
- Product or goods delivery information
- Ability to track local to worldwide information of above factors
- Provide real time information of all above factors
- A crucial area that improves with good SCM information systems is Inter-organizational information flow – both within and between organizations.

Designing the SCM system for competitive advantage through information enrichment: Recent research looks at the impact of information usage on the supply chain system (Mason-Jones and Towill, 1997). The researchers argue that market place information must move quickly from customers through the entire supply chain without delay. An example in industry is the Efficient Consumer Response (ECR) process used in supermarkets, discussed earlier. Information from the market place comes via the Internet or EDI (electronic data exchange). Such an enriched supply chain can reduce uncertainty and time delay and provide several benefits. The benefits include an increase in the speed of response in processes and reduced inventory levels. The overall result can be a seamless and holistic supply chain, which allows a company to be more competitive. However, this research focuses on forecasting and production, and the conclusions drawn are from a computer model.

9. Customer relationship management

Customer relationship management (CRM) has become important as customers start to demand mass customization or personalized products and services (Schonfeld, 1998). CRM is the management of technology, processes, information, and people in order to maximize each customer contact by obtaining a 360-degree view of the customer (Galbreath and Rogers, 1999). To be effective, CRM has to extend through multiple channels (Bradshaw and Brash, 2001). Effective CRM can result in high customer satisfaction, which is achieved through customization, personal relationship, and after-sales support (Galbreath and Rogers, 1999). In order to maintain competitive advantage, a company has to have an effective CRM program and integrate it tightly -

via process, people, and information - with its supply chain management activities (Al-Hakim, 2002).

10. Metrics and tools to manage and improve performance

Any supply chain activity or system can be managed better or improved. To this end there are metrics and tools to help achieve this goal. Tyndall et al. (1998) have proposed looking at three facets: total cost approach, enterprise wide demand/supply matching, and a dashboard of select metrics (consisting of operational costs, time to response, margins, and customer service). Another more comprehensive approach is called SCOR, or Supply Chain Operational Reference (Supply Chain Council, 2001). This consists of a series of 18 metrics that measure customers/quality, time, costs, and asset utilization. With these metrics a firm can measure and strive to keep improving supply chain performance by getting a better score. “Best in Class” companies are able to show an advantage in supply chain management costs of 3 to 6 percent of revenue (Supply Chain Council, 2001). Firms are advised to use competitive benchmarking to review their performance in each category against the industry leaders, and then endeavor to emulate their success (Supply Chain Council, 2001). Some proponents recommend other tools such as process mapping, and reengineering to review current supply chain processes and improve them based on customer needs (Hammer, 1997, 1999; Poirier, 1999; Tenner and DeToro, 1997). Other proponents recommended computer modeling to select best manufacturing and distribution location and combination of supply chain factors (Rockford, Lee, and Hall, 1998).

2.4 Supply Chain Management (SCM), SCM Systems, and Advanced SCM Systems

The advent of computer systems software for supply chain management, which links all the factors of the supply chain, and the convergence of supply chain management with the Internet has led to the realization of Supply Chain Management (SCM) Systems. These systems contribute to tighter linkages from factory to customer, better communications, increase in productivity, and the may lower costs.

2.4.1 Topography of SCM Systems and Advanced SCM Systems

Companies continue to pursue better SCM Systems, through use of powerful information technology systems applications. Some of the pertinent and relevant progress includes the following:

- The basic SCM system
- Supply chain management: an empirical study on its impact on performance and the Dell Computers model
- The agile and leagile (lean and agile) SCM System
- The virtual supply chain
- The holistic and holonic SCM system
- Development of SCM systems in high technology firms
- Barriers to better supply chain integration and SCM Systems

The basic SCM system:

The basic SCM system consists of (at least) all the factors of the supply chain, managed by a computer system, and displayed in figure 2-3. Typically, early efforts of SCM systems were internally focused and dedicated to cutting costs, but eventually the SCM system has to be externally focused and customer connected (Poirier and Bauer, 2000).

Supply chain management: an empirical study and the Dell model:

One empirical study concludes that the SCM system consisting of supply chain, suppliers, manufacturers, and customers, must be effectively integrated in order to achieve financial and growth objectives at a firm (Tan et al., 1999). Such integration will make a firm more successful. The study leaves open to further research the question of how multiple organizations should integrate and bring to customers technological innovations at the lowest cost and quickest time.

Other studies cite the Dell Computers (Company) model and its optimized supply chain system. Dell's optimized supply chain permits it to have a business model that

allows for “build-to-order” manufacturing. This allows Dell Computers to respond more quickly to customer demand, have lower inventory, have a shorter cash to cash cycle, and achieve higher profitability (Tyndall et al., 1998; Magretta, 1998). Currently, Dell’s inventory turnover is 109 times, or ½ a week of inventory, and productivity, as measured by revenue per employee, is about US\$ 900K per employee (MSN, 2003). This is the best performance in the manufacturing industry. The cash to cash cycle is the time taken to convert an order into cash and is a key measure of financial performance. Hence, if production material is already procured and in stock, the cash to cash cycle starts before the order is received. In the manufacturing environment, the cash to cash cycles range from a few days to over 100 days. A superbly managed company can have a negative cash to cash cycle, by collecting monies from customers before the inventory of parts is purchased.

Dell Computers has invested heavily in optimizing its supply chain (Magretta, 1998; Bagozzi et al., 1998). Its cash to cash to cycle is – (minus) 8 days. Dell Computers’ negative cash to cash cycle time and low inventory is a benchmark in the industry and very few companies are able to match its success. This is shown in figure 2-4. This situation reflects the concept of core competencies of the corporation, discussed earlier by Hamel and Prahalad, (1998), who argue that a firm cannot buy such competencies, instead a firm and its managers have to devote time to build core competencies.



Key Takeaways and Recommendations

1. Cash is King... welcome to Michael Dell's World
2. Cash Conversion Cycle (CCC, or Cash to Cash Cycle)

$CCC = \text{Days of Supply} + \text{Days of Inventory} - \text{Days Payable Outstanding}$

$CCC = \text{Accounts Receivable} + \text{Inventory} - \text{Accounts Payable}$

Dell: In 1994 $CCC = 40$ days

In 1998 $CCC = -$ (minus) 8 days

Figure 2-4: Dell's Cash to Cash Cycle (progress over 4 years)
Source: Hewlett-Packard, 2000.

The agile and leagile SCM System:

Turbulent and volatile markets are becoming the norm because of shorter product life cycles; this situation creates risks if the supply chain is lengthy or has slow moving logistics.

One solution to this situation is an agile supply chain (Christopher, 2000; Christopher and Towill, 2000). An agile supply chain is flexible and has a business-wide capability that embraces organizational structures, information systems, and logistics processes. Agility is not leanness or low inventory, which is a major goal of supply chain management. Such agility comes from 4 key areas:

- Market sensitivity, or understanding real customer demand
- A virtual supply chain created through information technology
- Shared information via process integration and collaboration between suppliers, companies, and customers
- Confederation of partners linked via computer networks

A good working example of a company with agility is Zara, the Spanish fashion house. Zara works with a network of suppliers and manufacturers to ensure a responsive and flexible supply chain to meet customer's changing needs for color, fit, and design (Christopher, 2000). Leading companies need to be agile and implement marketing strategies that are underpinned by a strong SCM system. Research indicates that agility results in quicker and better responsiveness to customer and market needs, and ensures a high customer service-level (Power, Sohal, and Rahman, 2001). Agility will be the key to surviving and competing in the uncertain and turbulent markets of the 21st Century (Power, Sohal, and Rahman, 2001).

In reality, some businesses (commodities) require a lean supply chain, while others (fashion) requires an agile supply chain. However, some researchers, argue for the leagile supply chain system, i.e. a supply chain that was both lean and agile (Mason-Jones, Naylor, and Towill, 2000). The early (and planning part) of the supply chain should be lean, while the later (or customer focused/order management part) should be agile. The entire supply chain should be networked and information enriched throughout to respond very quickly to customer's changing (and gyrating) demand.

The virtual supply chain:

Greater supply chain synchronization is possible by sharing information via the Internet. This sharing of information on market intelligence can further reduce supply chain costs, and provide better products quickly and increase revenue, according to Johnson (2000). He proposes an OEM (Original Equipment Manufacturer) managing information via a network of component manufacturers, component distributors, manufacturing services providers, distributors, and channel resellers. He argues that sharing product and information content can provide better products quickly and increase revenue. Johnson's web-centric approach is shown in Figure 2.5. In the figure, the key activity is managing product content and information, and not the physical flow of material. This is one of the earliest proposals of the virtual supply chain, which is managed and enabled via the Internet (Johnson, 2000).

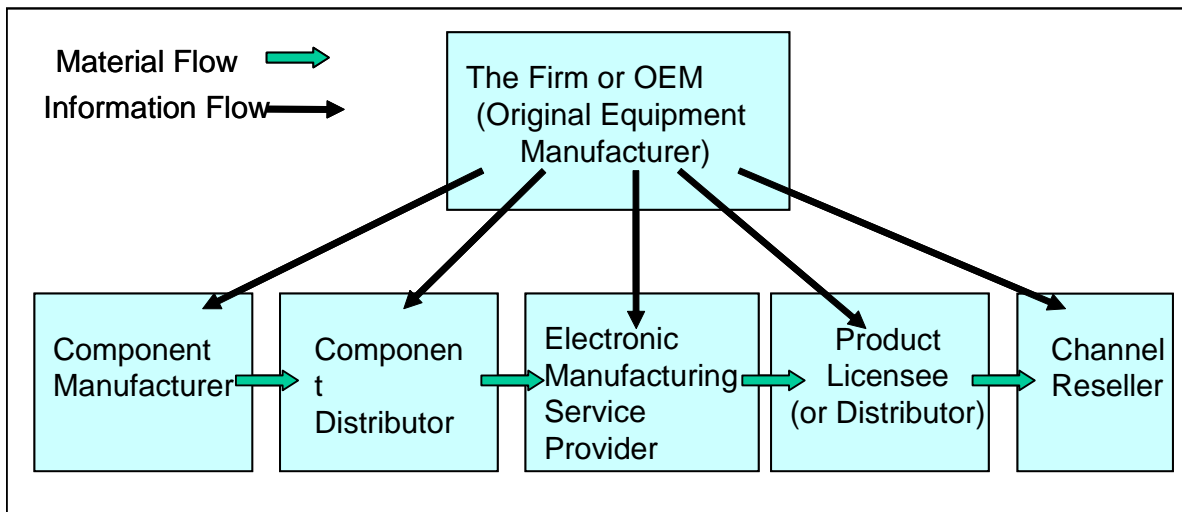


Figure 2.5: Typical Virtual Supply Chain in Computer & Electronics Industry

Note: This figure shows the virtual supply chain, managed and enabled via the Internet

Source: Johnson, 2000

The concept of the virtual supply chain has gathered momentum among visionaries – they believe that with it companies can focus on intellectual capital - brands, technology, new product development, and new channel strategies – and outsource operational activities (Bovet and Sheffi, 1998). However, the virtual supply chain like the E-supply chain remains a vision that is virtually non-existing (Van Hoek, 2001).

The holonic SCM System

As advances in networking proliferate, many visionary researchers are proposing holonic or holistic systems. This holonic system attempts to go beyond the E-supply chain and proposes the holonic network, which creates virtual companies, and gives substantial competitive advantage to a firm (McHugh, Merli, and Wheeler, 1997). Holonic principles are a driving factor of holonic networks, and included the following:

- Successful business process reengineering (BPR) to improve existing processes
- New technology requirements to achieve mass customization (providing customer demand, etc.)

- Customer involvement, i.e. understanding of real demand.
- Capacity management at each node of the network. Such a node can be
 - A virtual resource, i.e. suppliers and outsourced vendors.
 - Support activity of customer, customer service, etc.
 - Operational activity, such as assembly or manufacturing.
 - The Integrator, or the company that markets and owns the end product.
- Little supervisory overheads, because key activities are driven automatically by systems, e.g. transmit the customer demand activity to all nodes to drive plans and purchasing.
- Information technology to integrate all the holonic network

The advantages of such a holonic network include leverage (synergy of internal processes), speed (in decision making), flexibility (meeting changing customer needs), shared assets or costs (across the organization), and responsiveness (to failures or problems). All this can result in faster growth and profits. An example of such a holonic network was Aprilia, an Italian manufacturer of motorcycles for companies like BMW (McHugh, Merli, and Wheeler, 1997). The holonic concept of virtual companies, in 1997, is visionary and anticipates the concept of a virtual company that is quick, responsive, has lower costs, and is competitive. It integrates all of the concepts and supply chain factors discussed in this review, such as outsourcing, capture of real-time customer demand, agile supply chain, and integration via computer networks.

However, very few companies have been able to reach such a visionary structure. Some researchers predict that holonic networks will be most successful in Japan and Europe because of geography, and less successful in North America because of its “freedom and individual” culture (McHugh, Merli, and Wheeler, 1997). Other researches argue that a breakthrough in supply chain management can only come if a company reengineers its key processes, and moves toward a holistic model, requiring connectivity and collaboration with partners (Alshawi, 2001).

SCM Systems in high technology firms

The solution to better business performance in the high technology industry is to have a networked supply chain (Kuglin and Rosenbaum, 2001). Such a networked supply chain will connect (with its planning, purchasing, inventory management, manufacturing, order management and tracking, and customer management) to suppliers, contract manufacturers, sales channels, and customers. The backbone to the networked high technology supply chain is communications. Most important, a networked high technology supply chain can increase shareholder value by improving capital efficiency, reducing costs, and increasing profits (Kuglin and Rosenbaum, 2001). An example cited is Dell Computers (Kuglin and Rosenbaum, 2001; Magretta, 1998; Bagozzi et al., 1998). However, this example is able to achieve only some of the characteristics of the networked supply chain and has many manual processes.

SCM systems in high technology firms are changing and evolving as technology and marketing strategy changes. The key evolution has been from a lean supply chain to an agile and customized supply chain. The PC industry, in particular has evolved rapidly, and its key changes are summarized as follows (Christopher and Towill, 2000):

- Product driven in early 1980s (lean functional silos, focus on quality and costs)
- Market oriented in late 1980s (lean supply chain, focus on cost and availability)
- Market driven in early 1990s (flexibility, focus on availability and lead time)
- Customer driven in late 1990s (customized and agile, focus on lead time and quality)

Many high technology companies (in the USA) are investing in supply chain management programs via the Internet. For example,

- Cisco Systems has initiated the E-Hub (Electronic Hub), a private network accessible via the Internet (Chan, 2001). This provides an end-to-end visibility of the supply chain to Cisco Systems staff and its partners.

- Hewlett-Packard has initiated an online private exchange, called TradingHubs.com, to buy and sell excess parts and inventory to a host of partners and high technology companies (Chan, 2001).
- Inventec Electronics has set up a supply chain system to allow communication with its suppliers via the Internet (Chan, 2001). This allows Inventec to have visibility across its entire supply chain and to communicate and buy from its 600 suppliers.

All 3 companies mentioned here have a goal of reducing inventory. Such examples indicate that SCM systems in most companies discussed in this review seem to consist of pockets of innovation, indicating continual evolution and innovation. Hence, a potential research issue of the study is to review the supply chain management factors in high technology companies and the benefits they are realizing from them.

Barriers to better supply chain integration and SCM Systems

Although it is clear that the supply chain must be integrated from supplier (or upstream activities) to internal processes, to downstream activities, and to customers, there seem to be few examples of truly integrated supply chains (Handfield and Nicholas, 1998). Hence, the synchronized supply chain seems to be more aspiration than reality. Furthermore, according to Siekman (1999), quoting Sandor Boyson, co-director of Supply Chain Management Center at the University of Maryland, “..only a fourth of 117 companies in an e-commerce association claim to have extended trading via e-commerce”. Evidently, as companies work towards better coordination and integration of the various supply chain activities into SCM systems, they are faced with many barriers, such as lack of internal support, short-term performance focus, misaligned measures and rewards, poor use of technology, and lack of trust (Stank et al. 2001).

2.4.2 Using supply chain management to achieve competitive advantage

The research shows that competitive advantage comes primarily from process (or skills) that are difficult to copy, product or service differentiation, or lower costs. In fact, supply chain management and integration may provide one of the last sources of such a competitive advantage as product standardization and commoditization gravitate competition toward price, and sources of differentiation become more difficult to establish (Power, 2004). The proponents of the supply chain approach have identified specific activities, backed by detailed processes, which can improve a firm's competitive advantage and success. In addition, the proponents quote that, "best in class companies enjoy an advantage in (lower) total supply chain management costs of 3 - 6% of revenues (estimated)" (Boyson, et. al, 1999). The savings come from better management of a company's activities and assets, resulting in lower costs, better products and service, and competitive advantage.

There are several other factors driving and shaping the move into better supply chain management to achieve competitive advantage. Some of the factors are competition, globalization, and consumer demand (Bovet and Sheffi, 1998). Consumer demand includes the customer's need for a high level of service, customization, and product availability – all at the same time. The proponents of supply chain management reviewed in this section argue that these issues can be addressed or improved with supply chain management. Most companies agree that supply chain integration of suppliers, manufacturers, and customers is necessary to achieve financial and growth objectives and is key to long-term financial success (Tan et al., 1999), but these alone are insufficient for business success.

2.5 Identification of areas for further research

2.5.1 Development of framework to identify areas for further research

This Literature Review has identified an abundance of supply chain factors that can create benefits for a company. However, several gaps were noticed and these present opportunities. Figure 2-6, summarizes gaps in the literature, and shows the framework

used to identify areas for further research. This is followed by a discussion on the gaps in the literature and identification of the research objective and issues.

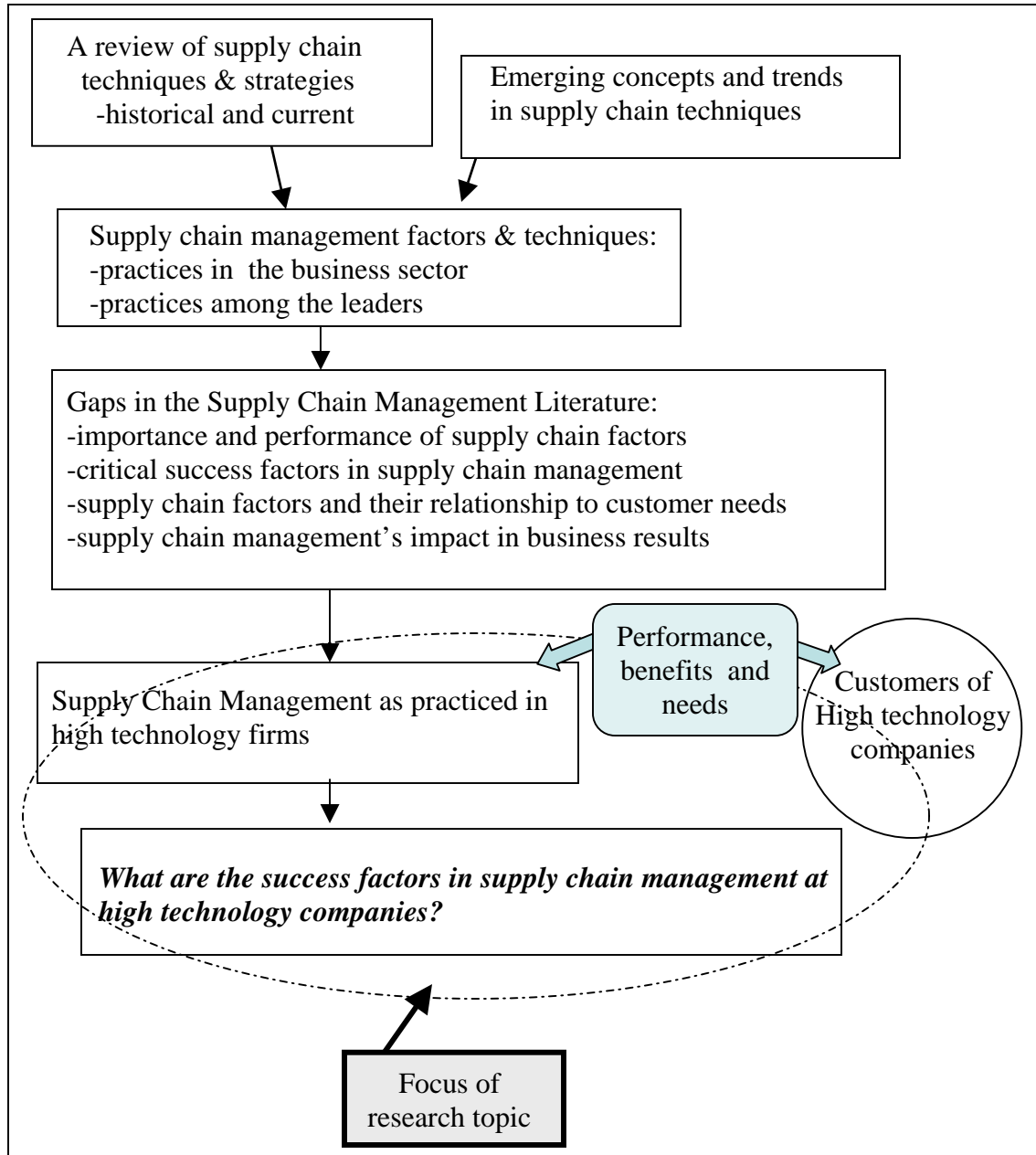


Figure 2.7: Development of a conceptual framework to identify an area for further research:

Source: Developed for this study

2.5.2 Gaps in the literature

Benchmarking of supply chain management in the high technology industry

The research and discussions in the literature have covered the manufacturing industry and discussed specific advances in some sectors of the industry including the high technology companies. However, there is a need for better benchmarking and more research to understand how the high technology industry implements supply chain management to achieve competitive advantage. The high technology companies are companies that create and deliver computer and electronic products, for example: computers, computer systems and networks, electronic measurement systems, and other electronic products. There is an expectation that these high technology companies will use unique and leading edge technology, and invest heavily in supply chain management. Hence, it will be beneficial to understand how such companies manage their supply chain and also if there are differences in critical success factors at various high technology companies.

Furthermore, this will fulfill a request from a high technology company: The author of this study works for a high technology company, head-quartered in California USA, and was requested to investigate the company's supply chain system and propose improvements to help make it more competitive.

Important or critical success factors

There is little information or research in the literature on the importance of the various supply chain factors. This important supply chain factors are also defined as critical success factors. The concept of critical success factors (CSF) was first defined by Rockart (1979) as the limited number of identified operational goals shaped by the industry, the firm, the manager, and the broader environment. If the CSF are satisfactory, they will ensure successful competitive advantage and performance for the organization (Laudon and Laudon, 2002).

Differences in critical success factors between high technology companies and benchmark companies

Information on critical success factors in the high technology companies and non-high technology companies is also lacking. When reviewing the supply chain management practices at high technology companies, it will be useful to understand if there are differences between critical success factors at various high technology companies and non-high technology (or benchmark) companies.

Performance gaps and opportunities

Information on performance gaps in supply chain factors is lacking in the literature. Appropriate analysis and understanding of performance gaps and opportunities can come from distinguishing between a supply chain factor's importance and its perceived performance. A successful company aims high, hence there will be gaps between the expected importance of a critical success factor and the perceived factor performance. In most cases perceived performance is worse than the expected importance. In such a case there will be a performance gap.

The concept of performance gap, that is expected importance – (minus) perceived performance, was first introduced by Martilla and James (1977). Performance gaps can provide some indication as to whether executives are successful in translation of their vision and direction to their employees. Hence such gaps can give an indication regarding the degree of employees' alignment with the organization's vision and direction. Gaps can be classified as opportunities in critical supply chain factors that require attention, focus, and good execution, in order to achieve greater success in supply chain management (Martilla and James, 1977; Al-Hakim, 2003).

Customer needs and their relationship to supply chain factors

However, the traditional methodology of analyzing performance gaps (Martilla and James, 1977) looks only at a prioritized list of company's internal performance gaps, and does not look at performance gaps from the customer's viewpoint. A

methodology that provides a process to look at customer needs is quality function deployment (QFD).

QFD is a comprehensive quality tool that can be used to uncover customers spoken and unspoken needs, and convert these needs to product or service design targets and processes (Akao, 1990). A well-designed QFD process is able to link and display customer needs, targets and processes into visual charts or tables. The outcome can be a better product or service that meets or exceed customer needs, resulting in better sales and higher customer satisfaction. The QFD methodology is very prevalent in the product design and quality literature. In service quality, at least one researcher has used it for designing service quality of an engineering laboratory (Pun, Chin, and Lau, 2000). Another researcher has used it for market research (Prasad, 1998) to predict product offerings that can interest customers. It has also been used to design services for healthcare providers (Lim and Tang, 2000). However, it does not seem to have been used in the supply chain literature.

Hence, there is an opportunity for further research in using QFD methodology to understand customer needs and their relationship to a company's internal performance gaps in supply chain factors - this will provide a definitive contribution to the supply chain literature. Such an analysis will also help identify critical success factors that will benefit customers and increase a firm's competitiveness.

Impact of external Vs internal supply chain factors on business success

In the literature review both external and internal supply chain factors were reviewed. Examples of external factors are activities such as customer relationship management and doing business via electronic commerce and the Internet. An example of an internal factor is a focus on internal manufacturing. Although research has been done on such factors, it will be beneficial to research the dynamics and impact of these internal and external factors on business success. Such an analysis will help identify critical success factors that benefit a company and increase its competitiveness.

2.5.3 The research topic and issues

Based on the request from a high technology company to the author of this dissertation to investigate the company's (business unit) supply chain system, and the gaps in the literature, the research objective is:

Determine the critical success factors in supply chain management at high technology companies.

In fulfilling this objective, the following research issues will be considered:

1. Are there differences between critical supply chain management factors at various high technology companies?
2. Are there differences between critical supply chain management factors at high technology companies and non high technology (or benchmark commodity) companies?
3. Will a focus on external supply chain management factors give better business results?
4. Are perceived critical gaps (and opportunities) in performance derived from traditional methodology similar to those deployed from customer needs?

2.6 Conclusion

This chapter presented a theoretical framework to provide an understanding of a firm's performance, and gave an overview of the literature on competitive advantage. The review discussed approaches on achieving competitive advantage and the research showed that competitive advantage came primarily from a process (or skill) that was difficult to copy, product or service differentiation, and lower costs. The review then narrowed down to a detailed discussion on supply chain management, supply chain factors, and their benefits. The review also discussed and looked at the current state and topography of supply chain management and supply chain management systems.

From the literature review, gaps and opportunities for further researched were identified. The review concluded with the research objective and issues. The next chapter discusses the research questions and methodology and design that will be adopted for this study.

Chapter 3

Research Methodology

The previous chapter reviewed the relevant literature, identified gaps in the literature, and concluded with the research objective and issues. This chapter discusses and determines the research methodology and process for the dissertation. The chapter starts with a review of the two types of research methods, quantitative and qualitative, and is followed by the justification to use qualitative methodology to investigate the research objective. This is followed with a discussion on the preparation of the questionnaire and data collection process. Next, there is a review of the process used for analysis, determining gaps, and generating recommendations from the questionnaire. The chapter concludes with discussions on the limitations of case study research, ethical issues, and the conclusion.

3.1 Qualitative versus Quantitative research methods and the selected methodology for this dissertation

Data can be quantitative or qualitative. The two methods are considered complementary rather than competitive (Malhotra, 1993; McPhail and Perry, 1999; Perry, 1998). Quantitative research attempts to quantify data and uses statistical analysis to test the hypothesis that the researcher begins with. This is the default research method for much of scientific research (McPhail, 1999). On the other hand, qualitative research produces findings without the use of statistical procedures (Neuman, 1997). Furthermore, qualitative research provides insights and understanding, while quantitative research tries to generalize the insights to a population (Perry 1998).

There is much debate on the benefits and differences between quantitative and qualitative research (Denzin and Lincoln, 1994; Yin, 1994). Many researchers argue that a quantitative approach to research is superior to a qualitative one because the use of surveys, experimental design, and statistics are perceived to provide both scientific rigor and objectivity. Therefore

quantitative research is assumed to have greater validity, generalizability, and replicability. Hence it provides greater theoretical contributions (Guba and Lincoln 1994).

Despite these criticisms of qualitative research, there are strong counter-pressures against quantitative methods according to Guba and Lincoln (1994). A variety of implicit problems in quantitative research include: context stripping (due to selective selection of variables), exclusion of meaning and purpose (that is, not understanding human behavior), and exclusion of the discovery dimension in inquiry (because the verification of hypothesis tends to gloss over the source or the discovery process) according to Guba and Lincoln (1994). For these reasons, qualitative research is gaining popularity especially in marketing research (Easterby-Smith, Thorpe, and Lowe, 1991; Parkhe, 1993).

Selected research methodology for this dissertation

For this study, it is decided to use the qualitative research process using multiple case studies.

There are several reasons for this:

- Since the focus of this research is on high technology companies operating in California, USA, there is a concern that there will be a small number of companies willing to participate in a large (sample size) quantitative survey.
- Supply chain management is a vast collection of techniques. Hence, selection of supply chain factors and strategies can be a complex process. In such a dynamic setting it is best to use qualitative research methodology (using case studies) to understand the situation.
- Face-to-face meetings with respondents can help provide understanding and information on several qualitative areas, such as: reasons for implementing specific supply chain factors (or strategies), customer needs data, and discussions and feedback on the questionnaire.
- A multiple-case study can provide a robust insight and thus achieve a higher level of external validity and reliability
- Cases can be viewed and studied alone and across cases (within-case analysis and cross-case analysis) to provide comparison and contrast and richer details and insights regarding the research issues (Eisenhardt 1989; Stake 1994; Yin 1994).

Hence it is decided to use a multiple case study approach using structured interviews from a questionnaire (Yin, 1994).

3.2 Research Process Phase 1 - Preparation of questionnaire and data collection

3.2.1 Preparation of the questionnaire

Prior theory as a springboard for the case

Case study research is an inductive, theory generation, process (Parkhe, 1993). There is, however, the question of whether one starts from a zero base or some prior theory. One school of thought recommends the zero-base or grounded-theory approach – in such a case the process is inductive, flexible, and opportunistic, and allows for adding questions during a series of interviews (Eisenhardt, 1989). However, according to other researchers, this flexibility can cause difficulties, one of which is that cases cannot be compared to each other (McPhail and Perry, 1999). Yin (1994) strongly recommends developing some preliminary theory. Therefore, for this dissertation, the prior theory approach is utilized. Hence a detailed questionnaire from the theory is developed from the Literature Review.

Questionnaire: content, design, and structure

The questionnaire was developed from the research topic and questions. Table 3-1, below, shows the structure of the proposed questionnaire.

Next the content of questionnaire was developed by combining the following tables:

- Table 3.1 (Process to structure questionnaire in relation to the topic and questions), shown below, and
- Table 2.2 (Supply Chain Categories, Factors, and their Benefits)

The combination is shown in Table A1-1. From Table A1-1, the questionnaire was designed.

Questionnaire Design

The questionnaire was designed using the approach of Watson and Frolick (1992) for structuring interviews with executives. In this approach the respondents are requested to rate both the *expected importance of a factor* and the *perceived factor performance* of each supply chain factor. Such an approach allows measurement of gaps between expected

importance and perceived performance of factors. The final questionnaire has 12 categories, with 58 questions, that are graded for importance and performance on a Likert scale. Also, there is one question on competitiveness rated on a Likert scale. In addition, there is one question requiring a forced ranking, from 1 (most important) to 6 (least important), of supply chain categories. More details of the questionnaire structure and design, and the finalized questionnaire are given in Appendix A1.

Table 3.1 Process to structure questionnaire in relation to the research topic

Research topic: What are the success factors in supply chain management at high technology companies?	
Research questions	Questions to cover following areas and provide structure to provide analysis
1. Are there differences between important supply chain management factors at various high technology companies?	<ul style="list-style-type: none"> • Prepare questions to detect and measure items in supply chain categories and factors as discussed in Literature review Table 2-2. • Rank importance of supply chain categories.
2. Are there differences between important supply chain management factors at high technology companies and non-high technology (or benchmark) companies?	<ul style="list-style-type: none"> • Contrast and compare supply chain management categories and factors from benchmark and high technology companies.
3. Does a focus on external supply chain factors give better business results?	<ul style="list-style-type: none"> • Measure competitive position and performance in questionnaire
4. Are perceived critical gaps (and opportunities) in performance derived from traditional methodology similar to those deployed from customer needs?	<ul style="list-style-type: none"> • Measure importance and performance of supply chain factors in order to determine gaps
5. Additional Useful Information Decision making and organizational factors that impact supply chain management	<ul style="list-style-type: none"> • Measure importance and performance of management and organizational issues. • Measure employee involvement and performance in supply chain management • Measure company performance in supply chain management

Source: Developed for this study

3.2.2 Case selection, companies, and respondents

In this section the rationale for the focus on the high technology industry, selection of business firms, unit of analysis, and the number of companies and respondents in the study is explained and documented:

3.2.2.1 Selection and focus on high technology companies

The companies reviewed in the multiple case study will be high technology companies. There are several reasons for this:

- These are companies that create and deliver computer and electronic products. Examples include companies with the following products: computers, computer systems and networks, electronic measurement systems, Internet infrastructure, and other electronic products. There is an expectation that these high technology companies will use unique and leading edge technology, and invest heavily in supply chain management. Furthermore, the companies selected have leadership positions in the industry. Hence, it will be beneficial to understand how such companies manage their supply chain.
- In order to ensure information richness, companies with consumer products (short, less than a year, product life cycles) and industrial products (with medium to long lifecycles of several years) will be selected. Moreover, a range of companies will help obtain either convergent or divergent views for the research topic.
- Since all the selected companies are high technology companies, they are expected to be facing similar business and external issues. Therefore a smaller number of cases can be deemed sufficient and appropriate to compare and contrast findings and establish replication (Yin 1994).

3.2.2.2 Number of companies selected

The number of cases recommended by various authorities varies. Ideally, the number of cases should be the quantity that provided theoretical saturation, or the point at which incremental learning became minimal (Eisenhardt, 1989). Other researchers recommend replication till there is redundancy (Guba and Lincoln, 1985). But in reality, practical matters, such as time and money are important (Eisenhard, 1989). In general, the more cases used in a case study research, the higher the degree of certainty and hence, external validity (Yin 1994). But, with

fewer than four cases it is considered difficult to generate theory (Yin, 1994; Perry, 1998; Eisenhardt, 1989), and its empirical grounding is likely to be unconvincing (Eisenhardt 1989).

Nevertheless, guidelines are considered only as starting points because, “The validity, meaningfulness and insights generated from quantitative inquiry have more to do with the information-richness of the cases selected and the observations/analytical capabilities of the researcher than with sample size” (Patton, 1985).

Since all the cases for this research are high technology companies, they are subjected to and faced with similar external issues. Hence, for this dissertation, five (5) companies, with five cases or business units, are studied.

3.2.2.3 Selection of cases, the unit of analysis, and number of respondents

The cases to be selected and the unit of analysis are important. That is, what is the ‘*case*’ being reviewed? A case can be an individual, an organization, a nation, and so on. The use of a proper unit of analysis will provide construct validity. Yin (1994) argues that as a general guide, the definition of the unit of analysis (and therefore the case) is related to the way the initial research questions are defined. For this case, five high technology companies have been selected. Within the five companies, the unit of analysis is the company’s business unit. A business unit is defined as a specific business, one level lower than the overall company. The reason for this distinction is that each business unit has a specific product and business strategy, supported by its supply chain management strategy.

Table 3-3: Case selection, the unit of analysis, and interview matrix

	Dimension 1: High Technology Companies				
	Dimension 2: Type of High Technology Company				
	Consumer Company (Consumer products, with short product life cycles of about 1-2 years)		Industrial/Commercial Company (Commercial products, with longer product life cycles of 2 to 5 years)		
	2 companies		3 companies		
	Company		Company		
	X	H	A	P	C
Business units studied	1	1	1	1	1
Number of respondents	3	4	4	3	3

Source: Developed for this study

To ensure richness of data for good analysis, business units are selected from a range of high technology companies. Table 3-3 shows the types of companies selected. In addition the Table also shows the number of respondents selected from each business units. Specific details of the Companies selected and the profile of respondents is given in Chapter 4 during analysis and interpretation.

Section 3.2.3 Data Collection

The objective of data gathering is to obtain a rich set of information for this dissertation in order to capture the research topic’s complexity, corroborate the learning, and to be able to triangulate one’s findings. This phase is considered important and critical to ensure that dissertation’s findings are accurate. Hence, advance preparation is essential for the research to ensure that multiple sources of evidence are investigated (Stake 1994, 1995; Yin 1994).

In this dissertation, questionnaires are the primary data collection technique. These data are complemented and triangulated with other sources of evidence such as internal company documents, company websites, and information from secondary sources, such as Internet Web-sites. Refer to the Appendix A4 for information on all the data sources used in the study.

Benchmark companies

For this case study, benchmark data on supply chain management will be obtained from four (4) non-high technology companies. This will allow comparison of practices between high technology companies and the benchmark companies. The supply chain management practices of the benchmark companies will be compared to the high technology companies in the cross-case analysis. The Benchmark companies are selected from the membership roster of the Council of Logistics Management, USA. Profiles of these companies are provided in Chapter 4.

Database

An Excel database has been developed and will be used to enhance the validity and reliability of the dissertation (Yin 1994). The data from the questionnaires will be tabulated into the database, and analysis for the case study will be done within this database.

Completion of questionnaire and interview process

A 'field package' will be sent to all interviewees, by e-mail. This package consists of a letter of introduction, objectives of the dissertation, definitions of terms, and the questionnaire.

A sample of the field package is shown in Appendix A2. Before sending the field package to the respondents, a telephone call will be made to the respondents to explain the objective of the case study, explain why they are being approached, and to set up a face-to-face meeting. At the meeting there will be a discussion to further explain the purpose of the study, explain the purpose of the importance and perceived performance terminology, and to receive the responses to the questionnaire.

Each company's identity will be concealed by naming them Company A, C, H, P, X. Furthermore, the identity of each interviewee will be identified as 'Interviewee A-1, A-2, A-3, (for company A), and so forth. This will allow accurate coding of the data in the database. During the analysis stage, most of the respondents will be approached to answer and clarify the responses to the questionnaire and to get additional data.

3.3 Research Process: Phase 2 - Data analysis, gaps, conclusion drawing, and design for quality

3.3.1 Content (data) analysis

After the interviews are completed, the contents will be analyzed. The main goal of data analysis is to produce convincing conclusions and to eliminate alternative explanation. Data analysis involves reviewing, categorizing, tabulating, and recombining evidence to ascertain meaning related to the dissertation's initial aim and objective, research questions and issues (Miles and Huberman, 1994; Yin, 1994). Analysis of field data and the succeeding interpretation are considered the heart of theory building from case studies. However, this is the most difficult and the least codified part of the process (Eisenhardt, 1989). It is very important to ensure that all data are treated equally and without bias while preserving its original meaning and context (Yin 1994).

Hence in this dissertation, data analysis will begin after the first questionnaire is collected, and will continue through the entire data collection phase and beyond. This approach will be used to guide the data collection process and will provide a focus to limit the amount of excess data collected (Morse 1994). It is planned to enhance the data analysis by

- Relying on all available and relevant information
- Considering alternative explanations and rival theories
- Focusing on the most significant aspects of the data, and
- Building on prior experience and expert knowledge

The data analysis process to be used for this dissertation is illustrated in Figure 3-1 and consists of three important and interactive processes

- Data reduction
- Data display, and
- Conclusions: drawing and verifying

These are discussed next with details on the approach taken in this study.

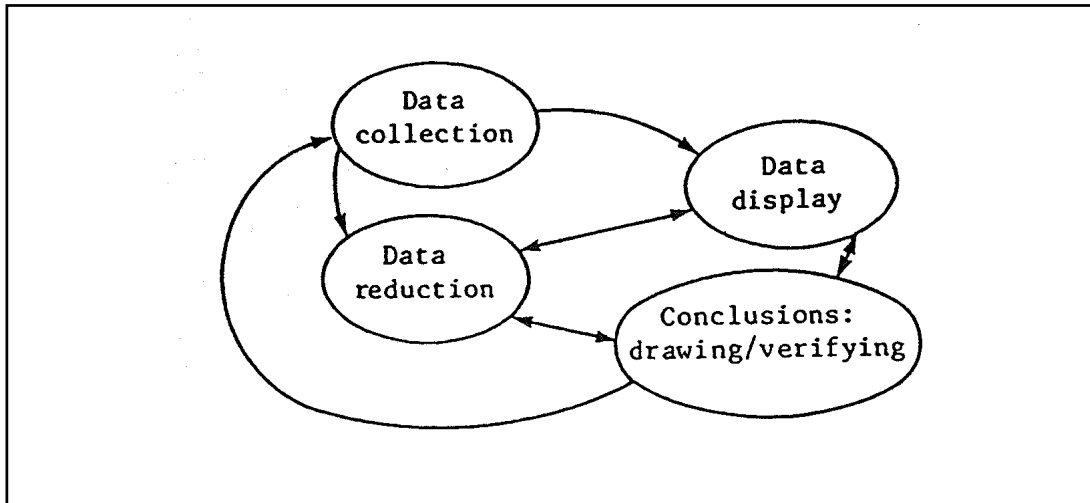


Figure 3-1 Components of data analysis: An interactive model
 Source: Miles and Huberman (1994).

Data Reduction is the process of focusing, simplifying, condensing, and structuring the data into manageable units. Data reduction also helps in providing a system for cross-referencing and data verification. Common techniques of data reduction include: summary narratives, tables, bullet points or lists, and diagrams (Miles and Huberman, 1994). All of these techniques are used in this dissertation.

Data display is necessary to manage heaps of data collected and analyzed in this dissertation. Data display refers to how the data are presented and communicated – this is an instrumental part of data analysis and useful for both within-case and cross-case analyses.

3.3.2 Drawing and verifying conclusions

The final process in data analysis involves drawing and verifying of conclusions. This process will help to draw meaning and interpretation from the data displays, while ensuring strong analytical validity (Miles and Huberman, 1994). In doing analysis of the cases, the following strategies will be implemented:

- Generate meaning from data
- Draw conclusions from meaning

The techniques used in data reduction, display, and conclusions are summarized in Table 3-4, below.

Table 3.4 Techniques in data collection, reduction, and analysis for the research topic and questions of this study

Research objective: Determine the critical success factors in supply chain management at high technology companies.	
Research issues	Data reduction process and further analysis
1. Are there differences between critical supply chain management factors at various high technology companies?	<ul style="list-style-type: none"> Rank questionnaire responses from high-tech companies by most important scores. Analyze data from individual case study companies and between case study companies
2. Are there differences between critical supply chain management factors at high technology companies and non high technology (or benchmark commodity) companies?	<ul style="list-style-type: none"> Rank questionnaire responses from benchmark companies Compare benchmark companies responses with the high technology companies.
3. Will a focus on external supply chain management factors give better business results?	<ul style="list-style-type: none"> Get business and financial performance information from company websites and other financial websites. Display competitive position from questionnaire and financial performance in table Review external versus internal supply chain focus of the case study companies from analysis in research question 1
4. Are perceived critical gaps (and opportunities) in performance derived from traditional methodology similar to those deployed from customer needs?	<ul style="list-style-type: none"> Measure importance and performance of supply chain factors, in order to determine critical performance gaps Get customer needs information from customers of high technology companies, and use Quality Function Deployment (QFD) methodology to develop and prioritize the most important performance gaps for high technology companies.

Source: Developed for this study.

The next step is to draw conclusions from meaning at the several levels of investigation and inquiry (Yin, 1994). To achieve this within-case analysis will be performed to provide the summary for each individual case by business unit. This is an important process step because the volume of data collected from each case is expected to be overwhelming. This approach will help to identify patterns for each individual case, which can be compared to other cases during the cross-case analysis (Eisenhardt 1989). Subsequently, cross-case analysis will be performed with the data. The goal of cross-case analysis is to expand the investigation in

order to develop a more complete and robust understanding of the phenomenon in question (Eisenhardt 1989).

The findings of the analysis will be displayed in tables. From the data displays, the process of drawing meaning and verifying conclusions will be done with the guidance provided by Yin (1994) and Miles and Huberman (1994). This is summarized in Table 3-5, shown below.

Table 3.5 Tactics for drawing meaning and verifying conclusions

Description	Questions used to draw meaning and verifying conclusions
Within-Case Observations	<ul style="list-style-type: none"> • What common themes and patterns emerge from this case? • Are the findings from other sources of evidence and interviews consistent with what was discovered here? • What divergent data exist, and how can they be explained? • Are the findings congruent with, connected to, or confirmatory with prior theory? If so, how? If not, why? • Do the findings “ring true”, and seem convincing and plausible? • What are the key findings and main contributions from this case?
Cross-Case Observations	<ul style="list-style-type: none"> • Which case or cases stand out as exemplary and why? • What common themes and patterns emerge from the cases? • What similarities and differences exist between each case and can they be explained? • What categories or clusters can be created across cases? • Do the cases illustrate that replication has occurred? If so, how and where? If not, why? • What divergent data exist? What explanations exist or account for these discrepancies? • Are the findings congruent with, connected to, or confirmatory with prior theory? If so, how? If not, why?
Issues that go beyond the narrow scope of the study: Business and Policy Conclusions and Implications	<ul style="list-style-type: none"> • What are the key findings of the entire dissertation? • Are the findings and conclusions convincing, plausible and rational? • What conclusions can be drawn from this dissertation’s findings, and what is the significance of these conclusions? • Can tentative theory be developed? If so, what is it? • To what degree can these findings and conclusion be generalized? • What are the limitations and shortcomings of this dissertation? • What recommendations can be made to future researchers regarding this dissertation? • Do the findings stimulate working hypotheses, for readers, for future action? If so, what are they? • What opportunities exist for future research? Can they be prioritized?

Source: Adapted and developed from Yin (1994), Miles and Huberman (1994).

3.3.3 Design for quality

“Qualitative study has everything wrong with it that its detractors claim”, according to Stake (1995). His recommended approach for case studies is primarily qualitative with heavy use of triangulation to provide accuracy and validity. Yin (1994) and Perry (1998b), unlike Stake, take a more quantitative approach to case studies by requiring measurements and procedures in order to get accuracy and validity. Four design tests have been proposed for empirical research to ensure validity and reliability (Yin 1994). The 4 tests are construct validity, internal validity, external validity, and reliability. These 4 tests are discussed next and a summary of their application in this dissertation is given below in Table 3-6.

Construct validity is the use of correct operational measures for the concept being studied. Specifically these measures are use of multiple sources of evidence, establishing a chain of collected evidence. Multiple sources of evidence can be obtained via triangulation. Both Yin (1994) and Stake (1995) list 4 types of triangulation, namely

- Data triangulation,
- Investigator triangulation,
- Theory triangulation, and
- Methodological triangulation

Stake favors methodological triangulation (observation and interpretation by a different researcher). However, Yin’s recommendation of data triangulation by collecting data from multiple sources will be used, because multiple sources of data are rated better than those that rely on single sources of information. Yin (1994) calls this, ”convergence of multiple sources of evidence.” The approach to triangulation is summarized in Table 3-6.

Internal validity is recommended for causal explanatory studies and is not relevant for this study.

External validity is the ability to generalize the dissertation’s findings to broader theory. Yin recommends using replication via multiple case design (Yin, 1994). However, this is replication and not sampling, because conducting (say) 5 case studies, arranged effectively within a multiple case design, is analogous to conducting 5 scientific experiments on related

topics (Yin, 1994). After the individual case reports are prepared, a cross-case analysis will be used to help generate theory. Furthermore, the objective of external validity is to address this study's ability to generalize the findings beyond the cases used in this research. In other words, external validity is supposed to define the domain for which the findings can be interpreted and applied (Yin 1994). That is, analytical generalization will be used from a number of cases to generalize to broader theory (Yin 1994). This approach to external validity is summarized in Table 3-6.

Table 3-6. The four tests for design quality and their application in this dissertation.

Recommended test	Definition and recommendations	Application within this dissertation
Construct validity	Development of sufficient operational measures for collecting data. Recommendations are multiple sources of data	<ul style="list-style-type: none"> • Literature review (Chapter 2). • Multiple sources of evidence A4-1.
Internal validity:	The measures used in the dissertation. This is recommended for causal studies, hence not relevant.	<ul style="list-style-type: none"> • Not relevant for this dissertation.
External validity (Generalizability)	Establishing the domain to which a dissertation's finding can be generalized. Recommendations are to use replication logic within a multiple case design and cross-case analysis.	<ul style="list-style-type: none"> • Replication logic using multiple cases (Discussed in section 3.3.2). • Verifying patterns with cross-case analysis (Discussed in section 3.4.1 and 3.4.2).
Reliability	Demonstrating that the operations of a dissertation (such as data collection procedures) can be repeated with the same results. Recommendations are to use a detailed questionnaire and case study database.	<ul style="list-style-type: none"> • Use a detailed questionnaire and establish case study database (section 3.3.1 and 3.3.2).

Source: Adapted and developed from Yin (1994) and Miles and Huberman (1994)

Reliability is essential to ensure that the dissertation findings are dependable and reliable. Therefore it is important to ensure that if another researcher does this case, he or she will come to the same conclusion. To insure reliability every step in the process will be documented - the interviews, the coding, details of any triangulation analysis, and the steps towards generalization (Perry and McPhail, 1999). Yin gives similar recommendations by requesting for a case study database. The approach to ensure reliability that is used in this dissertation was summarized in Table 3-6.

3.4 Limitations of this dissertation

There are several limitations in the proposed dissertation.

First, the number of cases conducted for the dissertation is 5 business units, with 17 questionnaire/interviews. This is more than the minimum recommended by Perry (1998b). Nevertheless, this researcher takes encouragement from Patton (1985), because, “The validity, meaningfulness and insights generated from quantitative inquiry have more to do with the information-richness of the cases selected and the observations/analytical capabilities of the researcher than with sample size.”

Second, supply chain techniques, management, and the business environment are rapidly changing and evolving. This will have some impact on the validity of the proposed theory.

3.5 Ethical Issues

There are several ethical issues to consider for this dissertation, including worthiness, consent, and confidentiality.

Informed consent

It is important to give full information about the project to the interviewees (Miles and Huberman, 1994) in order ensure that they understood the nature of the project, objective of the research, and benefits if any to the researcher. This has been done via the letter of introduction to the interviewees.

Honesty and confidentiality

The issue of privacy, confidentiality, deception, and accuracy of reporting is important for researchers (Zikmund 1997). These ethical issues include the perspectives of the researcher and the respondent. To this end, high standards of honesty and confidentiality have been maintained to ensure that the data are accurate and the analysis objective. Furthermore, the privacy and anonymity of the respondents and their companies will be maintained. This issue will be addressed in writing to the respondents. Lastly, it is assumed that the respondents will provide truthful and accurate answers. However, this area is not fully controlled as honest cooperation is the main obligation of the respondents (Zikmund 1997).

3.6 Conclusion

This chapter presented the research methodology used in this dissertation. The two types of research methods, quantitative and qualitative, were discussed. A justification for the use of qualitative research, using a case study approach to investigate the research topic, was given. This was followed with a detailed discussion on appropriate case study research parameters that were to be used for this dissertation – parameters such as process steps, case selection and the unit of analysis, prior theory, data collection process, data analysis, and design for quality. This was followed by discussions on the limitation of the case study approach and ethical issues.

In summary, this chapter established a foundation for the data collection and analysis. The next chapter documents the case study research analysis.

Chapter 4

Analysis of data and interpretation

This last chapter presented the research methodology used in this dissertation and established a foundation for the data collection and analysis. This chapter analyzes the data collected from the selected companies and respondents and aims to interpret the data in relation to the research problem. The chapter consists of six sections. It starts with an overview of the case study companies and participants. This is followed by details of the plan for case and cross-case analysis. The next four sections provide an analysis and interpretations of the four research issues. Finally the chapter concludes with a summary of the research findings.

4.1 Overview of case study companies and participants

4.1.1 Profile of case study companies

Five high technology companies were selected for this study. In brief, these companies were selected because of their leadership position in the high technology industry in California and the World. The profiles of the selected companies are shown in Table 4-1. An important factor to note is that all 5 case study companies are either the market leader or among the market leaders in their product categories.

Table 4-1. Profile of case study companies

Company Name	Lines of business	Number of employees	Annual Revenue (Last 12 months)
Company X Founded in 1906	A global company engaged in developing, manufacturing, marketing, servicing and financing a complete range of document equipment, software, solutions and services. The market leader in documentation equipment.	67,000	US \$ 15B
Company H Founded in 1939	A global provider of products, technologies, solutions and services to consumers and businesses. Its offerings span information technology (IT) infrastructure, personal computing and access devices, global services and imaging and printing. The market leader in printers and PC sales.	140,000	US\$70B
Company A Founded in 1939	A global diversified technology company that provides enabling solutions to markets within the communications, electronics, life sciences and chemical analysis industries. A market leader in analytical and measurement instruments.	32,000	US\$6B
Company P Founded in 1985	Manufactures and markets ultra-linear radio frequency (RF) power amplifiers for use in the wireless communications market. The market leader in independent RF equipment companies.	1,000	US\$330M
Company C Founded in 1984	Manufactures and sells networking and communications products, and provides services associated with that equipment and its use. The market leader in networking equipment.	36,000	\$19B

Note: Codes used for company identification are not sequential

Source: Developed for this study with data from MSN Web-Site on 7 July 2003

4.1.2 Profile of Benchmark companies

Four benchmark-manufacturing companies were selected from the membership roster of the Council of Logistics Management, USA, and were approached to participate in the case study. These four companies, with a total of four respondents are commodity type companies. The profiles of the selected companies are shown in Table 4-2. As in the case of the case study companies, the benchmark companies are either the market leader or among the market leaders in their product categories.

Table 4-2 Profiles of Benchmark Companies

Company	Lines of Business	Revenue, latest quarter
Company J	A company dealing in up-market mineral water and other beverages – a market leader	US\$ 2.8B
Company K	A company dealing in sugar manufacturing and distribution – among the market leaders	No comparable data Available
Company L	A company dealing in tools and appliances – among the market leaders	US\$ 1.2B
Company M	A company dealing in windows, window frames, and other home items – among the market leaders	No comparable data Available

Source: Developed for this study with data from MSN Web-Site on 7 July 2003

4.1.3 Profile of respondents

The respondents have been selected to ensure that they are from different functional groups in each business unit. Selecting people from different functional groups of each business unit provided more comprehensive information for triangulation. The selected functional expertise is in business and customer expertise or content and theory expertise. For each case study company, a very detailed questionnaire is required to be completed respondents. Table 4-3 gives a short profile of the respondents for this dissertation and the specific job categories selected within each functional expertise. In addition, Table 4-3 shows the profile of the respondents from the benchmark companies. A much more detailed profile of the respondents is given in appendix A7.

Table 4-3 Profile of case study respondents and identification codes

Company	Case Study Companies					Benchmark Companies
	X	H	A	P	C	J, K, L, M
Business Units Reviewed	1	1	1	1	1	4
Respondent profile:						
Business or Customer Expert: CEO, General Manager, Sales Director or Manager, or Operations Manager	1 (X1)	1 (H4)	1 (A4)	1 (P3)	2 (C1, C2)	2 (J1, L1)
Content and Theory Expert: Supply Chain, Distribution or Materials Manager	2 (X2, X3)	3 (H1, H2, H3)	3 (A1, A2, A3)	2 (P1, P2)	1 (C3)	2 (K1, M1)
Total Interviewed	3	4	4	3	3	4

Note 1: The data base identification code for each respondent is shown in brackets.

Source: Developed in the case study protocol, appendix A2

Identification of respondents in case study:

The study's respondents are identified individually using two characters: first, a company identification (A, H, etc.), and second, by the respondent number (1, 2, 3,). This identification system preserves case anonymity and also keeps cases separate. A total of 17 respondents were selected for this study from the high technology companies and 4 from the benchmark companies. Specific behavior of the respondents was as follows:

- A total of 25 respondents were selected from the case study companies. Out of these 17 responded, and they were interviewed for this study.
- The interviews were done face-to-face and the questionnaire was filled by hand or typed immediately into a Microsoft Word file by the respondent.
- The 4 benchmark-manufacturing companies were selected from membership records of the Council of Logistics Management. Respondents from these companies agreed to participate in the case study, and were subsequently interviewed via telephone.

4.1.4 Questionnaire and other data sources

As discussed in the chapter 3, the main objective of data gathering is to obtain a rich set of data on the phenomenon under study, to capture the contextual complexity, and to corroborate or triangulate one's findings. This phase is considered important and critical to ensure that dissertation's findings are accurate. Hence, advance preparation is essential for the research to ensure that multiple sources of evidence are investigated (Stake 1994; Yin 1994). The summary of the primary and secondary sources of information used in this study is shown in Table A4-1, in appendix A4.

4.1.5 Tabulating quantitative and qualitative data for efficient analysis

The following data has to be reviewed, analyzed, and interpreted:

- From the questionnaire
 - Completed questionnaire from 5 companies or cases. This was data from 17 respondents answering 58 questions (each answered twice)
 - A question on competitive rating of each company
 - A question to rank the top 6 out of 9 supply chain (broad) categories
- Business and financial data from each company (inventory data, financial results, etc.)
- Separate customer needs data from high technology company customers, for comparison and analysis with case study company performance
- Benchmark data from 4 non high technology companies

This has resulted in the collection of a vast amount of data. All this has to be presented in an efficient and comprehensible manner. Therefore this analysis uses a large mix of tables of various compositions to interpret the data. There are several reasons for this method of using so many tables. Firstly, because this research is an in-depth investigation of a complex and under-researched area, it has to be fairly detailed to capture the underlying perceptions of respondents. Secondly, because much of the data are quantitative, it is crucial that the data are displayed in tables to allow good comprehension. Thirdly, the respondent's perceptions and case study company

performance has to be derived from the vast amount of data without losing its richness, and yet presented in an unbiased and succinct style.

4.2 Interpretation of Research Issue 1: Are there differences between critical supply chain management factors at various high technology companies?

The first research issue investigates the differences between critical supply chain management factors at various high technology companies. The questions in the questionnaire require the respondent to rate both the importance of each supply chain factor and the perceived factor performance. The rating is done via a 5-point Likert scale. The average or mean value of the Likert rating scale is the popular usage indicator for measuring a factor's importance. The higher the mean value, the more important the factor. By arranging the factors in descending order with respect to the mean value of their importance, it is possible to identify the critical supply chain management factors at each company. For the analysis of Research Issues 1 and 2 only the importance of supply chain factors is used, while the perceived factor performance is used in Research Issues 3 and 4 to gauge performance gaps.

In the questionnaire, there are 52 questions (out of a total of 59) that pertain to supply chain factors that will have specific influence on supply chain management. The remaining 7 factors, that are excluded, are supply chain performance metrics. The list of 52 supply chain management factors is shown in Table 4-4, below, and is coded as questions 1 through 52 in the questionnaire (refer to appendix A1). From the importance ratings, the most important areas and key features of each company's supply chain is identified and extracted. In this analysis, the top 5 factors are listed in order of importance and discussed. But in the case of tie with the fifth factor, all others with the same score are reviewed. This prioritization allows for an understanding of what the case study companies consider as very important and also sheds light on the character and direction of the companies.

Table 4-4: List of 52 supply chain management factors in questionnaire

Question
1. A centrally coordinated logistics function
2. Provide on-time delivery to customers
3. Provide logistics at lowest cost
4. Company-wide logistics (outsourcing) contracts
5. Partnership with suppliers
6. Focus on reducing the number of suppliers
7. Just-in-time (JIT) delivery
8. Company-wide purchasing contracts for best pricing
9. Company-wide coordination and management of inventory
10. Just-in-time (JIT) delivery
11. Vendor managed inventory (VMI) at production sites
12. Lowest inventory driven costs
13. Regional distribution centers for product distribution
14. Automated warehouse management systems
15. Effective use of CAD, CAE, and CAM Systems
16. Effective use of ERP and MRP systems
17. Responsiveness to meet engineering changes
18. JIT (Just In Time) manufacturing
19. Product customization or postponement to meet customer needs
20. Outsourcing of non-core manufacturing activities
21. Product design for environmental and recycling needs
22. Zero-defect manufacturing or use of 6-Sigma concepts
23. Company-wide quality program
24. Superior product quality compared to competitors
25. Sell-through information (point of sales data) from distributors/partners
26. Planning and involving customers in demand management
27. Information sharing with supply-chain partners
28. Monitoring and measuring customer service level
29. Effective management of customer complaints
30. A process to manage customer dissatisfaction returns
31. A 360-degree view of customer needs and preferences
32. Effective use of multiple-media to manage customer relationships
33. Effective use of Internet to manage Business-to-B commerce
34. Effective use of Internet to manage Business-to-Consumer commerce
35. Collaboration and bidding for parts and commodities via the Internet
36. Inter-organizational information coordination and sharing
37. Intra-organization information systems to coordinate/integrate the entire S Chain
38. Optimizing the supply chain via Efficient Consumer Response (ECR)
39. Eliminating non-value layers (such as wholesalers) in supply chain
40. Radical and successful business process reengineering
41. Responding to unexpected demand from customers
42. Responding to high market fluctuations
43. Top management commitment
44. Employees are trained in supply chain concepts and management
45. Employees are empowered to make decisions and changes
46. Employees are involved in supply chain management
47. Teamwork and inter-organizational coordination
48. There is high employee morale
49. There is high employee productivity
50. Quick resolution of industrial disputes
51. High utilization of employee's skills and abilities
52. The concept of internal customers is widely understood

Note: Question numbers correspond to complete questionnaire in appendix A1

Source: Developed for this study from questionnaire in appendix A1

In addition to the questions on supply chain management factors, there is 1 question (question 60) that requires the respondents to force rank the importance of 9 broad supply chain categories. The categories cover 47 of the 52 questions, mentioned above and shown in Table 4-4. The questions not covered are questions 48-52, pertaining to ‘Employee Performance’. The respondents are asked to choose the top 6 categories and rank them from 1 to 6. Any category that receives one vote or less in each company is discarded. The purpose of this forced ranking exercise is to understand overall priorities and important areas in supply chain management at the case study companies.

Table 4-5 Supply chain categories that require ranking by the respondents

Supply chain category	Covered by questions numbers:
Logistics	1 to 4
Procurement	5-8
Inventory Management	9-14
Manufacturing	15-24
Partnership and Collaboration	25-27
Customer Relationship Management	28-32
Information Systems and Technology	33-39
Supply Chain Agility	40-42
Decision Making and Organization Factors	43-47

Note: Respondents were asked to rank the top 6 categories only
 Source: Developed for this study from questionnaire in appendix A1

Tabulating and display of data for Research Issue 1

Because of the vast amount of data that needs analysis, the following detailed summary tables are used to display the data:

Table 4-6 displays the ranked supply chain categories for all the case study (high technology) companies

Table 4-7 displays the 5 most important supply chain factors at each case study company.

Table 4-8 is similar to Table 4-7, and provides a cross-case analysis.

4.2.1 Analysis and interpretation of important areas at Company X

In the case of Company X, the most important category is perceived to be Partnership and Collaboration with its suppliers. This is followed by Supply Chain Agility and Procurement. Much lower on the list are Decision Making and Organizational Factors and Information Systems. Table 4-6 shows the ranking of the most important supply chain categories.

When Company X respondents rated the 52 supply chain factors, the 5 most critical factors were: Top management commitment, teamwork and organizational coordination, on-time delivery to customers, effective ERP/MRP systems, and responsiveness to meet engineering changes. Table 4-7 shows the ranking of the most critical supply chain factors.

Surprisingly, during the category ranking process, the '*Decision Making and Organization*' category is deemed unimportant (Table 4-6), but two of the decision making factors (management commitment and teamwork and organizational coordination) are deemed to be the most important when the respondents scored the 52 supply chain factors. Refer to Table 4-7, below. This is attributed to the fact that at a high strategic level, the category '*Decision Making and Organization*' is deemed less important than the other categories. However, at the individual factor level the respondents seem to be answering from recent experience and responding to the topics of the day. Several respondents from different companies made comments like, "I answered some of your questions based on current company issues."

After the management factors, the remaining are manufacturing, which indicates a strong emphasis on manufacturing at Company X.

Hence overall, the areas of importance for company X are:

Important Supply Chain Categories (High Level View)

- Partnership and collaboration with their suppliers
- Supply chain agility

- Procurement

Critical supply chain factors (Tactical View)

- Top management commitment and teamwork (2 factors)
- On-time delivery to customers
- Advanced manufacturing, specifically in effective ERP/MRP systems, and responsiveness to meet engineering change (2 factors)

It is possible to make some conclusions and observations about Company X's behavior: Company X behaves like a Traditional 'old style' manufacturing company and its supply chain activity is internally focused.

Note: The term Traditional 'old style' manufacturing company is used to describe a company that focuses its supply chain management activity (that is, considers them more important) on manufacturing-type efforts (including quality), and other activity that occur prior to manufacturing such as supplier management, and procurement. This traditional manufacturing or internal focus is given priority by the company over supply chain activity that looks forward and allows closer connection with customers. Such a company can be termed as Traditional 'old style' manufacturing company or an internally focused company. This definition is prepared for this study. However, the definition is not arbitrary but backed by specific behavior and expectations that are observed here.

At the category level, Company X's primary focus is on Partnership and Collaboration, Supply Chain Agility, and Procurement. When identifying critical supply-chain factors its emphasis is internally focused on management and manufacturing. Company X has less emphasis on external supply chain issues such as customer relationship management, Internet commerce, and information systems that can connect with customers.

Table 4-6 Ranking of supply chain categories at each high technology company

Company:	X	H	A	P	C
Logistics	4			3	
Procurement	3		6	2	
Inventory Management		4	2	5	5
Manufacturing		6	1	4	4
Partnership and Collaboration	1	5	3	1	6
Customer Relationship		1	4	6	1
Information Systems	6	3			3
Supply Chain Agility	2				6
Decision Making and Organization Factors	5	1	5		2
	Observations	Observations	Observations	Observations	Observations
	<u>Manufacturing View.</u> Category focus is in on Supplier Partnership and Procurement. Also looking forward to emphasize Supply Chain Agility.	<u>Progressive View</u> Category focus is on Customers and Organization (a tie), and Information Systems Management.	<u>Manufacturing View.</u> Category focus is on Inventory Management, Manufacturing and Supplier Partnership.	<u>Manufacturing View.</u> Category focus is in on Supplier Partnership, Logistics, and Procurement.	<u>Progressive View.</u> Focused on Customers, Organization and Information Systems Management.

Note: The top 3 categories in each company are shaded

Source: Developed for this study from questionnaire in appendix A1

4.2.2 Analysis and interpretation of important areas at Company H

In the case of Company H, when selecting the most important supply chain categories, the top item is perceived to be Customer Relationship, which ties with Decision Making and Organization Factors. This is followed by Information Systems. This is shown in table 4-6. The more traditional supply chain categories, such as Logistics and Procurement are considered less important.

When asked to rate the 52 technical supply chain factors, the 5th most critical factor ties all the way to the 7th factor. The top 7 critical factors are delivery to customers, outsourcing of non-core manufacturing activities, sell through information, employee empowerment, monitoring and measuring customer service level, a process to manage customer dissatisfaction returns, and teamwork and inter-organizational coordination. Refer to Table 4-7. The selected critical factors indicate a strong balance in priorities – 2 customer factors, manufacturing (specifically outsourcing), partnership with sales channel/distributors, and 2 Decision Making and Organization Factors.

Manufacturing factors (advance manufacturing and quality programs such as product quality, zero-defects and 6 Sigma) are considered less important by the respondents and are way down on the importance list. This seems related to the fact that there is a strong focus for outsourcing by all respondents; hence such programs may be conducted by the outsourced vendors. This has been confirmed in subsequent discussion via phone calls, with some of the respondents.

Hence overall, the important areas for Company H are:

Supply Chain Categories (High Level View)

- Customer relationship management
- Decision making and organizational factors (ties for first place)
- Information systems management

Critical supply chain factors (Tactical View)

- On time delivery to customers
- Outsourcing of manufacturing activities
- Sell through information via partnership with distributors and retailers

- Employee empowerment, and Teamwork and inter-organizational coordination (2 factors)
- Monitoring and measuring customer service level, and a process to manage customer dissatisfaction returns (2 factors)

In summary, Company H is a less traditional (compared to Company X) and can be termed a progressive manufacturing company, and its supply chain activity is externally focused.

Note: The term progressive manufacturing company is used to describe a company that focuses its supply chain management activity (that is, considers them more important) on customer relationships type activity and information systems that connect with the customers (such as business to business Internet commerce). This external, or customer, focus is given priority by the company over supply chain efforts that look backward into the manufacturing process - these efforts can be construed as the company reaching out to connect and communicate better with customers. Such a company can be termed as a progressive manufacturing company or an externally focused company. This definition is prepared for this study. However, the definition is not arbitrary but backed by specific behavior and expectations that are observed here.

At the category level, Company H's primary focus is external on Customers Relationships followed by Decision Making and Organization, and Information Systems management. The supply chain factors that are emphasized by the respondents of Company H indicate a strong balance in priorities between customers, manufacturing (outsourcing), partnership with distributors, and organization factors. The company emphasizes outsourcing and its manufacturing activity is heavily outsourced. This was confirmed during the interviews. Although Information Systems were considered very important at the category level, Internet commerce (Business to business and business to consumer) was not considered important at the factor level. This is surprising given that this is a consumer oriented business unit/company. Furthermore, manufacturing and quality programs are considered unimportant by the respondents, because they are managed by outsourcing partners.

Table 4-7 Summary of the most critical supply chain management factors at each high technology company

Company X	Company H	Company A	Company P	Company C
43. Top management commitment	2. Provide on-time delivery to customers	5. Partnership with suppliers	18. Just-In-Time manufacturing	2. Provide on-time delivery to customers
47. Teamwork and inter-organizational coordination	20. Outsourcing of non-core manufacturing activities	16. Effective use of ERP and MRP systems	24. Superior product quality compared to competitors	20. Outsourcing of non-core manufacturing activities
2. Provide on-time delivery to customers	25. Sell-through information (point of sales data) from distributors/partners	42. Responding to high market fluctuations	2. Provide on-time delivery to customers	33. Effective use of Internet to manage Business-to-B commerce
16. Effective use of ERP and MRP systems	45. Employees are empowered to make decisions and changes	2. Provide on-time delivery to customers	5. Partnership with suppliers	36. Inter-organizational information coordination and sharing
17. Responsiveness to meet engineering changes	28. Monitoring and measuring customer service level	15. Effective use of CAD, CAE, and CAM Systems	6. Focus on reducing the number of suppliers	37. Intra-organization information systems to coordinate and integrate the entire Supply Chain
	30. A process to manage customer dissatisfaction returns	20. Outsourcing of non-core manufacturing activities	16. Effective use of ERP and MRP systems	
	47. Teamwork and inter-organizational coordination	22. Zero-defect manufacturing or use of 6-Sigma concepts	20. Outsourcing of non-core manufacturing activities	
		24. Superior product quality compared to competitors	42. Responding to high market fluctuations	
		28. Monitoring and measuring customer service level		
		41. Responding to unexpected demand from customers		

Note 1: Question numbers correspond to questionnaire in appendix A1, and are sorted by importance for the 5 critical factors. In the case of a tie, all the factors tied to 5th. place are included.

Source: Developed for this study from data obtained from questionnaire in appendix A1

4.2.3 Analysis and interpretation of important areas at Company A

At Company A the most important supply chain category is Manufacturing, followed by Inventory Management and Partnership and Collaboration. Refer to table 4-5.

When asked to rate the 52 supply chain factors, the 4th most critical factor ties all the way to the 10th important factor. Refer to Table 4-7. The important factors are: partnership with suppliers, supply chain agility (responding to market fluctuations and unexpected demand), on-time delivery, monitoring customer service level, and a host of manufacturing factors (effective use of ERP/MRP systems, effective use of CAD/CAE/CAM systems and outsourcing, zero-defects manufacturing and superior product quality).

However, there is low emphasis on customer relationship factors and information systems factors (such as Internet commerce).

Hence, overall, the important areas for Company A are:

Supply Chain Categories (High Level View)

- Manufacturing
- Inventory management
- Partnership and collaboration.

Critical supply chain factors (Tactical View)

- Partnership with suppliers
- Supply chain agility factors (responding to market fluctuations and unexpected demand)
- On-time delivery
- Monitoring customer service level
- Manufacturing factors (effective use of ERP/MRP systems, effective use of CAD/CAE/CAM systems and outsourcing, zero-defects manufacturing and superior product quality)
- Outsourcing

In summary, Company A behaves like a traditional, old style, manufacturing company, and its supply chain activity is internally focused.

It is internally focused and considers manufacturing, inventory, and partnership and collaboration as important at the category level. The critical supply chain factors emphasized by the respondents of Company A indicate a strong focus on manufacturing activity such as partnership with suppliers, a host of manufacturing (including quality) factors, responding to market fluctuations and unexpected demand, and monitoring of customer service level.

Although outsourcing is listed as important, during the interviews the respondents mentioned that only low-level assemblies were outsourced, while all product final assembly were done in-house. This explains the high focus the respondents place on manufacturing activity such as quality, CAD/Cam systems, and six-sigma activity.

There is low emphasis on Information systems factors such as Internet commerce. This is surprising given Company A's predominant market is industrial and business enterprises. However, during interviews, respondents did mention that Company A was planning to invest heavily in information systems for commerce and customer relationship management.

4.2.4 Analysis and interpretation of important areas at Company P

At Company P, Partnership and Collaboration is the most important supply chain category. This is followed by Procurement and Logistics. Inventory Management and Customer Relationship are lower on the list. Refer to Table 4-6.

When asked to rate the 52 supply chain factors, the 3rd most critical factor ties all the way to the 8th. Hence the top critical factors are: Four manufacturing factors (Just-in-time manufacturing, effective use of ERP and MRP systems, outsourcing, and product quality), on-time delivery to customers, partnership with suppliers, reducing number of suppliers, and responding to market fluctuations. See Table 4-7. The focus of company P seems to be on traditional supply chain factors and one newly emphasized factor –

responding to market fluctuations. Customer oriented factors, such as Internet commerce and customer relationships are considered less important.

Hence overall, the important areas for Company P are:

Supply Chain Categories (High Level View)

- Partnership and collaboration
- Procurement
- Logistics

Critical supply chain factors (Tactical View)

- Manufacturing factors: (Just-in-time manufacturing, effective use of ERP and MRP systems, outsourcing, superior product quality)
- On-time delivery to customers
- Partnership with suppliers and reducing number of suppliers
- Responding to market fluctuations

In summary, Company P behaves like a traditional, old style, manufacturing company, and its supply chain activity is internally focused.

The most important supply chain categories are Partnership and Collaboration, Procurement, and Logistics. Customer oriented supply chain categories such as Information Systems and Customer Relationships are considered less important.

The critical supply chain factors emphasized by the respondents of Company P are a host of Manufacturing factors, on-time delivery, partnership with and reducing number of suppliers, and responding to market fluctuations. There is low emphasis on customer-focused factors as Internet commerce, information systems, and customer

4.2.5 Analysis and interpretation of important areas at Company C

At Company C, Customer Relationship is the most important category. This is followed by Decision Making and Organization Factors and Information Systems. More traditional categories such as Inventory Management and Logistics are much lower on the list. Refer to Table 4-6.

When asked to rate the 52 supply chain factors, the most critical factors are on-time delivery to customers, outsourcing, effective use of the Internet for Business-to-Business

commerce, Inter-organizational information coordination and sharing, and Intra-organization information systems to coordinate/integrate the entire Supply Chain.

There is less emphasis on advanced manufacturing and quality factors. In discussing with the respondents, the reason for this is that Company had entirely outsourced its manufacturing activities. Refer to Table 4-7.

Hence overall, the important areas for Company C are:

Supply Chain Categories (High Level View)

- Customer Relationships
- Decision Making and Organization Factors
- Information Systems

Critical supply chain factors (Tactical View)

- On-time delivery to customers
- Outsourcing
- Three Information systems and Technology factors including: Effective use of the Internet for Business-to-Business commerce, Inter-organizational information coordination and sharing, and Intra-organization information systems to coordinate/integrate the entire Supply Chain.

In summary, Company C is a very progressive manufacturing company, and its supply chain activity is externally focused.

The most important supply chain categories are Customers followed by Decision Making and Organization, and Information Systems.

The most critical supply chain factors are outsourcing of manufacturing and three Information Systems factors (inter and intra-organizational information and Internet commerce). The company emphasizes outsourcing and its manufacturing is heavily outsourced. This was confirmed during the interviews - the company puts lower emphasis on traditional supply chain items such as logistics and manufacturing factors.

A review and analysis of secondary data sources (The Economist, 2000a; Business Week, 2003) confirmed that Company C is conducting a high portion of its business, in both purchasing and sales, via the Internet. These data sources also confirm that productivity from this new technology takes 3-5 years to mature, and Company C started investing several years ago. It conducts most of its internal transactions via information systems, and is considered a leader in managing its business via information systems and technology and networking.

4.2.6 Cross-case analysis and interpretation of Research Issue 1

In attempting to do a cross-case analysis of the companies, the following questions from Table 3-7 are considered:

- What common themes and patterns emerge from the cases?
- What similarities and differences exist between each case and can they be explained?
- What categories or clusters can be created across cases?

Note: Table 4-8 provides a summary of the overall cross-case analysis.

4.2.6.1 Cross-case analysis-comparison of ranked supply chain categories

A comparison of the ranking for supply chain categories can be made across case study companies. Cross-case data can be viewed in Table 4-6, shown earlier. There is no one single category that all companies consider important, and place in the number 1 category. However, the comparison of the categories provides interesting information about each company.

Clusters of similarities:

Company X, A, and P had partnership and collaboration among the top 2 categories. Furthermore, Company X and P are the only companies listing logistics as important.

Company H and C have similar high-level, strategic, direction. They both place a strong emphasis on customer relationships (number 1 in both companies) and decision-making and organization (number 2 in both companies). In addition, both companies emphasized

the importance of information systems. The customer relationship priority reflects on the progressive and external focus of both companies. The decision-making and organizational factor seems to reflect on the strong CEO leadership at each company – secondary data on both companies indicates the appointment of a very strong and well-known (always in the business news) CEO at each company. Because both companies emphasize the importance of customer relationship they can be termed as externally focused manufacturing companies.

Individual company characteristics:

Company X is a traditional manufacturing company focusing on partnership and collaboration and procurement. However, it seems to be trying to get out of the traditional approach with more emphasis on supply chain agility.

Company A is the most traditional, focusing on inventory management, partnership and collaboration, and manufacturing. Only after these categories does the company look at managing customer relationships. Hence it can be termed as an internally focused company.

Company P is also traditional and focusing on partnership and collaboration, procurement and logistics, with manufacturing as priority number four.

Company H is progressive and focusing on customer relationships, decision-making and organization factors, and information systems. Only after that does Company H focus on the traditional supply chain categories of inventory management, partnership and collaboration, and manufacturing. Hence it has a balanced approach looking first at external supply chain categories and then internal supply chain categories.

Company C is progressive and places a strong emphasis on customer relationship, decision making and organization factors, followed by information systems. Internal categories are further down on the list. It is very much externally focused, with

information systems helping to manage both external and internal issues. Its approach to supply chain category selection is similar to Company H.

4.2.6.2 Cross-case analysis - comparison of critical success factors

Next, as part of the cross-case analysis, a comparison is made of the most important critical success factors. The top 5 critical supply chain factors of each case study company are shown below in Table 4-8. The comparison provides interesting information.

Overall similarities

The factor 'On-time delivery to customers' is important at all case study and benchmark companies. This makes sense, since every company that cares for its customers should consider this of paramount importance. This fact validates the accuracy of the data collected – the respondents are putting some thought into answering the questionnaire accurately.

Cluster of similarities

When both the supply chain categories and factors are reviewed the companies can be segmented into 2 distinctive clusters: Traditional 'old style' manufacturing companies and more Progressive manufacturing companies. Segmenting the case study companies into several clusters can better explain the characteristics and behavior of the companies as opposed to taking an average approach.

Traditional 'old style' manufacturing companies

Note the term traditional, 'old style', manufacturing company, is used to describe a company that focuses its supply chain efforts on manufacturing-type activity (including quality), and other activities that occur prior to manufacturing, such as supplier management, and procurement. Specifically, the traditional companies are Company X, A, and P.

Companies X has selected the most important factors as: 2 organizational factors (teamwork and top management commitment) and 2 manufacturing factors (effective use of ERP and MRP systems and responsiveness to meet engineering changes)

Company A emphasizes a host of manufacturing factors (ERP and MRP systems, CAD, CAE, CAM systems, Zero-defect manufacturing, partnership with suppliers, responding to market fluctuations and unexpected customer demand, and outsourcing). It does, however, emphasize one customer-oriented factor –monitoring customer service level.

Company P also emphasizes many manufacturing factors (ERP and MRP systems, Just-in-time manufacturing, superior product quality), partnership with suppliers and reducing the number of suppliers. It further emphasizes the importance of outsourcing and responding to market fluctuations.

Progressive manufacturing companies

Note the term progressive manufacturing company, is used to describe a company that focuses its supply chain efforts on customer relationships type activity and information systems that connect with the customers (such as business to business Internet commerce). Specifically the progressive companies are Company H and C.

Companies H emphasizes 3 customer oriented factors (sell-through information to customers, managing customer dissatisfaction, and monitoring and measuring customer service level), 2 organizational factors (employee empowerment and teamwork), and outsourcing.

Company C respondents are focused and have selected 3 Information systems factors and outsourcing. However, the system factors include a customer orientated approach by using Internet commerce (Business to Business commerce). Company C is by far the most progressive because of its heavy emphasis on Information systems.

Table 4-8 Cross-case analysis and summary of the top critical supply chain management factors and categories at each company

Company X	Company H	Company A	Company P	Company C
43. Top management commitment **	2. Provide on-time delivery to customers *	5. Partnership with suppliers *****	18. Just-In-Time manufacturing ***	2. Provide on-time delivery to customers *
47. Teamwork and inter-organizational coordination **	20. Outsourcing of non-core manufacturing activities ***	16. Effective use of ERP and MRP systems ***	24. Superior product quality compared to competitors ***	20. Outsourcing of non-core manufacturing activities ***
2. Provide on-time delivery to customers *	25. Sell-through information (point of sales data) from distributors/partners	42. Responding to high market fluctuations	2. Provide on-time delivery to customers *	33. Effective use of Internet to manage Business-to-B commerce *****
16. Effective use of ERP and MRP systems ***	45. Employees are empowered to make decisions and changes **	2. Provide on-time delivery to customers *	5. Partnership with suppliers *****	36. Inter-organizational information coordination and sharing ****
17. Responsiveness to meet engineering changes ***	28. Monitoring and measuring customer service level	15. Effective use of CAD, CAE, and CAM Systems ***	6. Focus on reducing the number of suppliers *****	37. Intra-organization information systems to coordinate and integrate the entire Supply Chain *****
	30. A process to manage customer dissatisfaction returns	20. Outsourcing of non-core manufacturing activities ***	16. Effective use of ERP and MRP systems ***	
	47. Teamwork and inter-organizational coordination **	22. Zero-defect manufacturing or use of 6-Sigma concepts ***	20. Outsourcing of non-core manufacturing activities ***	
		24. Superior product quality compared to competitors ***	42. Responding to high market fluctuations	
		28. Monitoring and measuring customer service level		
		41. Responding to unexpected demand from customers		

Continued on next page

Table 4-8 (Continued) Cross-case analysis and summary of the top critical supply chain management factors and categories at each company

Company X	Company H	Company A	Company P	Company C
Observation	Observation	Observation	Observation	Observation
<p><u>Traditional manufacturing company.</u> Supply-chain factors are internally focused on manufacturing activity and organizational issues.</p>	<p><u>Progressive manufacturing company.</u> Balanced approach. Emphasizes customer and organizational factors. Manufacturing factors are heavily outsourced .</p>	<p><u>Traditional manufacturing company</u> A host of manufacturing factors are important. In addition, Company A wants to improve supply chain agility, and customer service.</p>	<p><u>Traditional manufacturing company.</u> Supply chain factors are focused on manufacturing and supplier factors.</p>	<p><u>Very progressive manufacturing company.</u> Supply chain factors are heavily focused on Information systems, including Internet commerce. Manufacturing factors are heavily outsourced .</p>
<p>Also has traditional, or manufacturing, focus at the category level. Refer Table 4-6</p>	<p>Focused on Customer Relationship, Organization, and Information systems at the category level. Refer Table 4-6</p>	<p>Focused on Inventory, Partnership, and Customer Relationship at the category level. Refer Table 4-6</p>	<p>Also has traditional, or manufacturing, focus at the category level. Refer Table 4-6</p>	<p>Focused on Customer Relationship, Information Systems and Organization factors at the category level. Refer Table 4-6</p>

Note 1: Question numbers correspond to questionnaire in appendix A1, and are sorted by importance for the 5 important factors. In the case of a tie, all the factors tied to 5th. place are included.

Note 2: Common categories are shaded in similar colors and marked with similar number of asterisks (*)

Source: Developed for this study from data obtained from questionnaire in appendix A1

4.2.7 Summary of analysis and interpretation for Research Issue 1

Research Issue asks: Are there differences between critical supply chain management factors at various high technology companies?

The factor ‘*On-time delivery to customers*’ is important at all case study companies. This is reasonable, since every company that cares for its customers should consider this of paramount importance. Beyond this commonality, the high technology companies behave differently, and can be segmented into 2 distinct clusters.

Segmentation into distinct clusters:

The case study companies can be segmented into 2 distinctive clusters: Traditional, 'old style', manufacturing companies and more progressive manufacturing companies.

Traditional 'old style' manufacturing companies that are internally focused

These companies supply chain management is focused on manufacturing-type activity and other activities that occur prior to manufacturing. This internal, or manufacturing focus is given priority by the company over supply chain efforts that look forward and allow closer connection with customers. Companies X, A, and P are in this cluster.

Progressive manufacturing companies that are externally focused

These companies supply chain management is focused on customer relationships type activity and information systems that connect with the customers. This external, or customer focus, is given priority by the company over supply chain efforts that look backward into the manufacturing process. Companies H and C are in this cluster.

Hence in summary there are differences between critical supply chain management factors at various high technology companies. The selection of the critical supply chain factors depends on whether a company is a traditional 'old style' manufacturing company or a progressive manufacturing company.

4.3 Interpretations of Research Issue 2: Are there differences between critical supply chain management factors at high technology companies and non high technology (or benchmark commodity) companies?

The second research issue investigates and seeks differences in critical supply chain management factors between high technology and non-high technology companies. Four non high technology companies participated in this case study. The benchmark companies are dealing primarily in commodities, specifically: Up-Market mineral water and other beverages, Sugar manufacturing and distribution, Tools and appliances, and Home windows furnishings. All four companies are among the market leaders in their commodity-type business. Their financial results are good and they are all profitable. Their supply chain practices are compared with the case study companies.

Because of the vast amount of data gathered and reviewed from the Benchmark Companies, their data are aggregated into the important supply chain categories and factors. Hence, these Benchmark Companies are discussed as a cluster vis-à-vis the high technology companies. Their prioritized supply chain categories and factors are displayed in Table 4-9 for both Benchmark and High Technology companies.

4.3.1 Analysis and interpretation of differences between benchmark and high technology companies

Important Supply Chain Categories (High Level View)

Looking at Table 4-9, it can be seen is observed that 5 of the top 6 categories are the same for benchmark and high technology companies. Hence it can be concluded that the focus of management at the high level is similar at both the benchmark and high technology companies. This is a balanced approach to category prioritization -- that is, they look at both internal and external categories.

Critical supply chain factors (Tactical View)

However, at the tactical or actual area of supply chain factor implementation, there are some similarities but major differences. On-time delivery to customers and superior product quality is very important just as it is in all the high technology companies. But after that factor, the critical supply chain factors are different.

At the benchmark companies, the top 6 critical factors are:

- Provide on-time delivery to customers
- Superior product quality
- Customer service levels
- Top management commitment
- Effective management of customer complaints
- Management of dissatisfaction returns

At the high technology companies the top 6 critical factors are

- Provide on-time delivery to customers
- Partnership with suppliers
- Effective use of ERP and MRP systems
- Outsourcing of non-core manufacturing activities
- Teamwork and inter-organizational coordination
- Superior product quality

This information suggests that companies dealing in commodity-type products have a different approach to supply chain management. On-time delivery is very important at all companies reviewed in this study, but beyond that these benchmark companies put a strong focus on supply chain factors that improve or manage customer satisfaction and product quality. Even if the top 10 critical supply chain factors are reviewed (in Table 4-9), this different approach persists. This different approach is, possibly, due to the fact that the benchmark companies deal in commodity type products and hence they have to focus on differentiating themselves through implementing supply chain factors that provide strong customer services.

Table 4-9 Summary of important supply chain categories and factors at benchmark companies and high technology companies

Supply Chain <u>Categories</u> prioritized by Rank			
BENCHMARK COMPANIES		HIGH TECHNOLOGY COMPANIES	
Supply Chain Category	Rank	Supply Chain Category	Rank
Manufacturing	1	Partnership and Collaboration	1
Decision Making and Organization Factors	2	Customer Relationship	2
Partnership and Collaboration	3	Decision Making and Organization Factors	3
Customer Relationship	4	Procurement	4
Logistics	5	Manufacturing	5
Inventory Management	6	Inventory Management	6
Supply Chain <u>Factors</u> prioritized by Importance			
BENCHMARK COMPANIES		HIGH TECHNOLOGY COMPANIES	
Supply Chain Factor	Average	Supply Chain Factor	Average
2. Provide on-time delivery to customers	4.75	2. Provide on-time delivery to customers	4.71
24. Superior product quality compared to competitors	4.50	5. Partnership with suppliers	4.65
28. Monitoring and measuring customer service level	4.50	16. Effective use of ERP and MRP systems	4.65
43. Top management commitment	4.50	20. Outsourcing of non-core manufacturing activities	4.65
29. Effective management of customer complaints	4.25	47. Teamwork and inter-organizational coordination	4.56
30. A process to manage customer dissatisfaction returns	4.25	24. Superior product quality compared to competitors	4.53
49. There is high employee productivity	4.25	43. Top management commitment	4.50
51. High utilization of employee's skills and abilities	4.25	42. Responding to high market fluctuations	4.47
5. Partnership with suppliers	4.00	17. Responsiveness to meet engineering changes	4.44
8. Company-wide purchasing contracts for best pricing	4.00	41. Responding to unexpected demand from customers	4.41

Note 1: Question numbers correspond to questionnaire in appendix A1

Note 2: Data are aggregated for 4 benchmark companies and 5 high technology companies

Source: Developed for this study from data obtained from questionnaire in appendix A1

4.3.2 Summary of interpretation of Research Issue 2

Research Issue 2 asks: Are there differences between critical supply chain management factors at high technology companies and non high technology (or benchmark commodity) companies?

The analysis of high technology companies and benchmark companies suggest that at the high level, or supply chain category, the management at all companies has a similar approach to supply chain management. However at the tactical, or critical, supply chain factor level, the analysis suggests that the benchmark companies (which happen to be companies dealing in commodity-type products) have a different approach to supply chain management. The benchmark companies are externally focused and put a strong focus on critical supply chain factors that improve or manage customer satisfaction. In addition just like the high technology companies they also emphasize product quality.

Hence in summary, there are differences between critical supply chain management factors at high technology companies and non-high technology (or benchmark commodity) companies.

4.4 Interpretations of Research Issue 3: Will a focus on external supply chain management factors give better business results?

The third research issue investigates whether a focus on external supply chain management factors will give better business results. Data to analyze and interpret this objective comes from the following sources:

- **Current business performance of the high technology company.** These data are obtained from Company Reports, Company Internet Web-sites, and other Internet Web-sites.
- **Analysis of Research Objective 1:** Analysis from Research Objective 1 was reviewed to understand which companies focused, or emphasized very strongly, on external supply chain management factors. Specifically, the summary of Research Objective 1, in Section 4.2.7, gives this information.
- **The questionnaire:** There are four questions that specifically measure competitiveness in supply chain management. The questions in the questionnaire require the respondent to rate both the importance of each supply chain factor and the perceived factor performance. A fifth question measures overall contribution to the company's competitiveness from supply chain management. The questions are rated on a 5-point Likert scale. The five questions are:
 - Q 54. Customers are very satisfied with our supply chain capabilities
 - Q 55. Supply chain performance is continuously improving
 - Q 57. Supply chain cost is low compared to competitors
 - Q 58. Supply chain performance contributes to cash flow
 - Q 59. Contribution to company's competitiveness from supply chain management

The first 4 questions are analyzed for expected factor importance and perceived factor performance. The gaps between importance and performance are also computed. A low gap means supply chain competitiveness is meeting expectations of the respondents, whereas a high gap means performance is not meeting expectations. For the overall competitiveness index, a score of 3 (on a 5 point scale) is considered as

Good. A score of 4 is considered Very Good and very competitive. A score of 5 is considered superior.

The information on competitiveness is juxtaposed with current business performance of the company, which includes inventory turnover and productivity. Although a direct relationship between supply chain competitiveness and business performance is not demonstrable and is beyond the scope of this case study, it is meant to provide some food for thought and suggest a case for further study. However, high inventory turnover is a good indicator of the company's supply chain management effort. These data are displayed for the high technology companies in Table 4-10.

4.4.1 Company X: Competitive position and business performance

Competitive position:

Company X respondents rated their performance on the competitiveness factors, and their ratings are shown in table 4-10. Specifically:

- They perceive that the performance of their supply chain in meeting customer satisfaction is Good (3 on a 5 point scale), with little gap from importance level.
- They are convinced that their supply chain performance is continuously improving, and is meeting expectations – there is no gap in performance.
- However, there are gaps between importance and performance of delivery cycle times from supplier to customers, and between supply chain costs compared to competitors.
- They perceive that their supply chain performance is contributing to cash flow, and almost meeting expectations.
- Overall contribution to the company's competitiveness from supply chain management is rated as Good (3 on a 5 point scale).

Business Performance:

The business performance of Company X is not good: it has negative profit in its latest financial quarter (-1.99%), low inventory turnover (6.2 times) equating to about 2 months of supply, and low revenue per employee at \$230K/employee.

Focus on external supply chain management factors

The analysis from Research Issue 1 suggests that Company X gives priority to internal and manufacturing supply chain factors.

Overall comments:

Company X respondents perceive that their performance of their supply chain in meeting customer satisfaction is Good, with little gap from importance level. They are very satisfied that their supply chain performance is continuously improving and is meeting expectations, with no gap between importance and performance. However, there are small gaps between importance and performance of delivery cycle times and between supply chain costs compared to competitors. Overall competitiveness is rated as Good (3 on a 5 point scale).

This overall confidence of Company X respondents with their supply chain competitiveness contrasts dramatically with their poor business performance of negative profit, low inventory turnover, and low revenue per employee. Moreover the respondents approach to supply chain management suggests that the company is internally focused on manufacturing issues.

Overall, the respondents of Company X are internally focused in supply chain management factors. They aim low, have low expectations, and do not expect much from supply chain management. The company has poor business performance.

Table 4-10 Competitiveness and business performance at each high technology company

Competitive-ness factor	Company X			Company H			Company A			Company P			Company C		
	Import-ance	Performance	GAP	Import-ance	Performance	GAP	Import-ance	Performance	GAP	Import-ance	Performance	GAP	Import-ance	Performance	GAP
54. Customers are very satisfied with our supply chain capabilities	3.67	3.00	0.67	4.75	3.00	1.75	4.75	2.50	2.25	4.33	2.33	2.00	4.33	3.67	0.67
55. Supply chain performance is continuously improving	3.67	3.67	0.00	4.50	3.25	1.25	4.50	2.67	1.83	4.33	2.67	1.67	4.33	4.00	0.33
56. Cycle times from supplier to customer delivery are excellent (low)	3.67	2.67	1.00	4.50	3.00	1.50	4.25	2.50	1.75	4.67	2.00	2.67	4.33	3.67	0.67
57. Supply chain cost is low compared to competitors	4.67	3.33	1.33	4.50	2.75	1.75	4.25	2.50	1.75	4.00	2.33	1.67	4.33	4.00	0.33
58. Supply chain performance contributes to cash-flow	4.33	4.00	0.33	4.25	2.25	2.00	4.67	2.67	2.00	4.00	2.33	1.67	4.33	4.33	0.00
59. Contribution to company's competitiveness from supply chain management		3.00			2.88			3.50			3.33			3.67	
Business Performance, latest quarter in year 2003 (Source: MSN Financial Web-Site and Company Web-Site)															
	Company X			Company H			Company A			Company P			Company C		
Profit Margin	- (minus) 1.99%			6.4%			- (minus) 10%			- (minus) 20%			20%		
Inventory Turnover	6.2			10.1			2.7			7.6			5.6		
Revenue per Employee	US\$ 232,000			US\$ 500,000			US\$ 200,000			US\$ 330,000			US\$ 528,000		
Supply Chain Focus: Analysis from Research Question 1															
Supply chain focus	Internal			External			Internal			Internal			External		

Note: Question numbers correspond to questionnaire in appendix A1
 Source: Developed for this study from data obtained from questionnaire in appendix A1

4.4.2 Company H: Competitive position and business performance

Competitive position:

Company H respondents rated their performance on the competitiveness factors, and their ratings are shown in table 4-10.

- They feel that the performance of their supply chain in meeting customer satisfaction is Good (3 on a 5 point scale), with a large gap from the importance level.
- In fact although competitive performance is close to Good (3 on a 5 point scale) for supply chain improvements, short cycle times from supplier to customer, and supply chain costs, their expectations are very high with large gaps between importance and performance
- The respondents feel that that supply chain performance barely contributes to cash flow, with a very large gap from importance.
- The respondents rate their overall competitiveness below Good (2.88 on a 5 point scale).

Overall, the respondents perceive that there are large gaps between importance and performance for all competitiveness factors.

Business performance:

The business performance of Company H is good: It is profitable in its latest quarter (6.4% net profit), has high turnover in inventory (10 times) equating to 1.2 months of supply, and high revenue per employee at \$500K/employee.

Focus on external supply chain management factors

The analysis from Research Issue 1 suggests that Company H gives priority to external supply chain management factors (such as customer relationships and outsourcing).

Overall comments:

Company H respondents perceive that the performance of their supply chain in meeting customer satisfaction is Good, with a large gap from the importance level. In fact although competitive performance is close to Good for supply chain improvements, short cycle times from supplier to customer, and supply chain costs, their expectations are very high with large gaps between importance and performance. The respondents rate their overall competitiveness as below Good. The respondents feel that there are large gaps between

importance and performance for all competitiveness factors. Although Company H respondents show large gaps between importance and performance for all competitiveness factors, the company does well with good profits, good inventory turnover, and high revenue per employee.

Overall the respondents of Company H are externally focused in supply chain management activity. They aim high and have high expectations in supply chain. In return for their high expectations, the company does well in supply chain competitiveness. As a possible consequence, the company has good business performance.

4.4.3 Company A: Competitive position and business performance

Competitive position:

Company A respondents rated their performance on the competitiveness factor, and their ratings are shown in table 4-10.

- They feel that the performance of their supply chain in meeting customer satisfaction is below Good (between Good and Average at 2.5 on a 5 point scale), with a large gap between importance and performance.
- The competitive performance for all supply chain factors is low, at around 2.5 for all factors. Furthermore, the expectations of all respondents are high with large gaps between importance and performance.
- Nevertheless, the respondents rate their overall competitiveness at above Good at 3.5 (on a 5 point scale). This is surprising given the low performance for the all competitiveness factors and large gaps from importance and expectations.

Despite large gaps in perceived performance from expectations for all competitiveness factors, Company A respondents feel that supply chain management is contributing to competitiveness.

Business performance:

The business performance of Company A is not good: It has negative profits in its latest financial quarter (-10%), very poor inventory turnover (of 2.7 times) equating to 4.4 months of supply, and low revenue per employee at \$200K/employee.

Focus on external supply chain management factors

The analysis from Research Issue 1 suggests that Company A gives priority to internal and manufacturing supply chain management factors and activity.

Overall comments:

Company A respondents perceive that their competitive performance for all supply chain factors is low for all factors. Furthermore, the expectations of all respondents are high with large gaps between importance and performance. This outlook is commensurate with very poor financial and inventory management performance. Nevertheless, it is surprising that the respondents rate their overall competitiveness from supply chain management as above good, with a 3.5 score, whereas they have very poor inventory turnover. The respondents seem unaware of the company's poor performance.

Overall, the respondents of Company A are internally focused in supply chain management. Although they aim high, they perceive their performance as low. However, they rate their competitiveness as above good when in reality their competitiveness is low. Their understanding of supply chain management seems poor, with high inventory and low productivity. The company has poor business performance.

4.4.4 Company P: Competitive position and business performance**Competitive position:**

Company P respondents rated their performance on the competitiveness factors, and their ratings are shown in table 4-10.

- They feel that the performance of their supply chain in meeting customer satisfaction is poor at just above average (at 2.3 on a 5 point scale), with a large gap between importance and performance.
- Competitive performance for all supply chain factors is low at between 2 and 2.7. Furthermore, the expectations of all respondents are high with large gaps between importance and performance.
- Nevertheless, the respondents rate the contribution of supply chain management to competitiveness at above Good, scoring 3.33 (on a 5 point scale).
- Despite gaps in performance from expectations, they feel that supply chain management is contributing to competitiveness.

Business performance:

The business performance of Company P is poor: It has negative profit margin (-10%) in its latest financial quarter, low inventory turnover (at 7.6 times) equating to 1.6 months of supply, and low revenue per employee at \$330K/employee. The business performance reflects the company's weakness in supply chain factors but contrasts dramatically with the overall perceived competitiveness which is rated high (3.3 on a 5 point scale).

Focus on external supply management factors

The analysis from Research Issue 1 suggests that Company P gives priority to internal and manufacturing supply chain factors and activity.

Overall comments

Company P respondents perceive that the performance of their supply chain in meeting customer satisfaction is poor, with a large gap between importance and performance. In fact competitive performance for all supply chain factors is low at between 2 and 2.7. Furthermore, the expectations of all respondents are high with large gaps between importance and performance. The respondents aim high but perceive they are doing poorly in perceived performance. This outlook is commensurate with the company's very poor

financial performance. Nevertheless, it is surprising that the respondents rate their overall competitiveness from supply chain management as above good.

Overall, the respondents of Company P are internally focused in supply chain management activity. Although they aim high, they perceive their performance as low. However, they rate their competitiveness as above good when in reality their competitiveness is low. Their understanding of supply chain management seems poor, with high inventory and low productivity. The company has poor business performance.

4.4.5 Company C: Competitive position and business performance

Competitive position:

Company C respondents rated their performance on the competitiveness factors, and their ratings are shown in table 4-10.

- They feel that the performance of their supply chain in meeting customer satisfaction is almost at Very Good (score of 3.67), with a small gap between importance and performance.
- The competitive performance for all supply chain factors is Good to Very Good, at between 3.67 and 4.00.
- Furthermore, the expectations of all respondents are high with small gaps between importance and performance (from 0 to 0.67).

Business performance:

The business performance of Company C is very good: It is very profitable in its latest quarter (20%), high revenue per employee at \$528K/employee, but its inventory turnover is only 5.6, equating to 2.1 months of supply.

Focus on external supply management factors

The analysis from Research Issue 1 suggests that Company C gives priority to external supply chain management factors such as customer relationships, outsourcing, and information systems that reach out to customers via Internet commerce.

Overall Comments:

Company C respondents perceive the performance of their supply chain in meeting customer satisfaction is almost at Very Good, with a small gap between importance and performance. In fact competitive performance for all supply chain factors is Good to Very Good. Furthermore, the expectations of all respondents are high with small gaps between importance and performance. Hence Company C respondents aim high and have high expectations in supply chain. In return for their high expectations, the company does well in supply chain competitiveness, and the Company does very well in business performance.

Overall the respondents of Company C are externally focused in their supply chain management activity. They aim high and have high expectations in supply chain.

Competitive performance for all supply chain factors is high and the company does well in supply chain competitiveness. As a possible consequence, the company has good business performance.

4.4.6 Performance in supply chain metrics at high technology companies

In the analysis of business performance of each high technology company, key supply chain metrics at the various companies were also measured. These are shown in Table 4-10. Specifically these include inventory turns and revenue per employee. The performance in supply chain and financial metrics at the high technology companies varies.

Employee productivity measured by revenue per employee ranges \$200-330K for the money losing companies (Company X, A, P) and about \$500K per employee for the profitable companies (Company H, C). Per the analysis of Research Issue 1, the 2 profitable companies have the highest outsourcing strategy and place it as very important and consider manufacturing as less important. This is the opposite stance from the 3 money-losing companies, which consider manufacturing important. High outsourcing tends to reduce the number of employees and helps to raise revenue per employee.

Inventory management measured by inventory ranges from 3 turns (worst) to 10 turns (best). Company A has the worst inventory turns of 2.7, while Company H has the best at 10.1 turns. This is very disappointing as a company reviewed in the Literature Review, Dell Computers, has over 100 turns. During discussions with the respondents, the reasons for the low inventory turnover were as follows:

- Company H stated that it was satisfied with the current inventory
- Company C stated that the inventory was due to the economic downturn and it expected improvement soon.
- Company X, A, and P stated that the low turnover economic downturn and would improve once they did more outsourcing. Furthermore, Company A stated that the low turnover was partly due to long product lifecycles and was the norm.

4.4.7 Cross-case analysis and summary of interpretation of Research Issue 3

Research Issue 3 asks: Will a focus on external supply chain management factors give better business results?

The case study companies can be segmented into 2 clusters, companies that perform well and companies that have poor business results.

Companies with good business results: Both Company H and C have shown very good business performance in profits and productivity per employee. Their respondents tend to have high expectations and aim high. This is commendable, given that the state of California has been in a recession through most of 2001-2003.

Their supply chain management activity is externally focused (on factors such as customer relationships, managing customer dissatisfaction, planning and involving customers in demand management, getting sell-through information in the distribution channel), they use Information systems to manage their business, and have a high outsourcing activity. They also emphasize decision making and organization issues as important. Furthermore Company C is aggressively conducting a large portion of its business via the Internet. Both companies

heavily outsource their manufacturing activity, which can result in high revenue per employee and lower costs.

Companies with poor business results: The other 3 companies (X, A, and P) have poor business performance and have low productivity per employee.

Their supply chain management activity is internally focused and they place a heavy emphasis on internal manufacturing and do not emphasize outsourcing. They have yet to embrace a strong customer relationship program or Information systems, to improve productivity or lower costs. They are doing poorly financially, in productivity, and in inventory management. Yet, overall the respondents seem unaware of their poor supply chain and financial performance. This implies that there may be insufficient management and performance reviews of supply chain performance.

Hence it can be concluded that an external focus on supply chain management factor and activity (such as customer relationships, information systems to manage their customers, and outsourcing) gives better business results.

4.5 Interpretation of Research Issue 4: Are perceived critical gaps (and opportunities) in performance derived from traditional methodology similar to those deployed from customer needs?

The fourth research issue investigates the perceived critical gaps in supply chain performance derived from traditional methodology and compares them to gaps deployed from customer needs. A list of critical performance gaps is deemed as an opportunity for improvement. To investigate the research issue, analysis and interpretation of the data are done via the two methodologies listed below:

1. Traditional Methodology: Understanding the highest performance gaps between the expected importance of factors and the perceived factor performance. This is done via cross-case analysis of the case study companies and as an aggregate for the 5 companies.
2. QFD Methodology: Using customer needs to identify the critical gaps, as an aggregate for the 5 case study companies. This is done by preparing a quality function deployment (QFD) table to list customer needs and relating them to the specific performance gaps that best meet these needs.

Highest gaps between the expected importance and perceived performance

Appropriate analysis and understanding of the gaps and opportunities comes from distinguishing between expected importance of a factor and its perceived performance. A successful company aims high; hence there will be gaps between expected importance of a factor and its perceived performance. The concept of performance gap, that is expected importance – (minus) perceived performance, was first introduced by Martilla and James (1977). A gap between the expected importance and perceived performance of a factor can provide some indication as to whether executives are successful in translation of their vision and direction to their employees.

In the questionnaire, there are 52 questions (out of a total of 59) that pertain to supply chain factors that can have specific influence on supply chain management. The remaining 7 factors, that are excluded in the gap analysis are supply chain performance metrics. The list of 52 supply chain management factors are coded as questions 1 through 52 in the questionnaire (refer to appendix A1). Furthermore, for the gap analysis, two factors relating to employee morale and teamwork are not utilized and discarded, as they are considered generic to all business activity.

The gaps are computed by subtracting perceived performance averages from the expected importance averages for each company. As there are 52 supply chain factors, the number of selected gaps has to be limited. In their analysis, Leisdecker and Bruno (1984) limited the number of success factors to six. Using that as a guide for this study, the 6 highest gaps (out of 52 questions) are identified and analyzed for each company.

The mean value of the 5-point Likert rating scale is the popular usage indicator for measuring a factor rating. The higher the mean value, the more important the factor. For this analysis, the gaps between factor importance and perceived factor performance are computed and sorted. By arranging the gaps in descending order with respect to the mean value of the gap, it is possible to identify the critical gaps or opportunities for improvement. The analysis is done for each case study company and between case study companies. To reduce clutter, the individual case study company gaps are listed in appendix A5. In appendix A5 the specific numerical gaps are also shown.

The highest gaps for each company are discussed individually and summarized in Table 4-11. The highest gaps are also aggregated and analyzed from all 5 companies in table 4-13.

4.5.1 Performance gaps and opportunities – Company X

The gaps and opportunities of Company X are in several areas. The top 6 gaps are listed in Table 4-11. These are the supply chain factors that the respondents perceive as those with the largest gaps in their company. By arranging the gaps in descending order with respect to the mean value of the gap, it is possible to identify the critical gaps, which are opportunities for

improvement. The gaps are analyzed and clustered into several supply chain categories. In addition the opportunity and benefits that these gaps provide is also discussed.

Information Systems and Technology

- Intra-organization information systems to coordinate and integrate the entire Supply Chain. This will help to better manage overall inventory and reduce costs.
- Optimizing the supply chain via the Efficient Consumer Response (ECR) process, which will help better manage inventory, improve deliveries to customers, and lower costs.
- Purchasing parts and commodities via the Internet, in order to get best prices.

Supply chain agility:

- Radical and successful business process reengineering. There is strong sentiment that supply chain costs are not competitive. Hence the company has to review its supply chain processes and take an approach of radical cost reductions and improvements.

Manufacturing:

- Superior product quality compared to competitors. Company X still needs to focus effort on internal manufacturing.
- Product design for environmental and recycling needs

Overall comments on gaps at Company X

At Company X, the gaps in performance are in the areas of information systems, supply chain agility, and manufacturing. Hence, although the company continues to perceive performance gaps in its core capability – manufacturing, it also perceives gaps in areas such as supply chain agility and information technology.

Table 4-11 Highest performance gaps and cross-case analysis at high technology companies

Company X	Company H	Company A	Company P	Company C
37. Intra-organization information systems to coordinate and integrate the entire Supply Chain *****	26. Planning and involving customers in demand management **	26. Planning and involving customers in demand management **	33. Effective use of Internet to manage Business-to-B commerce *****	7. Just-in-time (JIT) delivery from suppliers
38. Optimizing the supply chain via Efficient Consumer Response (ECR) *****	39. Eliminating non-value layers (such as wholesalers) in supply chain *****	42. Responding to high market fluctuations *****	40. Radical and successful business process reengineering *****	9. Company-wide coordination and management of inventory
35. Collaboration and bidding for parts and commodities via the Internet *****	44. Employees are trained in supply chain concepts and management	22. Zero-defect manufacturing or use of 6-Sigma concepts ***	42. Responding to high market fluctuations *****	2. Provide on-time delivery to customers *
21. Product design for environmental and recycling needs ***	30. A process to manage customer dissatisfaction returns	2. Provide on-time delivery to customers *	38. Optimizing the supply chain via Efficient Consumer Response (ECR) *****	3. Provide logistics at lowest cost *
24. Superior product quality compared to competitors ***	25. Sell-through information (point of sales data) from distributors/partners **	16. Effective use of ERP and MRP systems ***		4. Company-wide logistics (outsourcing) contracts *
40. Radical and successful business process reengineering *****	36. Inter-organizational information coordination and sharing *****	34. Effective use of Internet to manage Business-to-Consumer commerce *****		36. Inter-organizational information coordination and sharing *****
Observation	Observation	Observation	Observation	Observation
<p>Most frequent gaps are in Information Systems and Technology and Manufacturing categories.</p> <p>The gaps in indicate a need to improve in its core competency of manufacturing plus a need to improve Information Systems</p>	<p>Most frequent gaps are in Information Systems and Technology, and Partnership and Collaboration.</p> <p>The gaps in indicate a need to keep its progressive outlook of staying in touch with customers and improve Information Systems</p>	<p>Most frequent gaps are in Manufacturing category.</p> <p>The gaps in indicate a need to improve in its core competency of manufacturing, plus a need to reach out externally to customers.</p>	<p>Most frequent gaps are in Information Systems and Technology and Supply Chain Agility.</p> <p>The gaps indicate a need to diminish its focus on internal manufacturing and to reach out externally to customers and become more agile via Information systems</p>	<p>Most frequent gaps are in the Logistics category. Two other gaps cover physical movement and management of products.</p> <p>The gaps indicate a need to better manage outsourced manufacturing and improve Information Systems</p>

Note: Question numbers correspond to questionnaire in appendix A1, and were sorted by importance for the top 6 factors.

In the case of Company P, the 5th to 10th factor tied in score, hence only the top 4 gaps were listed.

Note on coding within boxes:

- Information Systems and Technology Category = blue color and 5*****
- Supply Chain Agility Category = Grey color and 4*****
- Manufacturing(Advanced manufacturing and quality) Category = Pink color and 3***
- Partnership and Collaboration Category = green color and 2**
- Logistics Category =Yellow/Beige and 1*
- Source: Developed for this study from data obtained from questionnaire in appendix A1

4.5.2 Performance gaps and opportunities at Company H

The gaps and opportunities of Company H are in several areas. The top 6 gaps are listed in Table 4-11 in descending order of mean value. This list gives the gaps in descending order and identified the critical gaps or opportunities for improvement. The gaps are analyzed and clustered into supply chain categories:

Partnership and Collaboration

- Sell-through information
- Planning and working with customers on demand management

Information Systems and Technology

- Eliminating non-value layers (such as wholesalers) in supply chain
- Inter-organizational information coordination and sharing

Customer relationship management

- A process to manage customer's dissatisfaction returns

Decision Making and Organization Factors

- Employees are trained in supply chain concepts and management

Overall comments on gaps at Company H

At Company H, gaps and opportunities are both external and internal. They are in the areas of customer relationship, information systems and technology, decision-making and organization factors, and planning and collaboration. However, there is no emphasis on manufacturing in the top gaps – this is believed to be related to Company H's emphasis on outsourcing of manufacturing activity, and is a pattern repeated in other analysis of Company H (Research Questions 1). This is a balanced approach, emphasizing both external and internal factors.

4.5.3 Performance gaps and opportunities at Company A

The gaps and opportunities of Company A are in several areas. The top 6 gaps are listed in Table 4-11 and arranged in descending order with respect to the mean value of the gap. From this it is possible to identify the critical gaps or opportunities for improvement. The gaps are analyzed and clustered into several areas:

Partnership and collaboration

- Planning and involving customers in demand management

Supply Chain Agility

- Responding to high market fluctuations

Logistics

- Provide on-time delivery to customers

Manufacturing Improvements:

- Zero-defect manufacturing or use of 6-Sigma concepts.
- Effective use of ERP and MRP systems

Information Systems and Technology

- Effective use of Internet to manage Business-to-Consumer commerce

Overall comments on gaps at company A

At Company A, gaps and opportunities were spread over many balanced between internal manufacturing issues, logistics and supply chain agility, and Business-to-Business commerce via information systems. Supporting the previous analysis in Research Issue 1, Company A respondents are consistently emphasizing the need to focus on manufacturing, one of their core competencies. However, the respondents are also emphasizing performance gaps in other areas and there is need to invest in supply chain agility and information systems.

4.5.4 Performance gaps and opportunities at Company P

The gaps and opportunities of Company P are in several areas. The top gaps are listed in Table 4-11 in descending order and identify the critical gaps or opportunities for improvement. In this case, the 5th place gap tied all the way to the 10th gap. These 10 gaps encompassed 7 supply chain categories – Information Systems and Technology, Supply chain agility, Procurement, Partnership and Collaboration, Decision Making and Organization Factors, Employee Performance, and Manufacturing. In such a case a better method is needed to set priorities for improvement, because such a long list is no longer a prioritized list. Therefore, only 4 gaps are listed in the Table 4-10. The remaining 6 gaps can viewed in the specific company gaps shown in appendix A4 (Table A4-4). Hence, eliminating the ties, the top 4 gaps are selected as the best opportunities, and listed below:

Information Systems and Technology

- Effective use of Internet to manage Business-to-B commerce
- Optimizing the supply chain via Efficient Consumer Response (ECR)

Supply Chain Agility

- Radical and successful business process reengineering
- Responding to high market fluctuations

Overall comments on gaps at Company P

At Company P, the performance gaps are prioritized as Information Systems and Technology (via Business-to-Business commerce and Efficient Consumer Response) and Supply Chain Agility (via radical and successful business process reengineering and responding to high market fluctuations). Although, Company P shows high importance in manufacturing areas (discussed in analysis in Research Issue 1), the respondents are emphasizing gaps in information systems and supply chain agility as most important. This may indicate a shift in emphasis by the company to de-emphasize manufacturing in future. A check with the respondents, including the Chief Operating Officer, during the interviews and follow-up discussions confirmed that the Company's future direction is to outsource all manufacturing

as quickly as possible. A check of secondary sources (the Company web-site) confirmed this approach.

4.5.5 Performance gaps and opportunities at Company C

The gaps and opportunities of Company C are in several areas. The top 6 gaps are listed in descending order in Table 4-11, and identify critical gaps or opportunities for improvement. However, it is observed that the numerical value of the gaps Company C is low compared to all other case study companies. Refer to Table A4-5 in appendix A4. This seems to imply that Company C respondents perceive that they are both successful and competitive in their supply chain management. The gaps can be clustered into several supply chain categories:

Logistics

- Company-wide logistics (outsourcing) contracts
- Provide logistics at lowest cost
- Provide on-time delivery to customers

Procurement

- Just-in-time (JIT) delivery from suppliers

Inventory Management

- Company-wide coordination and management of inventory

Information Systems and Technology

- Inter-organizational information coordination and sharing

Overall comments on gaps at Company C

At Company C, the performance gaps cover inventory management (an area that is shown to be weak in the business performance analysis in Research Issue 3), logistics, procurement (or delivery from suppliers), and information systems (inter-organizational coordination and sharing). There are no manufacturing issues, and this seems to relate to Company C's emphasis on outsourcing of manufacturing activity, and is a pattern repeated in other analysis (for Research Issue 1) of Company C. However, except for information systems, the performance gaps are primarily in the more traditional supply chain areas – logistics, procurement, and inventory management. On further questioning during subsequent

interviews, the respondents confirmed that because all manufacturing was outsourced at Company C, these factors were used to manage outsourced partners, e.g. logistics contracts, delivery from suppliers, delivery to customers, and inventory. Furthermore, Company C is a leader in information systems and technology management and is conducting a high portion of its business, in both purchasing and sales, via the Internet (The Economist, 2000a; Business Week, 2003). Hence this confirms the reason for Company C's major gaps, which are to manage outsourced partners, e.g. logistics contracts, delivery from suppliers, delivery to customers, and inventory.

It is observed that the numerical values of the gaps at Company C are much lower (range of 0.6 or less) than all other case study companies (range starting from 3.0 in one company and about 2.0 at the others) -- refer to Table A4-5, in appendix A4. This seems to imply that the respondents perceive that they are both successful and competitive in their supply chain management.

4.5.6 Cross-case analysis and interpretation for Research Issue 4

A comparison of the gaps and opportunities can be made across case study companies.

The highest gaps are listed in Table 4-11. In additions to the gaps, a summary of some of the observations at each company is shown in Table 4-11, and is elaborated here. The table is color and symbol coded to show more clearly similar gaps across companies.

Observations of similarities and differences

By looking at the categories of gaps, it is possible to group the companies into clusters of similarities, differences, or recurring patterns.

Overall similarities:

Need for Better Information Systems: Performance gaps in the Information Systems and Technology Category occurs a total of 9 times. Every company has from 1 to 3 gaps in this category. This indicates a need to reach out more to customers, have better organizational information, and to reduce costs. Clearly this is the most critical item, causing the highest gaps in performance, and represents the greatest opportunity.

Cluster of similarities

Traditional Manufacturing Companies, needing to improve current manufacturing performance and to have better information systems.

As in the case of Research Issue 1 analysis, some companies perceive gaps in manufacturing factors. This implies that they still consider manufacturing as their core competency and perceive a high performance gap in manufacturing factors. However, these companies also perceive a high gap in information technology and systems – needing to share information with customers, to have better organizational information, to have processes similar to ECR (Efficient Consumer Response), and to conduct more business via Internet commerce. Company X and A are in this category.

The major opportunity for these traditional manufacturing companies is to further improve their core competencies and also have better information systems and technology – as a result they can reduce inventory, get better communication with customers, improve customer satisfaction, and reduce costs.

Progressive Manufacturing Companies increasing their external focus by placing less importance on manufacturing factors, but more emphasis on customers:

As in the case of Research Issue 1 analysis, some of the case study companies are very progressive and place less importance on manufacturing factors, but more emphasis on customers, via external supply chain activity and information systems. This pattern is repeated in the performance gaps. The companies in this category are Company H and C.

Specifically, at Company H, the most frequent gaps are in Information Systems (reducing layers in the field and sales channel), and Partnership and Collaboration (involving customers in demand management and sell through information from customers).

Company C is quite different with 5 out of 6 gaps in the Logistics category or in physical movement and management of products (refer Table 4-12). These gaps indicate a need to better manage outsourced manufacturing. Further discussions with the respondents confirmed this. One gap covers information sharing via information systems, an area in which the

company is already a leader (The Economist, 2000a; Business Week, 2003). Hence, the gaps indicate a need to manage the external supply chain.

The opportunity for these companies is external management of their supply chain to support the complete outsourcing of manufacturing, with a focus on logistics, information systems and technology, and further connection with customers.

Traditional Manufacturing Companies transitioning from internal manufacturing to become Progressive Manufacturing Companies

Company P does not fit either of 2 clusters mentioned above. Although, Company P shows high importance in manufacturing factors (per the analysis in Research Issue 1), the respondents are emphasizing gaps in information systems and supply chain agility as most important. This may indicate a shift in emphasis by the company to de-emphasize manufacturing in future. Further discussions with the Chief Operating Officer, confirmed an aggressive and progressive move to outsource manufacturing as quickly as possible and to focus on Information systems to manage the business.

4.5.7 Aggregated performance gaps for all case study companies

In the previous sections, the performance gaps at each case-study company were reviewed. Subsequently a cross-case analysis was also done, and 3 different clusters of gaps were discovered. To allow for a different perspective of Research Issue 4, the performance gaps at all companies are aggregated, ranked by highest gaps, and reviewed here. The aggregated list of the highest gaps is obtained from the supply chain factors with the highest gaps between the importance and perceived performance ratings. This data was obtained and aggregated from the raw data of the individual case study companies. This is shown partially in appendix A5, where the specific numerical gaps are shown for the top 5 gaps at each company. The top 12 or highest gaps are listed in Table 4-12, below.

Table 4-12 Supply chain factors with the 12 largest gaps at all high technology companies

Supply chain factor	Value of gap
26. Planning and involving customers in demand management	1.82
37. Intra-organization information systems to coordinate/integrate the entire Supply Chain	1.71
44. Employees are trained in supply chain concepts and management	1.59
42. Responding to high market fluctuations	1.53
11. Vendor managed inventory (VMI) at production sites	1.50
38. Optimizing the supply chain via Efficient Consumer Response (ECR)	1.47
36. Inter-organizational information coordination and sharing	1.41
39. Eliminating non-value layers (such as wholesalers) in supply chain	1.40
40. Radical and successful business process reengineering	1.29
33. Effective use of Internet to manage Business-to-B commerce	1.24
10. Just-in-time (JIT) delivery to customers	1.24
12. Lowest inventory driven costs	1.24

Note 2: These data are aggregated for all high technology companies

Note 3: Question numbers correspond to questionnaire in appendix A1

Note 4: Only the factors with the 12 highest gaps are shown (out of 52 factors).

Note 5: Two factors relating to employee morale and teamwork were discarded, as they are considered generic to all business activity. Refer to appendix A-6 for details.

Source: Developed for this study from questionnaire in appendix A1, and QFD methodology process in appendix A5

From table 4-12, it can be seen that the 5 top gaps are:

1. Planning and involving customers in demand management
2. Intra-organization information systems to coordinate/integrate the entire Supply Chain
3. Employees are trained in supply chain concepts and management
4. Responding to high market fluctuations
5. Vendor managed inventory (VMI) at production sites

4.5.8 Using customer needs to identify the critical gaps and opportunities at high technology companies

The purpose of this analysis is to use the customer's needs to identify the critical performance gaps at high technology companies. QFD is a comprehensive quality tool aimed at meeting customer's needs. It is a technique to uncover customer's spoken and unspoken needs, and convert these needs to product or service design targets and processes (Akao, 1990). The outcome can be a better product or service that will meet or exceed customer needs. A well-designed QFD process is able to link and display customer needs, targets and processes into visual charts.

The analysis is done by looking at generic customer needs and their relationship to the 10 top supply chain factor performance gaps of all the 5 case study companies. When the relationship is strong between customer needs and a supply chain performance gap, then that supply chain factor is considered important for implementation at the companies. The QFD table can be prepared using guidelines suggested by Akao (1990).

Preparation of quality function deployment (QFD) table to list customer needs and identifying critical gaps and opportunities from customer's viewpoint

To prepare the QFD table, the customer's needs are obtained from 2 independent sources, specifically:

- A Supplier Rating Table, obtained from a customer of a case study company
- Customer needs data from a case study company

The detailed method of identifying the customer needs is shown in appendix A4.

The list of highest gaps in supply chain performance is obtained from the factors with the 12 highest gaps between the importance and performance ratings. The top 12 or highest gaps are listed in Table 4-13, below. The reason for selecting 12 gaps instead of less is to allow the QFD methodology to determine what gaps are critical to customer needs. This is a more objective process than arbitrarily coming up with a shorter and more manageable list of gaps. For this analysis, the aggregate data from all the high technology companies has been used for the computation. The highest gaps are listed in Table 4-12, shown in the previous section.

Using the customer needs and the highest gaps the QFD table can be developed. The detailed process of preparing the QFD table includes obtaining the customer's voice or needs and preparing a list of highest critical gaps in supply chain performance and is shown in detail in appendix A6.

The final, completed QFD Table is shown in Table 4-13. One of the outcomes of the QFD table is a list of supply chain factors that best met customer's spoken and unspoken needs. These have been ranked and are listed at the bottom line of the QFD Table 4-13.

Table 4-13 OFD Table to identify Customer’s Critical Supply Chain

Notes on numerical items in matrix A. Relationship code and score: 3 means strong relationship 2 means medium relationship Blank space means no relationship B. Number in (brackets) = weighted scores = relationship score X Importance score		Supply chain factors with the largest gaps (Expected Importance – Perceived Performance) Supply chain factor gaps are aggregated from data of all high technology companies												
		Importance Score	26. Planning and involving customers in demand management	37. Intra-organization information systems to coordinate/integrate the entire Supply Chain	44. Employees are trained in supply chain concepts and management	42. Responding to high market fluctuations	11. Vendor managed inventory (VMI) at production sites	38. Optimizing the supply chain via Efficient Consumer Response (ECR)	36. Inter-organizational information coordination and sharing	39. Eliminating non-value layers (such as wholesalers) in supply chain	40. Radical and successful business process engineering	33. Effective use of Internet to manage Business-to-B commerce	10. Just-in-time (JIT) delivery to customers	12. Lowest inventory driven costs
Primary needs of customer	Secondary needs of customer													
Before-Sales Support and Information Availability	1. Ease of ordering	4.5					3(13.5)	2(9)			3(13.5)			
	2. Fast acknowledgement of orders	3.5			2(7)		3(10.5)				3(10.5)			
	3. Availability of information (price, product availability, delivery date, etc.)	4.5		3(13.5)				3(13.5)		2(9)	3(13.5)			
Reliability of Delivery	4. On-time delivery	4.8	2(9.6)			3(14.4)	2(9.6)	3(14.4)		2(9.6)	2(9.6)		2(9.6)	
	5. Complete delivery	4.5	2(9)			2(9)	2(9)	3(13.5)		2(9)	2(9)		2(9)	
	6. Products received in good condition	4.3								2(8.6)	2(8.6)			
	7. Delivery Turn-Around-Time	4.7	2(9.4)	2(9.4)		2(9.4)	2(9.4)	3(14.1)		2(9.4)	2(9.4)		2(9.4)	
	8. Invoicing timeliness	3.5										2(7)		
Product Quality	9. Quality of products	5.0									2(10)			
Reasonable Cost	10. Low (relative) product and delivery cost	4.0				2(8)	2(8)	3(12)		3(12)	2(8)	3(12)	3(12)	
After-Sales Support	11. Ease of product returns	4.7	2(9.4)								2(9.4)	2(9.4)		
	12. Speed of support and communication	4.5			2(9)							2(9)		
	13. Proactive support	3.5			3(10.5)							2(7)		
Column Scores (sum of bracket scores)			37.4	22.9	26.5	40.8	36	78	22.5	48.6	73	81.9	28	12
IMPORTANCE RANK (TOP 5)						5		2		4	3	1		

Source: Developed for this study in appendix A6

From The QFD Table 4-13, the prioritized and most important supply chain factors are:

1. Effective use of Internet to manage Business-to-B commerce
2. Optimizing the supply chain via Efficient Consumer Response (ECR)
3. Radical and successful business process reengineering
4. Eliminating non-value layers (such as wholesalers) in supply chain
5. Responding to high market fluctuations

4.5.9 Summary of analysis and interpretation of Research Issue 4

Research Issue 4 asks: Are perceived critical gaps (and opportunities) in performance derived from traditional methodology similar to those deployed from customer needs?

The critical gaps were determined with the following methodologies:

Critical gaps determined via traditional methodology

1. Critical, or highest, performance gaps for each case study company. These are grouped into clusters after doing a cross-case analysis.
2. Critical gaps as an aggregate for the 5 companies.

Critical gaps via QFD methodology

This is done by using a quality function deployment (QFD) table to list customer needs and relating them to the specific performance gaps that best meet these needs. The raw performance data for this analysis is identical to that used for the gaps determined from traditional methodology.

These gaps from different methodologies are listed for comparison in Table 4-14, below.

Table 4-14 Comparison of critical gaps in performance derived from different methodologies

Gaps using traditional methodology		Gaps using QFD methodology
Gaps are grouped into 3 clusters, after doing a cross-case analysis, from gaps derived from highest numerical gaps at each company.	Gaps for aggregated company data, listed in order of highest numerical gap.	Gaps are listed in order of highest customer needs.
<p>Traditional Manufacturing Companies, needing to improve current manufacturing performance and to have better information systems. These companies still consider manufacturing as their core competency and perceive critical gaps in manufacturing. These companies also perceive critical gaps in information technology and systems.</p> <p>Progressive Manufacturing Companies increasing their external focus by placing less importance on manufacturing factors, but more emphasis on customer factors. They have gaps in a host of customer oriented-factors. For example in Managing customer dissatisfaction, Planning and involving customers in demand management, Sell-through information in the distribution channel, Logistics and physical movement and management of products, and various other Information system enabled activities.</p> <p>Companies transitioning from traditional (internal) manufacturing to become progressive manufacturing companies. One company formed a third cluster. Although, it showed high importance in manufacturing areas, it emphasized critical gaps in information systems and supply chain agility. This seems to indicate a shift in emphasis by the company to de-emphasize manufacturing gaps in future.</p>	<ol style="list-style-type: none"> 1. Planning and involving customers in demand management 2. Intra-organization information systems to coordinate/integrate the entire Supply Chain 3. Employees are trained in supply chain concepts and management 4. Responding to high market fluctuations 5. Vendor managed inventory (VMI) at production sites 	<ol style="list-style-type: none"> 1. Effective use of Internet to manage Business-to-B commerce 2. Optimizing the supply chain via Efficient Consumer Response (ECR) 3. Radical and successful business process reengineering 4. Eliminating non-value layers (such as wholesalers) in supply chain 5. Responding to high market fluctuations

Source: Developed for this study

From Table 4-14, it is observed that there are differences in critical performance gaps derived from different methodologies. In the case of the traditional methodology, using individual

company data and a cross case analysis, the case study companies can be grouped into three clusters:

- Traditional Manufacturing Companies, needing to improve current manufacturing performance and to have better information systems.
- Progressive Manufacturing Companies increasing their external focus by placing less importance on manufacturing factors, but more emphasis on customers.
- Companies transitioning from traditional (internal) manufacturing to become progressive manufacturing companies:

Furthermore, if traditional methodology is used with aggregated company data, the gaps are:

1. Planning and involving customers in demand management
2. Intra-organization information systems to coordinate/integrate the entire Supply Chain
3. Employees are trained in supply chain concepts and management
4. Responding to high market fluctuations
5. Vendor managed inventory (VMI) at production sites

Now if the gaps are derived from QFD methodology, the most important 5 gaps are:

1. Effective use of Internet to manage Business-to-B commerce
2. Optimizing the supply chain via Efficient Consumer Response (ECR)
3. Radical and successful business process reengineering
4. Eliminating non-value layers (such as wholesalers) in supply chain
5. Responding to high market fluctuations

The list derived from QFD methodology has no resemblance to the previous list above, and it excludes the gaps with the highest performance gap scores. In fact the 3 top gap are ranked 10, 6, and 9 respectively in table 4-13. These critical supply chain factors are quite different from the list developed from traditional methodology and shown in Table 4-14.

In summary, it can be concluded that perceived critical gaps (and opportunities) in performance derived from traditional methodology are different to those derived from customer needs.

The reason is primarily because traditional methodology emphasizes critical performance gaps with the highest scores, whereas performance gaps derived from customer needs emphasize what the customer wants and that is different from the internal perceptions of a company's managers.

4.6 Conclusion

Chapter 4 analyzed the data collected from the selected companies and respondents and interpreted the data in relation to the 4 research issues. The chapter provided both company and cross-case analysis of the data collected in this study, and identified patterns in the findings for each of the 4 research issues.

For the First Research Issue it is possible to conclude that there are differences between critical supply chain management factors at various high technology companies. The selection of the critical supply chain factors depends on whether a company is a traditional ‘old style’ manufacturing company or a progressive manufacturing company.

For the Second Research Issue it is possible to conclude that there are differences between critical supply chain management factors at high technology companies and non-high technology (or benchmark commodity) companies.

For the Third Research Issue it is possible to conclude that an external focus on supply chain management factor and activity (such as customer relationships, information systems to manage their customers, and outsourcing) gives better business results.

Finally, for the Fourth Research Issue it can be concluded that the perceived critical gaps (and opportunities) in performance derived from traditional methodology are different from those deployed from customer needs.

The research issues and the detailed findings are summarized and presented in Table 5-1, in Chapter 5. Based on the analysis of the data collected in this study, it is possible to say that the wealth of information that has been obtained sheds light on the research objective and the 4 research issues. The next (final) chapter offers the conclusions and implications for the findings presented in this chapter.

Chapter 5

Conclusions and Implications

The last chapter analyzed the data collected from the selected companies and respondents and interpreted the data in relation to the four research issues. In this chapter, conclusions and implications are drawn about each of the four research issues. The chapter starts with a summary of the analysis and interpretation of the research objective and issues. This is followed by the conclusions and insights of the analysis. Next the contributions to the literature and implications of the research topic are discussed. The chapter concludes with the limitations of the research and suggested direction for future research

5.1 Summary of analysis and interpretation of research topic

The analysis and interpretation of the data from the case study companies was drawn out in Chapter 4. The analysis is summarized and presented in Table 5-1, below.

Table 5-1 Summary of Analysis and Interpretation of Research Issues

Research Issues	Summarized Interpretation
<p>1. Are there differences between critical supply chain management factors at various high technology companies?</p>	<p>Yes: There are differences in critical supply chain management factors at various high technology companies. The selection of critical supply chain factors depends on whether a company is a traditional ‘old style’, internally focused, manufacturing company or a progressive, externally (customer) focused manufacturing company.</p> <p>Specifically, the case study companies can be segmented into 2 clusters:</p> <p><u>Traditional ‘old style’ manufacturing companies:</u> These companies’ supply chain activity is internally focused. When ranking high level supply chain categories they choose traditional, or historically important, categories. Specifically</p> <ul style="list-style-type: none"> • Manufacturing (quality and manufacturing systems) • Partnership and collaboration • Procurement • Inventory management <p>When selecting critical supply chain factors they choose:</p> <ul style="list-style-type: none"> • Various manufacturing processes and product quality • Supplier management issues • Management and teamwork issues <p>Note the term ‘traditional, old style, manufacturing company, is used to describe a company that focuses its supply chain efforts on manufacturing-type activity (including quality), and other activities that occur prior to manufacturing, such as supplier management, and procurement.</p> <p><u>Progressive manufacturing companies:</u> These companies’ supply chain activities are externally focused. When ranking high level supply chain categories they select the newly emphasized or more advanced categories. Specifically:</p> <ul style="list-style-type: none"> • Customer relationships • Decision making and organization factors • Information systems <p>When selecting critical supply chain factors they emphasize external, specifically:</p> <ul style="list-style-type: none"> • Sell-through information from distributors and retailers • Customer relationship activity • The Internet for Business-to-Business commerce • Various other information systems enabled activities. • Outsourcing of non-core manufacturing activities. <p>Note the term progressive manufacturing company, is used to describe a company that focuses its supply chain efforts on customer relationships type activity and information systems that connect with the customers (such as business to business Internet commerce).</p>

Table 5-1 (Continued) Summary of Analysis and Interpretation of Research Issues

Research Issue	Summarized Interpretation
<p>2. Are there differences between critical supply chain management factors at high technology companies and non high technology (or benchmark commodity) companies?</p>	<p>Yes: There are differences between critical supply chain management factors at high technology companies and non-high technology (or benchmark commodity) companies. The benchmark companies deal in commodity type products, and hence they focus on differentiating themselves through strong customer services and product quality. Specifically:</p> <ul style="list-style-type: none"> • At the high level, or supply chain category, the companies (high technology and non high technology) have a similar approach to supply chain management. • At the tactical level, the data suggests that the benchmark companies have a different approach to selecting critical supply chain management factors. The benchmark companies are externally focused and put a strong focus on supply chain factors that improve or manage customer satisfaction. In addition just like the high technology companies they emphasize product quality.
<p>3. Will a focus on external supply chain management factors give better business results?</p>	<p>Yes: A focus on external supply chain management factors (such as customer relationships, information systems to manage their customers, and outsourcing) gives better business results.</p> <p>Specifically</p> <ul style="list-style-type: none"> • Two companies (H and C) have shown very good business performance in profits and productivity per employee. Their respondents tend to have high expectations and aim high. Their supply chain management activity is externally focused. They also emphasize decision making and organization issues as important. Furthermore Company C is aggressively conducting a large portion of its business via the Internet. Both companies heavily outsource their manufacturing activity, which can result in high revenue per employee. • Three companies (X, A, and P) have shown poor business performance in profits and productivity per employee. Their supply chain management activity is internally and manufacturing focused and they have yet to embrace a strong customer relationship program or Information systems, to improve productivity or lower costs.

Table 5-1 (Continued) Summary of Analysis and Interpretation of Research Issues

Research Issue	Summarized Interpretation
<p>4. Are perceived critical gaps (and opportunities) in performance derived from traditional methodology similar to those deployed from customer needs?</p>	<p>No: The perceived critical gaps (and opportunities) in performance derived from traditional methodology are different from those deployed from customer needs? Specifically:</p> <p>Using traditional methodology, 2 methods are used: <u>Cross-case analysis of the case-study companies:</u></p> <ol style="list-style-type: none"> 1 Traditional Manufacturing Companies, needing to improve current manufacturing performance and to have better information systems. These companies still consider manufacturing as their core competency and perceive critical gaps in manufacturing. These companies also perceive critical gaps in information technology and systems. 2. Progressive Manufacturing Companies increasing their external focus by placing less importance on manufacturing factors, but more emphasis on external customer factors. They have gaps in a host of customer oriented-factors. For example in Managing customer dissatisfaction, Planning and involving customers in demand management, Sell-through information in the distribution channel, Logistics and physical movement and management of products, and various other Information system enabled activities. 3. Companies transitioning from traditional (internal) manufacturing to become progressive manufacturing companies: One company formed a third cluster. Although, it showed high importance in manufacturing areas, it emphasized critical gaps in information systems and supply chain agility. This seems to indicate a shift in emphasis by the company to de-emphasize manufacturing gaps in future. <p><u>Gaps for aggregated company data, listed in order of highest gap.</u></p> <ol style="list-style-type: none"> 1. Planning and involving customers in demand management 2. Intra-organization information systems to coordinate/integrate the entire Supply Chain 3. Employees are trained in supply chain concepts and management 4. Responding to high market fluctuations 5. Vendor managed inventory (VMI) at production sites <p>Using QFD Methodology, gaps are listed in order of highest customer needs.</p> <ol style="list-style-type: none"> 1. Effective use of Internet to manage Business-to-B commerce 2. Optimizing the supply chain via Efficient Consumer Response 3. Radical and successful business process reengineering 4. Eliminating non-value layers (such as wholesalers) in supply chain 5. Responding to high market fluctuations

Source: Developed for this study from Chapter 4

5.1.1 Research Issue 1: Are there differences between critical supply chain management factors at various high technology companies?

This research issue investigates the most critical supply chain management factors at various high technology companies. In the analysis it can be concluded that the high technology companies behave differently and can be grouped into two clusters.

Cluster 1: Traditional, 'old style', manufacturing companies.

Note the term 'traditional, or old style, manufacturing company, is used to describe a company that focuses its efforts on manufacturing-type activity (including quality), supplier management, and procurement. These activities can be considered very internal to company activity. This manufacturing focus is given priority over supply chain categories and factors that allow closer connection with customers. These companies' supply chain activity is internally focused and they emphasize internal supply chain activities. There are 3 companies (out of 5) in this cluster. Within this cluster, the important ranked (high level) supply chain categories are: Partnership and Collaboration, Logistics, Procurement, Inventory management, and Manufacturing (quality and manufacturing systems). Furthermore the critical supply chain factors are various Manufacturing Processes (including product quality), Supplier Management, Management and Teamwork issues.

Cluster 2: Progressive manufacturing companies.

Note the term 'progressive manufacturing' company is used to describe a company that focuses its efforts on customer relationships and information systems that connect with the customers (For example: Internet commerce, via business commerce). These activities can be construed as the company reaching out to connect and communicate better with customers. That is, customer focus is given a higher priority for both supply chain categories and factors. These companies' supply chain activities are more externally focused and they emphasize on external factors. There were 2 companies (out of 5) in this cluster. The important ranked supply chain categories are: Customer relationships, Decision Making and Organization factors, and Information systems. When choosing critical supply chain factors, the selected items are: Sell-through information from distributors and retailers, The Internet for Business-

to-Business commerce, Outsourcing of non-core manufacturing activity, Information system enabled activities.

Hence the answer to Research Issue 1 is: Yes. There are differences in critical supply chain management factors at high technology companies. The case study companies can be grouped into 2 distinctive clusters: Traditional ‘old style’ manufacturing companies and more progressive manufacturing companies. Each cluster behaves differently.

Comparison of Conclusion of Research Issue 1 with the theoretical framework developed in Chapter 2

The theoretical framework developed in Chapter 2, figure 2-2, adapted from Porter (1985) and the literature review proposes specific areas, or broad categories, for supply chain management to achieve competitive advantage. The framework proposes specific factors such as inbound and outbound logistics, operations and internal processes, and infrastructure processes such as procurement, human resource development, and technology processes. Hence, the important areas identified in Research Issue 1 (in Table 5-1), match this overall framework.

5.1.2 Research Issue 2: Are there differences between critical supply chain management factors at high technology companies and non high technology (or benchmark commodity) companies?

The second research issue investigates similarities and differences in supply chain management between high technology and non-high technology companies. The benchmark companies, selected for this study, are dealing primarily in commodities.

It can be concluded that at the high level, that is the broad supply chain category level, all companies (high technology and non high technology) have a similar approach to supply chain management. However, at the tactical, or critical supply chain factor level, the data suggests that the benchmark companies have a different approach to supply chain management. The benchmark companies are externally focused and put a strong emphasis on

supply chain factors that improve or manage customer satisfaction. In addition just like the high technology companies they emphasize product quality.

Hence the answer to Research Issue 2 is: Yes. There are differences between critical supply chain management factors at high technology companies and non-high technology (or benchmark commodity) companies.

Comparison of Conclusion of Research Issue 2 with the theoretical framework

developed in Chapter 2. The theoretical framework developed in Chapter 2 adapted from Porter (1985) and the literature review proposes specific areas, or broad categories, for supply chain management to achieve competitive advantage. However, the framework does not suggest specific strategies for different companies, or in this case for high technology and non-high technology companies. Therefore the analysis of this research issue suggests the need for different supply chain strategies based on product type.

5.1.3 Research Issue 3: Will a focus on external supply chain management factors give better business results?

The third research issue investigates the impact of supply chain management on the competitive position and business performance of the case study companies. It also looks at whether a strong focus on external supply chain management factors can give better business results. The results can be grouped into 2 clusters: companies that have good business results and companies that have poor business results.

Companies with good business results: Both Company H and C have shown very good business performance in profits and productivity per employee. Their respondents tend to have high expectations and aim high. Their supply chain management activity is externally focused on customer relationships, information systems, and outsourcing. They also emphasize decision making and organization issues as important. Furthermore Company C is aggressively conducting a large portion of its business via the Internet, which implies close

and constant communication with customers. Both companies heavily outsource their manufacturing activity, which can result in lower costs and high revenue per employee.

Companies with poor business results: The other 3 companies (X, A, and P) have shown poor business performance and low productivity per employee. Their supply chain management activity is internally focused and these companies place a heavy emphasis on internal manufacturing and do not emphasize customer relationships or outsourcing of their manufacturing. They are doing poorly financially, in productivity, and in inventory management. Yet, overall the respondents seem unaware of their poor supply chain and financial performance. This implies that there may be insufficient management and performance reviews of supply chain performance.

Hence the answer to Research Issue 3 is Yes. An external focus on supply chain management factors gives better business results.

Comparison of Conclusion of Research Issue 3 with the theoretical framework developed in Chapter 2

The theoretical framework developed in Chapter 2 from Porter (1985) proposes specific areas for supply chain management to achieve competitive advantage and better business results. Recommended strategies include cost leadership, differentiation, and focus (Porter, 1985).

In analyzing the choices that the case study companies make, the Traditional, ‘old style’, manufacturing companies are not lowering costs by moving into outsourcing of their non-core manufacturing activities. Although 2 of the 3 traditional ‘old style’ manufacturing companies (Company A and P) have selected outsourcing as an important factor, they also choose a host of manufacturing factors as important, indicating that they are not fully or heavily outsourced. This fact was confirmed in subsequent calls to the respondents. Hence these traditional companies are not moving towards a low cost supply chain strategy.

On the other hand the “Progressive manufacturing companies” (Company H and C) are differentiating themselves with an external supply chain focus, and emphasizing customer

relationships, sell-through information from distributors and retailers, Information systems for Business-to-Business commerce, other information system enabled activity, and a high emphasis on outsourcing of non-core manufacturing activities. Furthermore, verbal feedback from respondents of both companies, and secondary data sources, confirm that they are heavily outsourced in their manufacturing activity. Yet both companies are a little different from each other. Although both companies emphasize Customer Relationships and Decision Making and Organization Factors as important, Company C places a very high emphasis on customer connection via Internet commerce via Information systems.

Hence, it is possible to conclude Porter's (1980) generic model of competitive advantage applies to supply chain management. This implies that there should be proper selection of supply chain strategies that provided differentiation and cost leadership.

Also confirmed is the concept of core competencies by Hamel and Prahalad (1990, 1998), which argues that core competencies are a bundle of skills, that provide access to a wide variety of markets, provided customer benefits, and are difficult to imitate. In particular none of the case study companies come close to managing inventory at 109 turns achieved by Dell Computers – the best is 10 turns or 1/10th of that. Even the two case study companies that have high outsourcing of manufacturing have not yet emulated such success.

However, it is difficult to confirm the accuracy of research by Boyson, et. al (1999) that, “best in class companies enjoy an advantage in (lower) total supply chain management costs of 3 - 6% of revenues (estimated).” All respondent agree on the importance of implementing supply chain management and that it contributes to competitiveness and cash flow. Yet, only 2 of the 5 case study companies are profitable, but it is not possible to tie their profitability to supply chain management.

5.1.4 Research Issue 4: Are perceived critical gaps (and opportunities) in performance derived from traditional methodology similar to those deployed from customer needs?

This research issue investigates the gaps and opportunities for supply chain management in high technology companies. Analysis for this research issue is done by using 2 differing methodologies.

1. Understanding the highest performance gaps between the expected importance of factors and the perceived factor performance. This is done via cross-case analysis of the case study companies and as an aggregate for the 5 companies.
2. Using customer needs to identify the critical gaps, as an aggregate for the 5 case study companies. This is done by preparing a quality function deployment (QFD) table to list customer needs and relating them to the specific performance gaps that best meet these needs.

Using traditional methodology

Cross-case analysis of the case study companies gives the following clusters:

- Traditional Manufacturing Companies, needing to improve current manufacturing performance and to have better information systems.
- Progressive Manufacturing Companies increasing their external focus by placing less importance on manufacturing factors, but more emphasis on customers.
- Companies transitioning from traditional (internal) manufacturing to become progressive manufacturing companies.

Furthermore, if traditional methodology is used with aggregated company data, the gaps are:

1. Planning and involving customers in demand management
2. Intra-organization information systems to coordinate/integrate the entire Supply Chain
3. Employees are trained in supply chain concepts and management
4. Responding to high market fluctuations
5. Vendor managed inventory (VMI) at production sites

Using QFD methodology:

QFD methodology gives the following gaps that meet customer needs:

1. Effective use of Internet to manage Business-to-B commerce
2. Optimizing the supply chain via Efficient Consumer Response (ECR)
3. Radical and successful business process reengineering
4. Eliminating non-value layers (such as wholesalers) in supply chain
5. Responding to high market fluctuations

This list has no resemblance to the previous list above, and it excludes the gaps with the highest performance gap scores. In fact the 3 top gaps are ranked 10, 6, and 9 respectively in table 4-13. These supply chain factors are quite different from the list developed from traditional methodology and summarized in Table 4-14.

Hence the answer to Research Issue 4 is No. The perceived critical gaps (and opportunities) in performance derived from traditional methodology are different from those deployed from customer needs.

Comparison of Conclusion of Research Issue 4 with the theoretical framework developed in Chapter 2

The theoretical framework developed in Chapter 2 from Porter (1985) and the literature review lists strategies that can help achieve competitive advantage. However, the framework does not provide a methodology to select specific supply chain initiatives that can lead to competitive advantage and better business success. Hence both the traditional methodology used to identify the critical gaps and the use of QFD methodology to understand customer needs and their relationship to supply chain factors are useful additions to the literature. In particular, the QFD methodology provides a novel approach to determine critical supply chain gaps, based on customer needs.

5.2 Conclusion about the research topic

The research objective is to: Determine the critical success factors in supply chain management at high technology companies. In fulfilling this objective, the following four research issues were considered:

1. Are there differences between critical supply chain management factors at various high technology companies?
2. Are there differences between critical supply chain management factors at high technology companies and non high technology (or benchmark commodity) companies?
3. Will a focus on external supply chain management factors give better business results?
4. Are perceived critical gaps (and opportunities) in performance derived from traditional methodology similar to those deployed from customer needs?

All four research issues were answered definitively. However, there are several qualitative findings and insights that can be concluded from this research.

Summary of Conclusions

It is possible to conclude that Porter's (1980) generic model of competitive advantage applies to supply chain management. This implies that proper selection of supply chain strategy requires choosing factors that provided differentiation and cost leadership. If the strategy is well selected, it can lead to competitive advantage and business success. Also confirmed is the concept of core competencies by Hamel and Prahalad (1990, 1998), which argues that core competencies are a bundle of skills, that provide access to a wide variety of markets, provided customer benefits, and are difficult to imitate. In particular none of the case study companies are able to emulate Dell Computers strong supply chain performance in high inventory turnover and employee productivity.

The high technology companies selected in this study can be grouped into 2 clusters:

Traditional, 'old style', manufacturing companies and progressive manufacturing companies.

At the traditional manufacturing companies the selection of critical supply chain management factors is internally focused on factors that are manufacturing and quality focused. At the progressive manufacturing companies the selection of critical supply chain management

factors is externally focused on factors that are directed to customers and information systems. These results are very surprising given that the expectation is that high technology companies will use the latest advanced technologies (for example Information Systems and Technology and Customer Relationship Management) to manage their supply chain.

A possible conclusion is that the traditional manufacturing companies are not doing anything different from past historical practices: They have strong focus on internal manufacturing processes and high inventory as an insurance against inventory stock-outs or market fluctuations. Furthermore new ideas and technologies in supply chain management factors are neither understood nor implemented at the traditional manufacturing companies.

On the other hand the progressive manufacturing companies are aggressively pursuing supply chain strategies that connect with customers and provide lower costs – in part this can be attributed to senior management's direction and priorities, based on the way management selected the supply chain categories (or strategies) in the questionnaire.

There are differences between critical supply chain management factors at high technology companies and non-high technology (or benchmark commodity) companies that were selected in this study. The benchmark companies selected supply chain management factors that focus on customer services and quality. This different approach is, possibly, due to the fact that the benchmark companies deal in commodity type products and hence they have to focus on differentiating themselves through strong customer services and quality products.

At the case study companies, an external focus on supply chain management factors gives better business results – two of the case study companies are profitable. Coincidentally, or via good planning, the 2 profitable companies have a strong focus on customer relationship and management. They also have the highest outsourcing strategy. Furthermore, they place a very high importance on the 'Decision Making and Organizational' factors in their approach to supply chain management. This is the opposite stance from the 3 money-losing companies. Moreover, the 2 clusters identified here are also identical with the 2 clusters identified in Research Issue 1, which were Traditional 'old style' manufacturing companies and progressive manufacturing companies. One conclusion is that these companies have made a strategic selection of several high-impact and critical supply chain factors, such as

outsourcing, customer relationship management, managing customer service levels, understanding what sells in the customer channel, and Internet commerce to manage their business better. These factors align well with Porter's (1980) differentiation and cost leadership strategies. Currently the USA and the state of California are going through a painful recession. The companies with an external supply chain focus are doing well, while the companies with an internal focus seem to be handicapped in the current business environment. When the business environment is difficult, an external focus and a low cost strategy seem to give the case-study companies an added advantage.

From the analysis of the gaps and opportunities, it can be concluded that perceived critical gaps in performance derived from traditional methodology are different to those deployed from customer needs. If high technology companies wish to increase customer satisfaction, they have to use the QFD methodology to identify critical supply chain factors. The reason is primarily because traditional methodology emphasizes critical performance gaps with the highest scores, whereas performance gaps derived from customer needs emphasize what the customer wants and that is different from the internal perceptions of a company's managers. The initiatives that provide the greatest opportunity have been identified in this analysis as outsourcing of manufacturing, customer relationship management, information technology and systems. Furthermore, in order to get superior business performance, as measured by inventory turnover and productivity per employee, the companies need to implement radical business process reengineering, and implement the factors specifically identified in the supply chain agility category. These 5 supply chain factors represent the opportunities that will best meet customer's spoken and unspoken needs, and provide supply chain services that meet or exceed customer expectation.

Finally there is a need for better supply chain education as many respondents are unaware of their company's supply chain performance and its relationship to business performance, and hence seem to be disconnected from reality. This is despite the tremendous quantity of research and information about supply chain management available in the literature. One

possible reason could be information overload that high technology managers face and the resulting lack of focus in selecting critical, high impact, supply chain factors.

5.3 Contribution of research findings to the extant literature and theory on supply chain management

The findings from this study are presented in the context of the four Research Questions. This study's main contribution to theory is in the field of supply chain management at high technology companies.

Fills the gaps in the literature

This research helped fill the gaps in the literature on Supply Chain Management in high technology industries. The research identifies the characteristics and behaviors of high technology companies and also of non-high technology (commodity-type) companies. The research findings provide several levels of contribution and these are displayed in Table 5-2. The contributions are described with the following terminology:

- The term 'To some extent' indicates that the findings have been noted in the literature of supply chain management.
- The term 'Limited' indicates that the phenomenon have been noted in the literature, but only in a very limited way, and have not been investigated in detail.
- The term 'No' indicates the topic has not been addressed in the literature.

In Table 5-2, the value of this research is articulated by identifying the levels of contribution and new knowledge obtained from this study. As seen in the table the extant literature on supply chain management does not directly address the focus the high technology companies have in their current practice of supply chain management – however this research does help provide insights to such missing information.

Table 5-2 Contribution of research findings

Research Issue	Information is explicitly available in the literature on supply chain management	Information is explicitly available from the findings of this research study
<p>Research Issue 1: Are there differences between critical supply chain management factors at various high technology companies?</p>	No.	Yes. The analysis is able to identify differences in the selection of critical supply chain management factors at various high technology companies. The behavior and characteristics of high technology companies can be grouped into Traditional, ‘old style’, manufacturing companies and Progressive manufacturing companies. This analysis can help understand the behavior of high technology companies.
<p>Research Issue 2: Are there differences between critical supply chain management factors at high technology companies and non-high technology (or benchmark commodity) companies?</p>	No	Yes. The analysis is able to identify differences in the approach to selection of critical supply chain management factors at high technology companies and non-high technology (benchmark or commodity-type) companies. The commodity companies have a strategy of product differentiation through customer relationship management and quality. This analysis can help recommend the appropriate supply chain management approach for specific companies.
<p>Research Issue 3: Will a focus on external supply chain management factors give better business results?</p>	Information ranges from ‘limited’ to ‘some extent’. Supply chain performance and financial performance data is available for most companies on the Internet. However, it is not possible to correlate performance to a focus on external supply chain management factors.	Yes. Is possible to understand the characteristics and behavior of high technology companies in terms of an internal or external supply chain management focus. It is possible to show that a strategy of differentiation and cost leadership can influence business performance of a company.
<p>Research Issue 4: Are perceived critical gaps (and opportunities) in performance derived from traditional methodology similar to those deployed from customer needs?</p>	No	Yes. It is possible to conclude that QFD methodology, which is driven by customer needs can identify critical gaps that can meet customer needs and increase customer satisfaction.

Source: Developed for this study from Literature Review (Chapter 3), Chapter 4, and Table 5-1.

Specific contributions to theory

There are specific contributions of new knowledge to the field of supply chain management.

1. This research fulfils a request from a high technology company: The author of this study works for a high technology company, head-quartered in California USA, and was requested to investigate the company's (business unit) supply chain system and propose improvements to help make it more competitive.
2. This is the first research that investigates how high technology companies implement supply chain management. In this research, 2 clusters of company behavior and characteristics are identified: Traditional, 'old style', manufacturing companies and Progressive manufacturing companies. Each cluster behaves differently, and this has an influence on how the companies select critical supply chain management factors. Hence, this study contributes to the understanding of how high technology companies scope, design, and develop their supply chain management (SCM) System.
3. This research helps to identify critical supply chain management factors in the very complex and vast area of supply chain management. The field of supply chain management is very broad and there are many choices to be made. This study helps to select the appropriate critical supply chain factors that best meet a company's business objectives. For example, high technology companies will need to focus on different critical supply chain management factors than companies dealing in commodities. Furthermore the study identifies the critical supply chain management factors that can help improve a company's business performance.
4. This research goes beyond the work of Martilla and James (1977) and links critical performance gaps to customer requirements by using the quality function deployment (QFD) methodology. The resultant analysis is very different from the traditional methodology of determining critical gaps, and allows performance gaps to be analyzed and understood from the viewpoint of customers of high technology companies. This technique will allow the selection of those critical gaps that best meet customer needs and hence improve customer satisfaction.

Linking theory to practice

This research strongly supports Porter's (1980) posit of competitive advantage, which argues for a strategy of differentiation and cost leadership to achieve business success. By linking

theory to practice, the study identifies the critical supply chain factors that best help provide the differentiation and cost leadership.

Also confirmed is the concept of core competencies by Hamel and Prahalad (1990, 1998), which affirms that core competencies are a bundle of skills, that provides access to a wide variety of markets, provides customer benefits, and are difficult to imitate. The study confirms that none of the case study companies have emulated the success in supply chain management of an acknowledged leader.

5.4 Implications for practice

Based on the research findings, below is the summary of the suggestions to senior management at high technology companies on how they can enhance the efficiency and effectiveness of their supply chain management program:

1. There is a need for better supply chain education, as many employees may be unaware of their company's supply chain performance and its relationship to business performance. This education is necessary, despite the tremendous quantity of research and information about supply chain management available in the literature. One reason is the information overload that high technology managers face and hence they may lack the opportunity to assimilate and understand critical, high impact, supply chain factors.
2. Management needs to select strategies that focus on differentiation and cost leadership to achieve competitive advantage and business success. In the area of supply chain management, there are critical supply chain factors that support such strategies, and these are the priorities that management must focus upon. In this study, the appropriate critical supply chain factors have been identified and can serve as the first step for management to review and improve their company's strategies.
3. Management needs to analyse and understand their perceived critical gaps (and opportunities) in performance. After that they need to link these gaps to customer requirements using quality function deployment (QFD) methodology. The resultant analysis will allow critical performance gaps to be analyzed and understood from the viewpoint of customers of high technology companies. This technique will allow the selection of those critical gaps that best meet customer needs and hence improve customer satisfaction.

5.5 Limitations

The most significant weakness of this study can be attributed to the chosen case study research methodology. Yin (1994) cites several known limitations and criticisms of the case study research methodology. These include the lack of generalization, perceived lack of rigor, subjectivity, and voluminous documents. This study is an exploratory case study with a limited sample size. Therefore, the findings cannot be generalized beyond the context of this study. As an exploratory study, the goal of this research effort is to seek greater understanding that can lead to building a foundation for more extensive research in the future.

Another limitation of this study relates to the use of a fixed, inflexible, structured questionnaire, with verbal feedback for critical areas. Although a very systematic process is used for data collection and analysis to enhance the reliability and validity of the study, it may not have captured other data that is significant.

In brief, these two aspects do not represent severe limitations for the research. Nevertheless, the next section discusses the direction for further research.

5.6 Directions for future research

This research employs the case study methodology that relies primarily on an inductive approach to obtain data for analytical generalization rather than statistical generalization. Thus, the focus of this research is theory building and analytical generalization. It is recommended that further research should test this theory using a larger sample and use a more quantitative research method for the purpose of statistical generalization. After all, qualitative and quantitative methods are complementary to each other and enhance investigation findings (Zikmund 1997).

In this research, only high technology companies in California, USA, have been studied. Future research can extend research into different geographical areas. With globalization creating a borderless marketplace today, research about company behavior in countries in

Europe, Asia, and the USA could lead to potential consolidation of company supply chain strategies providing global competitive advantage.

Future research can also try to understand if there are different behavior and characteristics of companies, such as traditional and progressive manufacturing companies. If the difference can be confirmed, it can lead to recommended strategies on how companies can improve performance. Most importantly, future research can try to understand if specific critical supply chain factors can contribute to competitive advantage and business success.

There is also scope for research to be done on industries that were not investigated in this study, for example consumer or automobile companies. Comparison can then be made between the various industries to understand if critical success factors are similar or different across industries and countries. Such learning can help various industries develop supply chain strategies that lead to competitive advantage and business success.

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Appendix A1- Questionnaire: content, design, and structure

Content of the questionnaire

The content of the structure was prepared by combining the following tables:

- Table 3.22 (Process to structure questionnaire in relation to the research objective)
- Table 2.2 (Supply Chain Categories, Factors, and their Benefits)

The combination is shown in below in Table A1-1, from which the questionnaire was designed.

Questionnaire Design:

The questionnaire is designed using the approach of Watson and Frolick (1992) for structuring interviews with executives. In this approach the respondents are requested to rate both the importance and perceived performance of each factor. Such an approach allows measurement of gaps between expectations and importance and perceived performance. The final questionnaire has 12 categories, with 58 questions, that are graded for importance and performance on a Likert scale. In addition, there is one question on competitiveness rated on a Likert scale; and one question requiring a forced ranking, from 1 (most important) to 6 (least important), of supply chain categories.

The detailed structure of the questionnaire is discussed next:

Table A1-1: Preparation of Supply Chain Management questionnaire

	Categories	Factors	Potential Questions
1	Logistics (Transportation only)	<ul style="list-style-type: none"> • Inbound transportation into company • Outbound transportation to customers • Company wide logistics coordination and management 	<ul style="list-style-type: none"> • A centrally coordinated shipping function to provide fastest delivery at lowest costs • Company-wide logistics contracts for best pricing and service • Provide logistics at lowest cost
2	Purchasing or Procurement	<ul style="list-style-type: none"> • Strategic sourcing and centralized purchasing • Consolidate supplier base • Collaborative bidding 	<ul style="list-style-type: none"> • Partnership with suppliers • Reduce number of suppliers • Just-in-time delivery • Company wide purchasing contracts for best pricing
3	Inventory management	<ul style="list-style-type: none"> • Inventory management and reduction 	<ul style="list-style-type: none"> • Company-wide coordination and management of inventory • Just-in-time (JIT) deliveries • Vendor managed inventory (VMI) • Lowest inventory driven costs • Regional distribution centers • Automated warehouse management systems
4	Manufacturing techniques, mass customization, and quality	<ul style="list-style-type: none"> • Lean manufacturing • Late product differentiation and customization • Outsourcing of non-core activities 	<ul style="list-style-type: none"> • Effective use of CAD,CAE,and CAM systems • Effective use of ERP and MRP systems • Responsiveness to meet engineering changes • JIT (Just-in-time) manufacturing • Product customization to meet customer needs • Outsourcing of manufacturing and other supply chain activities • Product design for environmental needs • Zero-defect manufacturing. • Company wide quality programs • Superior product quality
5	Planning, partnership, and collaboration	<ul style="list-style-type: none"> • Collaborative planning • Demand generation (of products) 	<ul style="list-style-type: none"> • Planning and involving customers in demand management • Information sharing with supply chain partners • Sell-through information from distributors, partners, and retailers
6	Customer Relationship Management (CRM)	<ul style="list-style-type: none"> • Management of technology, processes, information, and people 	<ul style="list-style-type: none"> • Monitoring and measuring customer service level • Effective management of customer complaints • A process to manage customer dissatisfaction returns • A 360-degree view of the customer needs and preferences • Effective use of multiple (media) channels

7	Information systems and technology: (The Internet enabled supply chain, and order management)	<ul style="list-style-type: none"> • Electronic order management • I. T. systems to link the supply chain • Efficient Consumer Response (ECR) • Internet as the basic engine for e-commerce • Rebuilding the supply chain • Supply Chain Management information systems • Dis-inter-mediation and simplification of the supply chain 	<ul style="list-style-type: none"> • Effective use of Business-to-Business/consumer commerce • Collaboration and bidding via the supply chain • Inter-organizational information coordination and sharing • Intra-organizational information coordination and sharing • Optimizing the supply chain via ECR (Efficient Consumer Response) • Eliminating non-value layers in the supply chain
8	Advanced Supply Chain Strategies	<ul style="list-style-type: none"> • The agile supply chain • The E-supply chain • The virtual supply chain • The holonic SCM System 	<ul style="list-style-type: none"> • Radical and continuous business process reengineering • Responding to unexpected demand from customers • Responding to high market fluctuations
9	Improving Supply Chain Performance	<ul style="list-style-type: none"> • Metrics to track key elements of supply chain performance • SCOR (Supply Chain Operations Reference) model • Competitive benchmarking process 	<ul style="list-style-type: none"> • Deliveries in full and on time to customers • Customers are very satisfied with supply chain performance • Supply chain performance is improving • Cycle times from supplier to customer delivery are low • Supply chain cost is low compared to competitors • Supply chain performance contributes to cash flow
10	Decision making and organizational factors that impact supply chain management	<ul style="list-style-type: none"> • Importance and performance of management and organizational issues. • Employee involvement and performance in supply chain management 	<ul style="list-style-type: none"> • Top management commitment • Employees trained in supply chain concepts and management • Employees involved in supply chain management • Teamwork and inter-organizational coordination Employee morale • Employee productivity • Quick resolution of industrial disputes • High utilization of employee skills and abilities • Concept of internal customers
11	Competitive position and ranking of supply chain factors	<ul style="list-style-type: none"> • Competitive measurement and ranking of factors 	<ul style="list-style-type: none"> • Measure competitiveness • Rank supply chain factors

Source: Developed for this study from Table 2-2 (Chapter 2) and Table 3-1

Structure of questionnaire

The overall structure of the categories and questions is as follows: There were 12 categories. Referring to Chapter 3, the categories are:

1. Logistics (Transportation only)
2. Procurement
3. Inventory management
4. Manufacturing and advanced manufacturing
5. Manufacturing -quality
6. Partnership and collaboration
7. Customer Relationship Management (CRM)
8. Information systems and technology:
9. Supply chain agility
10. Decision making and organizational factors
11. Performance – employee performance
12. Performance - supply chain performance

Within the 12 categories, there are 58 questions with supply chain **factors**, that that are graded for importance and perceived performance by the respondents.

Question number 59 requires the respondents to rate their company's competitiveness. Finally, *question number 60* requires the respondents to force rank 9 of the supply chain categories, from 1 (most important) to 6 (least important).

The mean value of the Likert rating scale is the popular usage indicator for measuring a factor importance. The higher the mean value, the more important the factor. For each question, the respondents are provided with a 5 point Likert scale. Negatively worded items are not used - only a positive format is used because some studies (Parasuraman, Zeithmal, and Berry, 1991) have discovered that negatively worded items can result in confusion for respondents. The finalized questionnaire is attached on the next page.

Section 2: Supply Chain Management Questionnaire - Importance & Perceived Performance of Factors											
	Column 1 Importance					Column 2 Performance					
	Little	Some	Average	High	Extreme	Poor	Fair	Good	Very Good	Excellent	Not Applicable
Note: In Column 1 , please rate the importance of each factor from your perceptions, with an X in the appropriate column. In Column 2 , please rate the actual performance of each factor in your organization, with an X, in the appropriate column.											
Logistics											
1. A centrally coordinated logistics function											
2. Provide on-time delivery to customers											
3. Provide logistics at lowest cost											
4. Company-wide logistics (outsourcing) contracts											
Procurement:											
5. Partnership with suppliers											
6. Focus on reducing the number of suppliers											
7. Just-in-time (JIT) delivery											
8. Company-wide purchasing contracts for best pricing											
Inventory Management											
9. Company-wide coordination and management of inventory											
10. Just-in-time (JIT) delivery											
11. Vendor managed inventory (VMI) at production sites											
12. Lowest inventory driven costs											
13. Regional distribution centers for product distribution											
14. Automated warehouse management systems (automatic storage and retrieval systems)											
Manufacturing - Advanced Manufacturing											
15. Effective use of CAD, CAE, & CAM Systems											
16. Effective use of ERP & MRP systems											
17. Responsiveness to meet engineering changes											
18. JIT (Just In Time) manufacturing											
19. Product customization or postponement to meet customer needs											
20. Outsourcing of non-core manufacturing activities											
21. Product design for environmental & recycling needs											
Manufacturing - Quality											
22. Zero-defect manufacturing or use of 6-Sigma concepts											
23. Company-wide quality program											
24. Superior product quality compared to competitors											

Section 2: Supply Chain Management Questionnaire - Importance & Perceived Performance of Factors											
	Column 1 Importance					Column 2 Performance					
	Little	Some	Average	High	Extreme	Poor	Fair	Good	Very Good	Excellent	Not Applicable
Note: In Column 1 , please rate the importance of each factor from your perceptions, with an X in the appropriate column. In Column 2 , please rate the actual performance of each factor in your organization, with an X, in the appropriate column.											
<i>Partnership & Collaboration</i>											
25. Sell-through information (point of sales data) from distributors, partners, & retailers											
26. Planning and involving customers in demand management											
27. Information sharing with supply-chain partners											
<i>Customer Relationship Management</i>											
28. Monitoring and measuring customer service level											
29. Effective management of customer complaints											
30. A process to manage customer dissatisfaction returns											
31. A 360-degree view of customer needs & preferences											
32. Effective use of multiple-media to manage customer relationships											
<i>Information Systems & Technology</i>											
33. Effective use of Internet to manage Business-to-Business commerce											
34. Effective use of Internet to manage Business-to-Consumer commerce											
35. Collaboration and bidding for parts & commodities via the Internet											
36. Inter-organizational information coordination & sharing											
37. Intra-organization information systems to coordinate & integrate the entire supply-chain											
38. Optimizing the supply chain via Efficient Consumer Response (ECR) system											
39. Eliminating non-value layers (such as wholesalers) in the supply chain											
<i>Supply Chain Agility</i>											
40. Radical and successful business process reengineering											
41. Responding to unexpected demand from customers											
42. Responding to high market fluctuations											

Section 2: Supply Chain Management Questionnaire - Importance & Perceived Performance of Factors											
	Column 1 Importance						Column 2 Performance				
	Little	Some	Average	High	Extreme		Poor	Fair	Good	Very Good	Excellent
Note: In Column 1 , please rate the importance of each factor from your perceptions, with an X in the appropriate column. In Column 2 , please rate the actual performance of each factor in your organization, with an X, in the appropriate column.											
<i>Decision Making & Organization Factors</i>											
43. Top management commitment											
44. Employees are trained in supply chain concepts & management											
45. Employees are empowered to make decisions and changes											
46. Employees are involved in supply chain management											
47. Teamwork and inter-organizational coordination											
<i>Performance - Employee Performance</i>											
48. There is high employee morale											
49. There is high employee productivity											
50. Quick resolution of industrial disputes											
51. High utilization of employee's skills and abilities											
52. The concept of internal customers is widely understood											
<i>Performance - Supply Chain Performance</i>											
53. Deliveries in full and on time to customers											
54. Customers are very satisfied with our supply chain capabilities											
55. Supply chain performance is continuously improving											
56. Cycle times from supplier to customer delivery are excellent (low)											
57. Supply chain cost is low compared to competitors											
58. Supply chain performance contributes to cash-flow											
<i>Competitiveness</i>											
59. The contribution to our competitiveness from supply chain management is, on a scale of 1 to 5, with 1 being lowest and 5 being highest (Please select one number, by circling or mark with X): Not Competitive 1 2 3 4 5 Very Competitive											

Section 2: Supply Chain Management Questionnaire - Importance & Perceived Performance of Factors

	Column 1 Importance						Column 2 Performance						
Note: In Column 1 , please rate the importance of each factor from your perceptions, with an X in the appropriate column. In Column 2 , please rate the actual performance of each factor in your organization, with an X, in the appropriate column.	Little	Some	Average	High	Extreme		Poor	Fair	Good	Very Good	Excellent	Not	Applicable
60. Our ranking of the top 6 key supply chain factors (please mark with rank from 1 to 6) ___ Logistics ___ Procurement ___ Inventory Management ___ Manufacturing ___ Partnership & Collaboration ___ Customer Relationship Management ___ Information Systems & Technology ___ Supply Chain Agility ___ Decision Making & Organization Factors													

Appendix A2 Field Package for high technology companies

Consisting of:

- **Letter of introduction**
- **Objectives of research study**
- **List of definitions**
- **Instructions to complete the questionnaire**
- **Questionnaire**



8 December 2002

Dear

Many thanks for agreeing to help and work with me to complete my research study with the University of Southern Queensland (USQ). For your information, USQ was voted the top Australian University by the Australian Parliament in 2000. I am really looking forward to your inputs to my questionnaire.

My research is via a multiple-case study to understand the *success factors in supply chain management at high technology companies*.

A copy of the questionnaire is attached. I will be calling you to plan for a face-to face meeting, when we can discuss and complete the questionnaire. After completing the questionnaire, I may call you to supplement my investigation with any relevant or related information that you may agree to give to me. Hence, your assistance in helping to provide me with additional information will be greatly appreciated.

I would like to assure you that I will treat all data as confidential, including the name of your company, the individuals participating in the questionnaire, and any proprietary information. All data will be reported in aggregate only. If details of the company are given in the case study, it will be done only after you provide approval.

Thank you very much for agreeing to participate in my study.

With best regards,

Soin Singh

Section 1:

Objective: Multiple case-study research on

'The success factors in supply chain management at high technology companies.'

There are some definitions that you might find useful while answering the questionnaire:

- *Logistics:* The management and movement of product and services. This includes storage and warehousing of products, and their transport via air, land, and water.
- *Supply Chain:* All the necessary activities required for creating and delivering products and services to customers.
- *Supply Chain Management:* The management of upstream and downstream activities, resources, and relationships with suppliers and customers that is required to deliver products or services.

Completing the attached questionnaire

I will plan for a face-to-face meeting with you to discuss and complete the questionnaire. In the attached questionnaire, for each factor, you will be asked to rate the importance of each factor from your perceptions. You will also be asked to rate the perceived performance of each factor in your organization. *It will take about 45 minutes to discuss and complete the questionnaire.*

You can either print out the questionnaire and mark your responses with a pen during our discussions, or complete it electronically in the MS Word File.

About the interview participant (general information)

- What is your current title in your company? _____

- Briefly describe your current job responsibilities? _____

Section 2: Supply Chain Management Questionnaire - Importance & Actual Performance of Factors											
	Column 1 Importance					Column 2 Performance					
	Little	Some	Average	High	Extreme	Poor	Fair	Good	Very Good	Excellent	Not Applicable
Note:											
In Column 1 , please rate the importance of each factor from your perceptions, with an X in the appropriate column.											
In Column 2 , please rate the actual performance of each factor in your organization, with an X, in the appropriate column.											
Logistics											
1. A centrally coordinated logistics function											
2. Provide on-time delivery to customers											
3. Provide logistics at lowest cost											
4. Company-wide logistics (outsourcing) contracts											
Procurement:											
5. Partnership with suppliers											
6. Focus on reducing the number of suppliers											
7. Just-in-time (JIT) delivery											
8. Company-wide purchasing contracts for best pricing											
Inventory Management											
9. Company-wide coordination and management of inventory											
10. Just-in-time (JIT) delivery											
11. Vendor managed inventory (VMI) at production sites											
12. Lowest inventory driven costs											
13. Regional distribution centers for product distribution											
14. Automated warehouse management systems (automatic storage and retrieval systems)											
Manufacturing - Advanced Manufacturing											
15. Effective use of CAD, CAE, & CAM Systems											
16. Effective use of ERP & MRP systems											
17. Responsiveness to meet engineering changes											
18. JIT (Just In Time) manufacturing											
19. Product customization or postponement to meet customer needs											
20. Outsourcing of non-core manufacturing activities											
21. Product design for environmental & recycling needs											
Manufacturing - Quality											
22. Zero-defect manufacturing or use of 6-Sigma concepts											
23. Company-wide quality program											
24. Superior product quality compared to competitors											

Section 2: Supply Chain Management Questionnaire - Importance & Actual Performance of Factors											
	Column 1 Importance					Column 2 Performance					
	Little	Some	Average	High	Extreme	Poor	Fair	Good	Very Good	Excellent	Not Applicable
Note: In Column 1 , please rate the importance of each factor from your perceptions, with an X in the appropriate column. In Column 2 , please rate the actual performance of each factor in your organization, with an X, in the appropriate column.											
Partnership & Collaboration											
25. Sell-through information (point of sales data) from distributors, partners, & retailers											
26. Planning and involving customers in demand management											
27. Information sharing with supply-chain partners											
Customer Relationship Management											
28. Monitoring and measuring customer service level											
29. Effective management of customer complaints											
30. A process to manage customer dissatisfaction returns											
31. A 360-degree view of customer needs & preferences											
32. Effective use of multiple-media to manage customer relationships											
Information Systems & Technology											
33. Effective use of Internet to manage Business-to-Business commerce											
34. Effective use of Internet to manage Business-to-Consumer commerce											
35. Collaboration and bidding for parts & commodities via the Internet											
36. Inter-organizational information coordination & sharing											
37. Intra-organization information systems to coordinate & integrate the entire supply-chain											
38. Optimizing the supply chain via Efficient Consumer Response (ECR) system											
39. Eliminating non-value layers (such as wholesalers) in the supply chain											
Supply Chain Agility											
40. Radical and successful business process reengineering											
41. Responding to unexpected demand from customers											
42. Responding to high market fluctuations											

Section 2: Supply Chain Management Questionnaire - Importance & Actual Performance of Factors											
	Column 1 Importance					Column 2 Performance					
	Little	Some	Average	High	Extreme	Poor	Fair	Good	Very Good	Excellent	Not Applicable
Note: In Column 1 , please rate the importance of each factor from your perceptions, with an X in the appropriate column. In Column 2 , please rate the actual performance of each factor in your organization, with an X, in the appropriate column.											
Decision Making & Organization Factors											
43. Top management commitment											
44. Employees are trained in supply chain concepts & management											
45. Employees are empowered to make decisions and changes											
46. Employees are involved in supply chain management											
47. Teamwork and inter-organizational coordination											
Performance - Employee Performance											
48. There is high employee morale											
49. There is high employee productivity											
50. Quick resolution of industrial disputes											
51. High utilization of employee's skills and abilities											
52. The concept of internal customers is widely understood											
Performance - Supply Chain Performance											
53. Deliveries in full and on time to customers											
54. Customers are very satisfied with our supply chain capabilities											
55. Supply chain performance is continuously improving											
56. Cycle times from supplier to customer delivery are excellent (low)											
57. Supply chain cost is low compared to competitors											
58. Supply chain performance contributes to cash-flow											
Competitiveness											
59. The contribution to our competitiveness from supply chain management is, on a scale of 1 to 5, with 1 being lowest and 5 being highest (Please select one number, by circling or mark with X):											
<p style="text-align: center;"> Not Competitive 1 2 3 4 5 Very Competitive </p>											

Section 2: Supply Chain Management Questionnaire - Importance & Actual Performance of Factors

	Column 1 Importance					Column 2 Performance						
Note: In Column 1 , please rate the importance of each factor from your perceptions, with an X in the appropriate column. In Column 2 , please rate the actual performance of each factor in your organization, with an X, in the appropriate column.	Little	Some	Average	High	Extreme	Poor	Fair	Good	Very Good	Excellent	Not	Applicable
60. Our ranking of the top 6 key supply chain factors (please mark with rank from 1 to 6) <ul style="list-style-type: none"> ___ Logistics ___ Procurement ___ Inventory Management ___ Manufacturing ___ Partnership & Collaboration ___ Customer Relationship Management ___ Information Systems & Technology ___ Supply Chain Agility ___ Decision Making & Organization Factors 												

Appendix A3 Field Package for benchmark companies

Consisting of:

- **Letter of introduction**
- **Objectives of research study**
- **List of definitions**
- **Instructions to complete the questionnaire**
- **Questionnaire –same as in Appendix, A2. Hence not attached.**



25 May 2003

Dear

Greetings.

This is a request from a student member of the Council of Logistics Management to help me to complete my research study. After completing my research and dissertation I hope to move into the teaching profession at a University to train the next generation of Logistics and Supply Chain Experts.

My research is via a multiple-case study to understand the *success factors in supply chain management at high technology companies in California*. As part of the study, I am doing a benchmark of a few US manufacturing companies – this is where I need your help.

I trust you can spare a few minutes of your valuable time to discuss and complete the attached questionnaire for my dissertation with the University of Southern Queensland (USQ). For your information, USQ was voted the top Australian University by the Australian Parliament in 2000.

A copy of the questionnaire is attached. I will be calling you to plan for a face-to face meeting, or a to set up a phone discussion, so that we can discuss and complete the questionnaire. After completing the questionnaire, I may call you to supplement my investigation with any relevant or related information that you may agree to give to me. Hence, your assistance in helping to provide me with additional information will be greatly appreciated.

I would like to assure you that I will treat all data as confidential, including the name of your company, the individuals participating in the questionnaire, and any proprietary information. All data will be reported in aggregate only. If details of the company are given in the case study, it will be done only after you provide approval.

Thank you very much for agreeing to participate in my study.
With best regards,

Soin Singh

Section 1:

Objective: Multiple case-study research on

‘The success factors in supply chain management at high technology companies.’

There are some definitions that you might find useful while answering the questionnaire:

- *Logistics*: The management and movement of product and services. This includes storage and warehousing of products, and their transport via air, land, and water.
- *Supply Chain*: All the necessary activities required for creating and delivering products and services to customers.
- *Supply Chain Management*: The management of upstream and downstream activities, resources, and relationships with suppliers and customers that is required to deliver products or services.

Completing the attached questionnaire

I will plan for a face-to-face meeting with you to discuss and complete the questionnaire. In the attached questionnaire, for each factor, you will be asked to rate the importance of each factor from your perceptions. You will also be asked to rate the perceived performance of each factor in your organization. *It will take about 45 minutes to discuss and complete the questionnaire.*

You can either print out the questionnaire and mark your responses with a pen during our discussions, or complete it electronically in the MS Word File.

About the interview participant (general information)

- What is your current title in your company? _____

- Briefly describe your current job responsibilities? _____

Appendix A4- Sources of data for this research

The table below summarizes the sources of data for this research

Table A4-1: Summary of data sources for case study research

Category	Document type	Company						
		X	H	A	P	C	J, K, L, M	Other
1. Company information	Annual report and company web-site	!	!	!	!	!		
2. Primary sources for case study companies	Questionnaire in Appendix A1 and verbal discussions and interviews with respondents. Also interviews with other company staff to get specific information relating to gaps in questionnaire.	!	!	!	!	!		
3. Benchmark data from non-high technology companies	Obtained via the questionnaire in appendix A1.						!	
4. Secondary sources	Articles in trade press, research literature, and Internet Web-sites	!	!	!	!	!	!	
5. Customer needs information	Customer rating table showing supply chain factors with target expectations and measured performance from 4 high-technology companies							See Note 3
6. Customer needs information	Survey of 26 customers giving priorities of supply chain factors							See Note 4
<p>Notes:</p> <ol style="list-style-type: none"> 1. Companies X, H, A, P, and C are the 5 case study companies 2. Companies J, K, L, M are the non-high technology (benchmark) companies 3. Customer needs (of several high technology vendors) obtained from a customer of one case study company 4. Customer needs data obtained in a survey, from 28 customers of one of the case study companies. Each of these 28 customers buy products from 5-10 high technology companies – 2 of which are case study companies 								

Source: Developed for this study

Appendix A5: Gaps between Importance and Performance of Supply Chain Factors for High Technology Companies

The detailed numerical performance gaps for each of the high technology companies are shown here. Only the top 6 gaps are shown. If there is a tie for 6th place, additional gaps are listed.

Table A5-1 Gaps between Importance and Performance of supply chain factors for Company X

Supply chain factor	Gap
37. Intra-organization information systems to coordinate/integrate the entire Supply Chain	2.33
38. Optimizing the supply chain via Efficient Consumer Response (ECR)	2.17
35. Collaboration and bidding for parts and commodities via the Internet	1.83
21. Product design for environmental and recycling needs	1.67
24. Superior product quality compared to competitors	1.67
40. Radical and successful business process reengineering	1.67

Note 1: Question numbers correspond to questionnaire in Appendix 1

Note 2: Only the factors with the 6 highest gaps are shown (out of 52 factors)

Source: Developed for this study from data obtained from questionnaire in App. 1

Table A5-2 Gaps between Importance and Performance of supply chain factors for Company H

Supply chain factor	Gap
26. Planning and involving customers in demand management	2.25
39. Eliminating non-value layers (such as wholesalers) in supply chain	2.25
44. Employees are trained in supply chain concepts and management	2.25
30. A process to manage customer dissatisfaction returns	2.00
25. Sell-through information (point of sales data) from distributors/partners	2.00
36. Inter-organizational information coordination and sharing	2.00

Note 1: Question numbers correspond to questionnaire in Appendix 1

Note 2: Only the factors with the 6 highest gaps are shown (out of 52 factors)

Source: Developed for this study from data obtained from questionnaire in App. 1

Table A5-3 Gaps between Importance and Performance of supply chain factors for Company A

Supply chain factor	Gap
26. Planning and involving customers in demand management	2.00
42. Responding to high market fluctuations	2.00
22. Zero-defect manufacturing or use of 6-Sigma concepts	1.83
2. Provide on-time delivery to customers	1.75
16. Effective use of ERP and MRP systems	1.75
34. Effective use of Internet to manage Business-to-Consumer commerce	1.75

Note 1: Question numbers correspond to questionnaire in Appendix 1

Note 2: Only the factors with the 6 highest gaps are shown (out of 52 factors)

Source: Developed for this study from data obtained from questionnaire in App. 1

Table A5-4 Gaps between Importance and Performance of supply chain factors for Company P

Supply chain factor	Gap
33. Effective use of Internet to manage Business-to-B commerce	3.00
40. Radical and successful business process reengineering	3.00
42. Responding to high market fluctuations	2.67
38. Optimizing the supply chain via Efficient Consumer Response (ECR)	2.50
5. Partnership with suppliers	2.33
24. Superior product quality compared to competitors	2.33
26. Planning and involving customers in demand management	2.33
27. Information sharing with supply-chain partners	2.33
44. Employees are trained in supply chain concepts and management	2.33
52. The concept of internal customers is widely understood	2.33

Note 1: Question numbers correspond to questionnaire in Appendix 1

Note 2: Only the factors with the 6 highest gaps are shown (out of 52 factors). In this case there is a tie between item number 5 all the way down to item number 10

Source: Developed for this study from data obtained from questionnaire in App. 1

Table A5-5 Gaps between Importance and Performance of supply chain factors for Company C

Supply chain factor	Gap
7. Just-in-time (JIT) delivery from suppliers	0.61
9. Company-wide coordination and management of inventory	0.60
2. Provide on-time delivery to customers	0.58
3. Provide logistics at lowest cost	0.58
4. Company-wide logistics (outsourcing) contracts	0.57
36. Inter-organizational information coordination and sharing	0.57

Note 1: Question numbers correspond to questionnaire in Appendix 1

Note 2: Only the factors with the 6 highest gaps are shown (out of 52 factors)

Source: Developed for this study from data obtained from questionnaire in App. 1

APPENDIX A6 Preparation of QFD Table

Quality Function Deployment (QFD) is a process initially developed in Japan for incorporating the customer's voice, or real needs, into product design (Akao, 1990). The result of this process is a better designed product, with better sales and higher customer satisfaction.

The QFD table is prepared using guidelines suggested by Akao(1990). In preparing the QFD Table, the following 5 steps are required:

1. The WHAT's or customer's voice or needs and the importance of these needs.
2. The HOW's or important supply chain factors that would meet customer needs
3. The process to construct the QFD table
4. Interpretation of the information provided by the completed QFD table
5. Select important How's or critical supply chain factors that will improve performance to customers

1. The WHAT's or customer's voice or needs

The customer's voice or needs were developed from three separate independent sources. *These three sources identified customer needs for services or more specifically for supply chain management.* These sources are:

- A Supplier Rating Table from a customer of one case study company
- Customer needs data (used to prepare a business plan) from one case study company.

Customer Needs from a Supplier Rating Table

This table was provided to this researcher during the interviews with one of the respondents. It lists the key parameters used to monitor and measure performance of its suppliers, which are 3 high technology companies. It also lists importance of each parameter. These scores are used to rate the importance of the customer needs in the QFD Table.

In the supplier rating table there are 21 items covering before sales, during sales, and after sales items. Out of the 21 items, 9 are deemed as relevant needs for supply chain management for customers of the high technology companies. The irrelevant, or deleted, items include human resource items such as: flexibility, ability to listen, managing service contracts, skill-sets of after sales staff. The items, or customer needs, are listed with a rated score on a scale of 1-5. The customer needs are displayed in Table A6-1.

Table A6-1 Customer Needs from a Supplier Rating Table

Customer Needs	Rating on a 5 point scale
Product quality	5.0
Complete and accurate delivery	4.5
Quotation and price accuracy	4.5
Speed of (communication and solutions) during after sales support	4.5
Product installation quality/product received in good condition	4.0
Price of product	4.0
Fast acknowledgement of orders	3.5
Invoicing timeliness	3.5
Proactive after sales support	3.5

Source: Supplier rating table provided by a customer of high technology companies

Customer Needs Data

This customer needs data was provided to this researcher from one respondent during case study discussions. The respondent obtained the information from customer discussions during preparation of the annual business plan for a distribution operation of a case study high technology company. The data is aggregated from inputs from 28 customer companies in the annual plan. In the annual plan, there are 5 customer needs that have been identified as critical needs for supply chain management. *According to the respondent, his company had short-listed these 5 items from a much longer list during various customer meetings held over several years.* The items are listed with a rated score on a scale of 1-5 and are displayed in Table A6-2.

Table A6-2 Customer Needs from an Annual Business Plan

Customer Need	Rating on a 5 point scale
On time delivery - ability to stick to delivery commitment	4.8
Delivery Turn-Around-Time (TAT) – overall order to deliver time	4.7
Ease of Returns – the process of returning product defects and end-of-life products that were replaced by new products, etc.	4.7
Product received in good condition	4.6
Ease of ordering and effective communications during the order fulfillment cycle	4.5

Summary and aggregation of customer needs

The data from Tables A6-1 and A6-2 was summarized and aggregated in Table A6-3, below.

Table A6-3 Summary of Customer Needs

Customer Needs	Rating on a 5 point scale
Product quality	5.0
On time delivery - ability to stick to delivery commitment	4.8
Delivery Turn-Around-Time (TAT) – overall order to deliver time	4.7
Ease of ordering and effective communications during the order fulfillment cycle	4.5
Complete and accurate delivery	4.5
Quotation and price accuracy	4.5
Speed of (communication and solutions) during after sales support	4.5
Product installation quality/product received in good condition	4.3
Price of product and delivery	4.0
Fast acknowledgement of orders	3.5
Invoicing timeliness	3.5
Proactive after sales support	3.5
Ease of Returns – the process of returning product defects and end-of-life products that were replaced by new products, etc.	4.7

Note: The scores were aggregated for similar items in Tables A5-1 and 2.

Source: Developed from Tables A5-1 and A5-2.

2. The HOW's or important supply chain factors that would meet customer needs

In the survey questionnaire, there are 52 questions (out of a total of 59) that pertain to supply chain factors, that would have specific influence on supply chain management. The remaining 7 factors, that are excluded, are supply chain performance metrics. The list of 52 supply chain management factors is coded as questions 1 through 52 in the questionnaire (refer to appendix A1).

Furthermore, for this gap analysis, two factors relating to employee morale and teamwork have been discarded, as they were considered generic to all business activity. *The gaps are computed by subtracting perceived performance averages from the importance averages.* The factors with the 12 highest *gaps between* the importance and performance ratings are selected for this analysis. For this computation, the aggregate data from all the case study companies is used.

The top 12 or highest gaps are listed in Table A6-4, below. The reason for selecting 12 gaps instead of less is to allow the QFD methodology to determine which gaps are critical to customer needs. This is a more objective process than arbitrarily coming up with a shorter and more manageable list of gaps.

Table A6-4 Supply chain factors with the 12 largest gaps

Supply chain factor	Value of gap	Comment
26. Planning and involving customers in demand management	1.82	
37. Intra-organization information systems to coordinate/integrate the entire S Chain	1.71	
44. Employees are trained in supply chain concepts and management	1.59	
42. Responding to high market fluctuations	1.53	
11. Vendor managed inventory (VMI) at production sites	1.50	
38. Optimizing the supply chain via Efficient Consumer Response (ECR)	1.47	
36. Inter-organizational information coordination and sharing	1.41	
39. Eliminating non-value layers (such as wholesalers) in supply chain	1.40	
40. Radical and successful business process reengineering	1.29	
48. There is high employee morale	1.29	Discard
47. Teamwork and inter-organizational coordination	1.25	Discard
33. Effective use of Internet to manage Business-to-B commerce	1.24	
10. Just-in-time (JIT) delivery to customers	1.24	
12. Lowest inventory driven costs	1.24	

Note 1: Gaps are computed from Importance minus Performance scores

Note 2: The data is aggregate for all 5 case study companies

Note 3: Question numbers correspond to questionnaire in Appendix 1

Note 4: Only the factors with the 12 highest gaps are shown (out of 52 factors). Factors, whose gap score tied with 12th factor are included

Note 5: Two factors relating to employee morale and teamwork were discarded, as they are considered generic to all business activity.

Source: Developed for this study from questionnaire in Appendix 1

3. The process to construct the QFD table

A QFD relationship table or house of quality was prepared based on the model from Akao, 1990. Refer to Figure A6-1, below, which shows the structure of the QFD table.

Step 1: Developing Customer needs & importance (refer to steps in Figure A6-1).

The column on the left lists the ‘WHATs’ or customer needs. These customer needs were obtained from the sources of data mentioned earlier in this appendix. In preparing the customer’s voice in the QFD table, it is important to distinguish between secondary and primary needs of the customer (Akao, 1990). In many cases the customer’s need is a secondary item, and the primary need has to be imputed. For example, Ease of Returns was a secondary need, while the Primary need was After Sales Support.

Next to the WHAT’s column, is the importance column. This states the importance of each customer need with a score of 1 to 5. The information is extracted from Table A6-3.

Step 2: Developing the Hows

The row at the top of Figure A6-1, shows the ‘HOWs’ or important supply chain factors that would meet customer needs. These factors are the top gaps in supply chain management, from Table A6-4.

Step 3: Interpretation of the information provided by the completed QFD table

The next step is to interpret the information in the QFD table. This is done by preparing a relationship matrix within the QFD table by identifying the performance gaps which are most crucial in meeting customer needs. The relationship matrix is prepared by indicating the strength of the relationship at each intersection of the customer needs and performance gaps. Refer to Figure A5-1, below. The relationships are given based on the capability of each supply chain factor from the Literature Review and on this researcher’s experience. The ratings are as follows :

- Strong relationship is given a rating of 3
- Medium or some relationship is given a rating of 2

- No relationship was given a rating of 0, and left blank
- The supply chain factors gaps with strong relationships to customer needs are considered the best opportunities for the high technology companies.

However, the relationship at each intersection point is insufficient to make a decision on good opportunities for the high technology companies. Also crucial is the importance score of each customer need. Hence, a weighted scoring for each gap comprising importance and relationship was required.

Step 4: Compute weighted score for each relationship

The weighted score for each relationship or cell is computed by multiplying the relationship score by the importance score. Refer to Figure A6-1.

Step 5: Select important How's or critical supply chain factors

Next, the weighted score of each gap, or supply chain factor, is computed. This is done by computing the column score of each critical gap as follows:

The HOW or Gap Column score

= sum of scores at all weighted intersection scores per column,

= sum of (each customer need importance score at intersection X relationship score at each intersection) for entire critical gap column, which =

$$\Sigma (\text{Each customer need importance score X relationship score at intersection})$$

The weighted totals are summed at the bottom of each HOW or gap column in the QFD Table. Refer to Figure A6-2.

Finally, the weighted scores are ranked, with the highest score being ranked as number 1, and so on. From the ranked list, it is possible to decide which supply chain factor, or critical gap, is most important to implement. The completed QFD table, with the ranked critical supply chain gaps is shown in Table A6-5, below.

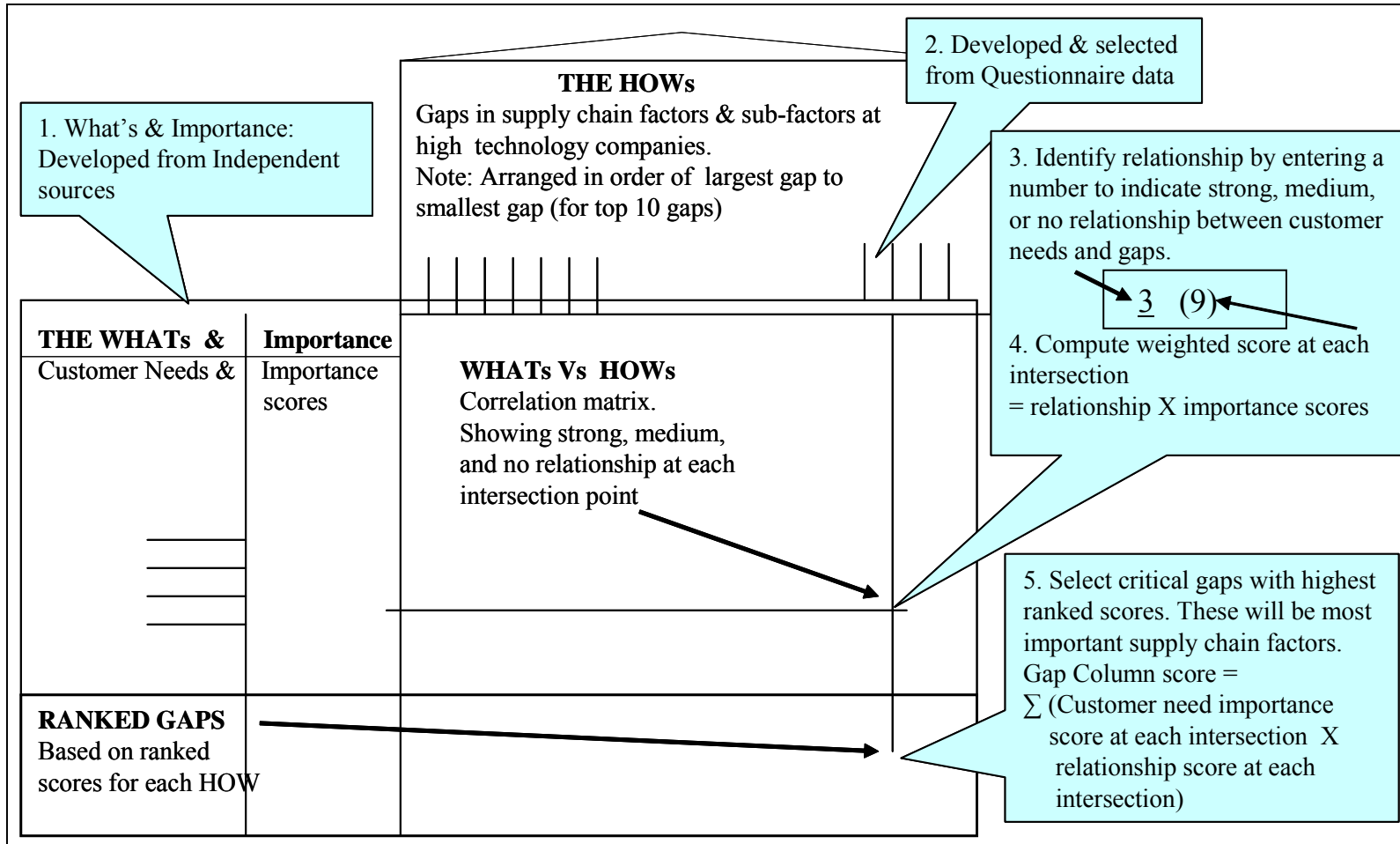


Figure A6-1 Construction of the QFD table to identify critical gaps in supply chain management

Source: Developed for this study, with guidelines from Akao (1990).

Table A6-5 QFD Table to identify Customer's Critical Supply Chain Gaps

Notes on numerical items in matrix A. Relationship code and score: <u>3</u> means strong relationship <u>2</u> means medium relationship Blank space means no relationship B. Number in (brackets) = weighted scores = relationship score X Importance score		Supply chain factors with the largest gaps (Importance – Performance) Supply chain factor gaps are aggregated from data of all high technology companies												
		Importance Score	26. Planning and involving customers in demand management	37. Intra-organization information systems to coordinate/integrate the entire Supply Chain	44. Employees are trained in supply chain concepts and management	42. Responding to high market fluctuations	11. Vendor managed inventory (VMI) at production sites	38. Optimizing the supply chain via Efficient Consumer Response (ECR)	36. Inter-organizational information coordination and sharing	39. Eliminating non-value layers (such as wholesalers) in supply chain	40. Radical and successful business process engineering	33. Effective use of Internet to manage Business-to-B commerce	10. Just-in-time (JIT) delivery to customers	12. Lowest inventory driven costs
Primary needs of customer	Secondary needs of customer													
Before-Sales Support and Information Availability	1. Ease of ordering	4.5					<u>3</u> (13.5)	<u>2</u> (9)			<u>3</u> (13.5)			
	2. Fast acknowledgement of orders	3.5			<u>2</u> (7)		<u>3</u> (10.5)				<u>3</u> (10.5)			
	3. Availability of information (price, product availability, delivery date, etc.)	4.5		<u>3</u> (13.5)					<u>3</u> (13.5)		<u>2</u> (9)	<u>3</u> (13.5)		
Reliability of Delivery	4. On-time delivery	4.8	<u>2</u> (9.6)			<u>3</u> (14.4)	<u>2</u> (9.6)	<u>3</u> (14.4)		<u>2</u> (9.6)	<u>2</u> (9.6)		<u>2</u> (9.6)	
	5. Complete delivery	4.5	<u>2</u> (9)			<u>2</u> (9)	<u>2</u> (9)	<u>3</u> (13.5)		<u>2</u> (9)	<u>2</u> (9)		<u>2</u> (9)	
	6. Products received in good condition	4.3							<u>2</u> (8.6)	<u>2</u> (8.6)				
	7. Delivery Turn-Around-Time	4.7	<u>2</u> (9.4)	<u>2</u> (9.4)		<u>2</u> (9.4)	<u>2</u> (9.4)	<u>3</u> (14.1)		<u>2</u> (9.4)	<u>2</u> (9.4)		<u>2</u> (9.4)	
	8. Invoicing timeliness	3.5									<u>2</u> (7)			
Product Quality	9. Quality of products	5.0								<u>2</u> (10)				
Reasonable Cost	10. Low (relative) product and delivery cost	4.0				<u>2</u> (8)	<u>2</u> (8)	<u>3</u> (12)		<u>3</u> (12)	<u>2</u> (8)	<u>3</u> (12)	<u>3</u> (12)	
After-Sales Support	11. Ease of product returns	4.7	<u>2</u> (9.4)							<u>2</u> (9.4)	<u>2</u> (9.4)			
	12. Speed of support and communication	4.5			<u>2</u> (9)						<u>2</u> (9)			
	13. Proactive support	3.5			<u>3</u> (10.5)						<u>2</u> (7)			
Column Scores (sum of bracket scores)			37.4	22.9	26.5	40.8	36	78	22.5	48.6	73	81.9	28	12
IMPORTANCE RANK (TOP 5)						5		2		4	3	1		

Source: Developed for this study

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Appendix A7- Detailed profile of respondents

The respondents for this study have been selected to ensure that they are from different functional groups in each business unit. Selecting people from different functional groups of each business unit provided more comprehensive information for triangulation. The selected functional expertise is in business and customer expertise or content and theory expertise. Table A7-1 gives a breakdown of type of respondents for each company surveyed. The study's respondents are identified individually using two characters: first, a company identification (A, H, etc.), and second, by the respondent number (1, 2, 3, ..). This identification system preserves case anonymity and also keeps cases separate. A total of 17 respondents were selected for this study from the high technology companies and 4 from the benchmark companies.

Table A7-1 Profile of case study respondents and identification codes

Company	Case Study Companies					Benchmark Companies
	X	H	A	P	C	J, K, L, M
Business Units Reviewed	1	1	1	1	1	4
Respondent profile:						
Business or Customer Expert: CEO, General Manager, Sales Director or Manager, or Operations Manager	1 (X1)	1 (H4)	1 (A4)	1 (P3)	2 (C1, C2)	2 (J1, L1)
Content and Theory Expert: Supply Chain, Distribution, or Materials Manager	2 (X2, X3)	3 (H1, H2, H3)	3 (A1, A2, A3)	2 (P1, P2)	1 (C3)	2 (K1, M1)
Total Interviewed	3	4	4	3	3	4

Note: The data base identification code for each respondent is shown in brackets.
Source: Developed in the case study protocol, Appendix 2

A more detailed profile of each respondent is given in Table A7-2. This table gives information such as detailed job assignment and numbers of years in the current company.

Table A7-2 Detailed profile of case study respondents

Identification code	Job Title	Current Assignment	Years in company (estimated)
A1	Operations Manager	Manages manufacturing operations.	Over 10 years
A2	Strategic Commodity Alliance Manager	Manages outsourcing of manufacturing activities.	Over 10 years
A3	Supply Chain Manager	Manage logistics and suppliers, coordinate all outsourcing activity, and create supply base for manufacturing.	Over 10 years
A4	Relationship Manager	Provides leadership in sales and support strategies, facilitates value chain, benchmarks inbound and outbound supply chain, and negotiates contracts in these areas.	15 years
C1	Director of Manufacturing	Manage company's manufacturing operations in one geographical region.	Over 5 years
C2	Director of Consumer Services	Design and manage strategy for consumer business.	Over 10 years
C3	Manager - Customer Operations	Manage critical customer operations to ensure product delivery and customer satisfaction.	5 years
H1	Director Supply Chain	Manage supply chain, planning, purchasing, and product line functions	Over 15 years
H2	Distribution Manager	Manage inbound functions, value added production, logistics, engineering and material activities, and order fulfillment	Over 10 Years
H3	Manager of Contract Manufacturing	Design and implementation of supply chain network.	Over 10 Years
H4	General Manager	Head of Corporate Worldwide supply chain and Corporate purchasing.	Over 20 years
P1	Materials Manager	Manages all purchasing, planning and warehousing.	5 years
P2	Supply Chain Manager	Design and manage outsourcing of manufacturing.	5 Years
P3	CEO – Chief Executive Officer	Manages entire company operations	3 Years
X1	Director of Purchasing, Suppliers, and Engineering	Management of all materials operations and engineering	Over 15 Years
X2	Materials Manager	Manages all material activities, including supply chain	10 years
X3	Product Development Manager	Manages introduction and manufacturing of new products.	10 Years

Identification code	Job Title	Current Assignment	Years in company (estimated)
J1	Senior Vice-President	Manages Operations and Logistics	Not available
K1	Distribution Manager	Manages distribution of company products	Not available
L1	Director of Distribution	Manages all operations and distribution	Not available
M1	Logistics Manager	Manages transportation and warehousing of raw and finished goods	Not available

Source: Developed for this study from the questionnaire responses (for current assignment) and verbal feedback from respondents (for estimated years in company)