Supply-Chain Software Systems: Current Issues and Imperatives in Selection and Implementation

by

Chow Yin Tan

M.Eng. (Hons.), Aeronautics (1997)

Imperial College
of Science, Technology and Medicine, UK

Submitted to the Technology and Policy Program
in Partial Fulfillment of the Requirements for the Degree of
Master of Science in Technology and Policy

at the

Massachusetts Institute of Technology

June 1998

Signature of Author .....
Technology and Policy Program
May 18, 1998

Certified by .....
James B. Rice, Jr.
Director, MIT Integrated Supply Chain Management Program
Center for Transportation Studies, Thesis Supervisor

Certified by .....
Richard D Tabors
Senior Lecturer, Technology and Policy Program
Thesis Supervisor

Accepted by .....
Richard de Neufville
Chairman, Technology and Policy Program

Supply-Chain Software Systems: Current Issues
and Imperatives in Selection and Implementation

by

Chow Yin Tan

Submitted to the Technology and Policy Program
on May 18th, 1998 in partial fulfillment of the
requirements for the Degree of Master of Science in
Technology and Policy

ABSTRACT

Supply-chain software systems have grown tremendously over the last few years. *Supply-chain management*'s principles for corporate planning, operational streamlining and value enhancement have also found acceptance among large numbers of companies today. Together, they are an instructive example of how the combination of technology and policy can improve corporate management and efficiency. This thesis examined the current issues in the selection and implementation of supply-chain software systems. In addition, through a study conducted among twenty companies which either have implemented or are currently implementing these technologies, imperatives necessary for the success of implementation projects were identified. Impediments and errors, which hindered the software implementation were also discussed.

The key areas of focus were: i) The comparative traits of supply-chain software systems, ii) The objectives of companies implementing these systems and their impact on implementation success, iii) The project costing of software implementation and the expenditures commonly overlooked, and iv) The influence of certain corporate policies (specifically, the identification of internal and external drivers) and the management of change on the implementation success.

Thesis Supervisor: James B. Rice, Jr.
Title: Director, MIT Integrated Supply Chain Management Program

Thesis Supervisor: Richard D. Tabors
Title: Senior Lecturer, Technology and Policy Program

ACKNOWLEDGMENT

Working on this thesis at times seemed like an eternity, while at others seemed like one mad rush.

During those hours when time was flowing like a calm meandering river, there were friends who broke the monotony with impromptu coffee breaks, the occasional unwinding drink, and the blood-rushing ice hockey games! To them, I owe much thanks. During seconds when time was gushing like a mob of hazardous rapids, there were also friends who e-mailed and kept in touch even though I wrote nothing. To them, I owe equally much thanks.

Jim Rice provided valuable time when he has little for himself. His guidance, financial support, and attention to details drove the project along through difficult times. From him, I also learned the finer details of interpersonal skills. Dr. Richard Tabors was helpful with ensuring that technology and policy were central themes to the thesis. I certainly hope they were.

Sembawang Corporation, my sponsors, provided the financial support that took me all over the place before ending up here. They have been truly great to me. Hopefully, I will soon be able to say something other than "who knows" when asked what I will be doing with my sponsors after graduation.

Thanks must also be extended to the many corporate executives who took time off their busy schedules to speak with me over the phone.

Lastly, I would like to thank my parents and brothers for putting up with me over the years when I complained in good times and in bad. I am also truly grateful for the support that Dr. K L Yee extended when I was in my less accommodating mood. Was it truly Ralph Waldo Emerson who claimed that "A scream is better than a thesis"?

Chow Yin
May 15th 1998

Contents

List of Figures

List of Tables

List of Acronym

SCM	Supply-chain Management
ERP	Enterprise Resource Planning
IT	Information Technology
SCP	Supply Chain Planning
ROI	Returns on Investment
RONA	Returns on Net Assets
Y2K	Year 2000
MIS	Management of Information Systems

Chapter 1

Background And Introduction

1.1 Supply-Chain Management: A Brief Insight

The concept of materials management first evolved in the 1970s. It entailed the cooperative management of functions such as production planning, material requirements planning, shop floor scheduling and purchasing. The goals were primarily to achieve inventory and cost reductions of these individual functions. With the advent of the 1980s, managers began to see the value of merging these functions with those of distribution and transportation. The goals expanded to include better customer delivery performance and faster inventory velocity, and to decrease the overall costs of bringing a product to the customers. Hence, the concept of integrated logistics was created. Integrated logistics was especially beneficial to large corporations with multiple plants and distribution centers. Coordination and synchronization between these functional silos (such as manufacturing, purchasing, or transportation) enabled companies to push their costs further down and to improve their revenues.

The concept of supply-chain management first evolved in the late 1980s. Nevertheless, it

was only in the early 1990s that the literature on supply-chain management truly proliferated, and the enthusiasm has continued to the present. For example, as recently as Jan 26th 1998, the Journal of Commerce ran an article detailing the important links in supply-chains. Logistics Management ran a six-part series of articles on supply-chain management from February to December 1997. In March 1997, the Harvard Business Review published an article on determining what kind of supply-chains work for what processes. Other publications and writings exist that point to the fact that supply-chain management is very much on many corporations' minds today. Evidently, despite the time duration of more than a decade since its inception, there is still much to be learned about supply-chain management; its principles, implementations and goals.

Also evident from the literature were many examples of how supply-chain partnerships have saved corporations much in terms of costs. More importantly, supply-chain management has helped to transform traditional thinking of logistics as a cost-adder into the more revolutionary value-adder. The best logistics executives are those who are able to get out of the "cost-containment mode" into the "revenue-enhancement mode"[1]. Many companies today are learning and adopting a new paradigm of viewing effective supply-chain management as a process for creating competitive advantage over their business rivals. Best-in-class supply-chain management companies not only excel in reducing operating costs, but also in improving asset productivity, timeliness, customer service, and ultimately profits. As a result, the shareholder-values of these companies were significantly increased.

In many ways, supply-chain management operates in the same spirit that drove the abolishment of trade-barriers between nations after the second-world war. Nations used to treat trading partners with caution, engaging in profit tugs-of-war. As a result of such self-centered isolationism policies that led to crippling bureaucracy, low productivity and

clandestine trade practices, global growth was stunted. In 1947, twenty-three nations began multilateral trade discussions aimed at removing artificial barriers to trade and improving inter-country trade cooperation. As a result, the GATT accord was signed, and global GNP growth blossomed. In the same vein, companies today should look beyond themselves. Inter-company cooperation (in information-sharing, production, or distribution optimization) is one of the main premises of supply-chain management. The creation of shareholder value should be considered across the entire supply-chain, from the raw material through to the final consumer.

Traditionally, companies have operated with functional silos such as purchasing, materials management, manufacturing, distribution and marketing. Goods, information and cash flows are usually sequenced in a top-down manner through these silos. Inter-company flow of goods, information and cash are similarly arranged, with the raw material company dealing only with the manufacturer and the manufacturer in turn dealing with the distributor. Finally, the distributor will deal with the end-customers. Such sequential decomposition of tasks and activities formed the basis of operations for many manufacturing companies in the past. Please refer to Fig. 1.1.

A key challenge of supply-chain management is to examine the entire value chain to identify redundant activities which can be eliminated. A value chain can be defined as a series of activities which adds value or improvement to a product or service. Often, many functional silos along a value-chain have different and conflicting objectives. For example, manufacturing would like to produce as much as possible to reap economies of scale and lower unit cost. However, if the production is not matched by consumer demand, then most of the goods will be stocked as inventory in the warehouse. It is difficult for warehousing to lower the rising cost of holding inventory if demand is insufficient. Hence, even though from

the manufacturing stand-point, costs per unit has been reduced, overall costs of bringing a product from the raw material stage to the end-consumer have increased as a result of the rising inventory.

Another example of the conflicting objectives of functional silos is the interaction between transportation and distribution[2]. For instance, distribution centers may have adopted the concept of continuous replenishments in order to minimize their inventory levels. If there is no synchronization or alignment of these efforts with a downstream component such as transportation, the inventory costs may simply be passed downstream. The higher premium of transportation as a result of the continuous replenishment by distribution centers may overcome the savings in inventories if there were no alignment between transportation and distribution. More expensive less-than-truckload deliveries will have to be balanced by actual savings from not holding inventories.

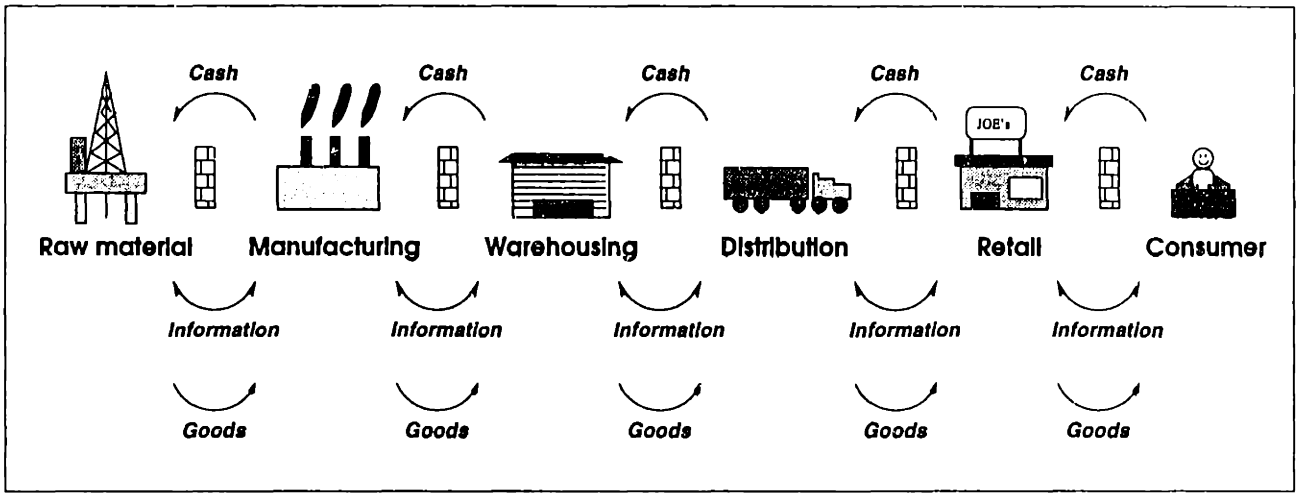


Figure 1.1: Traditional Flow of Goods, Information and Cash between Functional Silos Separated by Functional Walls

As a result of many companies' inability to quantify the strategic advantages inherent

within their supply-chains, their traditional methods of bringing and creating goods from source to end result in:*

- High hidden costs
- High material and finished goods inventories
- Unstable material flow despite stable demand
- Detrimental functional gamesmanship
- Unsatisfied consumers

Supply-chain management calls for product, information and cash flows to occur simultaneously throughout the functional silos within a company[3]. Please refer to Fig. 1.2. The symbolic "walls" separating each functional silos have been dismantled. Similarly, it also calls for better product, information and cash flows on the inter-company level. The focus is on the processes which create values for the customer, rather than on the functions of individual departments or individual companies. Bernard LaLonde, Professor Emeritus of Logistics at Ohio State University summed up supply-chain management succinctly as "the delivery of enhanced customer and economic values through synchronized management of the flow of physical goods and associated information from sourcing to consumption."[4] In its broadest scope, integrated supply-chain management includes sub-suppliers, suppliers, internal operations, trade customers, retail customers, end-users and even research and development.

1.2 Supply-Chain Principles

Some concepts of supply-chain management either overlap or encapsulate those of Just-in-Time management and Re-engineering[5]. However, the differences are significant. Just-in-

*Source: Peter Metz, MIT Center for Transportation Studies

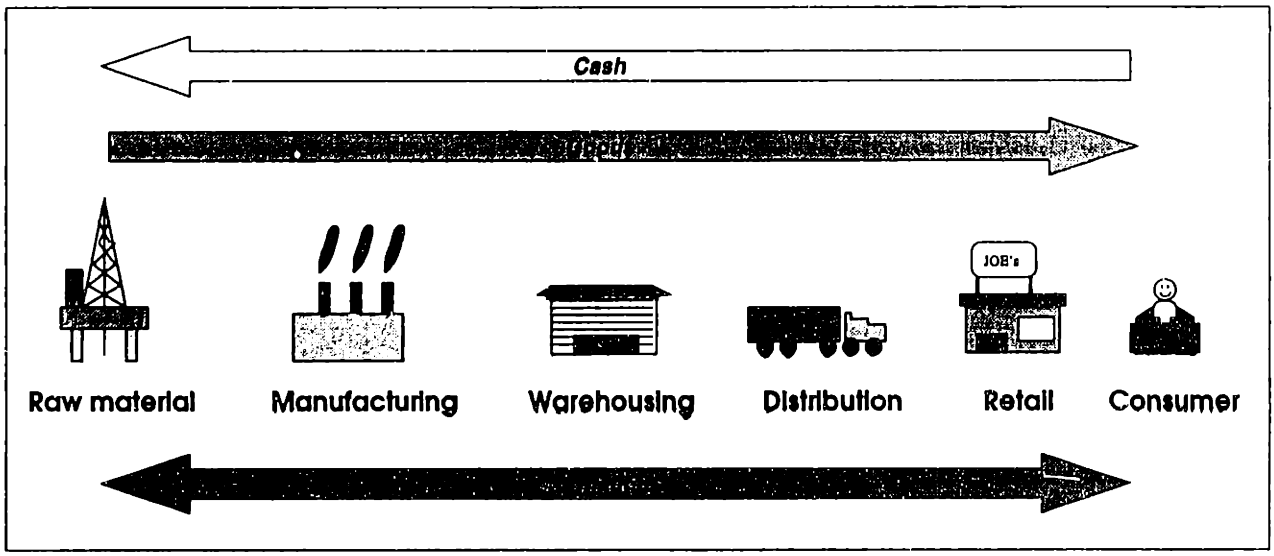


Figure 1.2: Borderless Flow of Goods, Information and Cash With Supply-Chain Management

Time (JIT) management enables cost reductions through timeliness of supply. JIT II goes a step further and includes supplier integration. Nevertheless, their scope do not extend to include a strong leaning towards customer satisfaction. The functional activity focus of JIT also falls short of the process-orientated approach of supply-chain management.

Re-engineering calls for the fundamental rethinking and radical redesign of business processes to achieve dramatic improvements in contemporary, yet critical measures of performance, such as cost, quality, service and speed. It focuses more on the activities within a single company to achieve these performance measures. It does not focus much on the synergistic relationships between companies and does not consider the entire supply-chain (inter- and intra-) per se.

The approaches of supply-chain management compared to traditional management are outlined in Table 1.1.

Element	Traditional	Supply Chain
Inventory management approach	Independent efforts	Joint reduction in channel inventories
Total cost approach	Minimize firm costs	Channel-wide cost efficiencies
Time horizon	Short term	Long term
Amount of information sharing and monitoring	Limited to needs of current transactions	As required for planning and monitoring processes
Joint planning	Transaction-based	On-going
Compatibility of corporate philosophies	Not relevant	Compatible at least for key relationships
Breadth of supplier base	Large to increase competition and to spread risk	Small to increase coordination
Channel leadership	Not needed	Needed for coordination focus
Amount of sharing of risks and rewards	Each on its own	Risks and rewards shared over the long term
Speed of operations, information and inventory flows	"Warehouse" orientation (storage, safety stock) interrupted by barriers to flows; localized to channel pairs	"Distribution Center" orientation (inventory velocity) interconnecting flows; JIT, Quick Response across the channel
Information systems	Independent	Compatible, key to communications

Table 1.1: Traditional and Supply-Chain Management Approaches Compared [6]

Andersen Consulting[4] has distilled their perspective on supply-chain management into seven principles as follows†:

1. Segment customers based on service needs

Traditionally, companies have segmented customers by industry, product, geographical location, or other basic distinctions. Effective supply-chain management, on the other hand, groups customers by their service needs. Such an overriding, pervasive customer-centric focus which acknowledges service as a critical component of a business is a key foundation of supply-chain management.

2. Customize the logistics network

Having identified the customers based on their service needs; the next logical step would be to customize the logistics network towards fulfilling that need. This principle is important as management of the logistics network is a cornerstone of supply-chain management. The focus should be on the service requirements of different customer segments and the profits in these segments can be maximized, not on creating a rigid logistics plan.

3. Listen to signals of market demand and plan accordingly

Forecasting is an important aspect of supply-chain management. This does not mean just predicting demand (more of a marketing function) but entails a more heuristic learning and understanding of ordering patterns, customer promotions, time and physical constraints, and so forth. The ability to plan for opportunities and prepare for contingencies is an important principle of effective supply-chain management.

†The explanations for these principles are based on my interpretation and were not necessarily stated in [4]

4. Differentiate product closer to the customer

Product-differentiation should be carried out as late as possible in the manufacturing process in order to satisfy specific consumer demands. By delaying product-differentiation, some economies of scale can be reaped through the large scale production of similar core components of different products. In addition, the final products have their distinguishing components added-on only later when demand figures are clearer.

5. Strategically manage the source of supply

The role of purchasing is just as important as the role of distribution. Companies which have excelled at supply-chain management have concentrated on getting the most out of a few suppliers, and entered mutually beneficially long-term agreements with the aim of improving each other's businesses. Making suppliers out-bid each other in terms of price is no longer a smart practice. Price is not the driving force of supply-chain management, value is. Value is created through strategic alliances between supplier and manufacturer/retailer. An example of one such arrangement is the concept of Vendor Managed Inventory (VMI), where the supplier undertake the management of its customers' inventory in exchange for point-of-sale information and a premium price.

6. Develop a supply-chain-wide technology strategy

Information technology is the enabling technology that drives supply-chain management. Today, there are many businesses unchanged from the time when computing power was expensive and of limited use. With algorithms and software that could perform linear algebra and network-optimization quickly and cheaply, the benefits of computers as a tool for supply-chain management cannot be dismissed. Information technology can be used to

facilitate multiple levels of decision-making that cuts across functional silos. It can also be used to monitor the flow of goods, information and cash across the supply-chain. In short, advances in computer technology have enabled communication, calculation and control of data and information that are critical to the success of supply-chain management.

7. Adopt channel-spanning performance measures

The old adage "you can't manage what you can't measure" is another underlying principle of supply-chain management. Effective performance measures are crucial because they enable improvements to be gauged. In addition, they also serve as benchmarks for companies to strive towards. Performance measures used must be holistic in nature and span the entire channel, rather than focusing on specific silos. At present, there are multitudes of consultants offering their own brand of performance measures[7]. It is beyond the scope of this thesis to explore the validity or effectiveness of these performance measures.

In addition to the principles mentioned above, the following are also critical towards the success of implementing a supply-chain management strategy:

8. Understand the dynamics of the business

Supply-chain management does not call for a specific approach that is applicable to all types of business. It requires managers to understand the dynamics of their business such as the nature of consumer demand, etc.. For example, the supply-chain for an innovative product can be significantly different from that of an everyday functional product. An innovative product, such as a computer equipment, will require a fast-changing and responsive supply-chain, where a degree of efficiency is sacrificed for some flexibility to change the quantities of production[8]. On the other hand, a functional product such as a toothbrush, where demand

is relatively stable, an efficient supply-chain in which per unit cost is minimized would be desired instead.

9. Adopt time-critical approach

The concept of employing real-time information has often been stressed as another important thrust of supply-chain management[9]. While the principle of being able to response to real-time changes is a desirable goal, it should not be the over-riding concern of companies. Especially so if the short-term responses conflict with longer term tactical and strategic decisions made by these companies. The concept of critical time is undoubtedly more important. Everyone within a supply-chain should have the information they need in time to meet customer demand, not necessarily as soon as the information is available. For example, one chemical supplier[10] discovered that its customer, the manufacturer, did not care how quickly the supplier can deliver the raw material. Instead, the customer was concerned about having reliable delivery such that the supply never runs out. Nevertheless, there are many instances where real-time data can be powerful, such as when sales personnel are able to extract real-time information about inventory and production when negotiating with customers.

10. Encourage and facilitate open communication

This is perhaps the most important principle behind the ideals of supply-chain management. Many of the principles discussed will be futile if there are no open channels for communication. A process-oriented approach depends greatly on the seamless flow of goods, cash and information which can only be achieved if distinct communication lines exist. Due to their cross-functional positions, senior management is best positioned to act as the facilitator to bring about changes required for a successful supply-chain management operation[11].

Cross-functional teams of employees from inter-related functions working closely together can cut across many organizational barriers such that the holistic costs of their company's business are well understood by all involved.

Most research initiatives in supply-chain management today cover at least one of the ten underlying principles of supply-chain management mentioned above. For example, at the Integrated Supply Chain Management Program in MIT's Center for Transportation Studies, past research topics have included formulating a framework for the implementation of inter-company operating ties and the use of horizontal process management for spanning functional boundaries[19]. The Lean-Aircraft Initiative at MIT has carried out a research on supplier relations in the aerospace industry.

1.3 Successes and Impediments

Despite the publicity surrounding supply-chain management and the time since its inception, there exists evidence that suggests few companies today are fully aware of how to apply its principles. For example, in a recent study[15] conducted by the MIT Integrated Supply-Chain Management Program on the automobile and food industry, it was found that only a handful of companies actually have well-defined inter-company operating ties. Some leading thinkers[16] in the field also agree that not all is progressing as expected. The main criticism is the lack of consensus on a common language when teams come together to improve their supply-chains. Without a common language to begin with, measurements and improvements cannot cannot be achieved. Below is a list of some impediments to the effective application of supply-chain management:

- Lack of common understanding on how to implement supply-chain management

- Lack of knowledge as to how improvements and costs can be quantified
- Deeply ingrained notions of price competition rather than strategic alliances
- Managers are generally risk-adverse
- Short-sighted managers seeking only internal supply-chain management
- Lack of leverage power to move big partners

However, there have been some recent developments toward a consensus for describing supply-chain management practices. A recent and popular framework[17] was the joint-effort of Advanced Manufacturing Research (AMR) and Pittiglio Rabin Todd & McGrath (PRTM) for the Supply-Chain Council, a 70-odd corporate alliance striving to develop a standard framework for supply-chain management. As a result of their work, the Supply Chain Operations Reference (SCOR) was devised. The model separated supply chain processes into four categories: planning, sourcing, making and delivering. It also established a set of bench-marking metrics in which the practices of best-in-class firms were defined. PRTM also managed to quantify how much advantage the best-in-class firms had over the median firms across different industry segments. The study quantified performance figures such as total supply-chain management costs, cash-to-cash cycle time, value-added productivity, order fulfillment lead time, inventory day s of supply, material acquisition costs, cumulative source or make cycle time and order management costs.

Some well-documented supply-chain management success stories include the ailiance between Procter & Gamble and Wal-Mart[12] to share point-of-sale information and facilitate vendor-managed inventory. P&G estimated that in 18 months, it was able to save its retailer customers more than US$65 million. Another example is Siemens Medical. SM was able to reduce its 22 weeks order to delivery cycle time to 6 weeks by improving the customization of its Computer Tomography equipment for individual hospitals. Two other examples are

Nabisco and Xerox. Nabisco[18] was able to cut its transportation costs by half through consolidating its shipments with a third-party logistics provider. Xerox improved its order lead-time by training its transportation personnel to install and operate copiers.

Hence, although the potentials of supply-chain management are still relatively unexploited, some companies have actually begun to reap its rewards. With the current technological advances in optimization and communication, more firms will soon begin to seek similar improvements.

1.4 Enabling Technologies

One of the key principles of supply-chain management is the development and use of an information technology strategy employing state-of-the-arts in optimization, communication and database technology. Without the growth of computing power over the last decade, advances in areas crucial to supply-chain management such as constraint-based optimization and critical-time data communication, would have been impeded Ken Sharma, the co-founder of i2, a firm that specializes in supply-chain software, claimed that the single biggest reason for the emergence of enterprise planning systems was the creation of low-cost memory chips. Table 1.2 shows some of the enabling technologies that have emerged to bring supply-chain ideals into reality.

As stated previously, supply-chain management involves coordinating three critical aspects of logistics or business management; goods, cash and information. Hence, supply-chain software should be systems that enable the coordination, optimization and management of these quantities. However, such a definition may differ from those applied by software vendors. The subsections below describe in more detail the classification of supply-chain

Business Drivers	Supply Chain Practices	Enabling Technologies
Shorter product life cycles	Collaborative product development	E-mail and work group conferencing
Reducing costs	JIT, Efficient consumer response, quick response, and continuous replenishment	Advanced warehouse and transportation management systems
Product proliferation	Deployment planning and vendor managed inventory	Point-of-sale data collection
Mass customization	Collaborative forecasting	Workflow
Thwart competition	Collaborative planning	Electronic messaging
Core competency focus	Schedule sharing	Advanced planning and scheduling
Meet/exceed customer service demands	Electronic commerce	EDI, the Internet and other public/private networks
The virtual enterprise	Competing supply chain threads	Cellular/RF, satellite communications and mobile computing

Table 1.2: Critical Supply-Chain Requirements [12]

enabling systems by their generally accepted name in the software industry[13].

1.4.1 Enterprise Resource Planning (ERP) Systems

ERP systems grew out of MRP (Manufacturing Resource Planning) systems which originally coordinated the flow of data within the manufacturing silos of a company. ERP took MRP further and integrated other departments and functions of the company such as logistics, finance, human resources, marketing, etc. into the system to create a consolidated enterprise information and financial-data backbone. The success of ERP can be largely attributed to the promise that these systems give to prospective buyers: automation of the data-flow processes and, enabling the company to be run more efficiently and more productively. ERP systems are acquired primarily to get the operational houses in order, integrating the flow of information from procuring from suppliers to meeting customer orders.

The top 10 ERP vendors in terms of sales in 1997 were SAP, Oracle Corp., J.D. Edwards, PeopleSoft, Baan, SSA, Computer Associates, JBA, Marcam Corp. and Intentia, earning a combined-revenue of $5.8 billion[14]. While sales are growing, these companies have not been resting on their laurels. They have been adding functionality such as workflow technology, transforming ERP beyond its core-competency as a transactional backbone to a user-defined dynamic system capable of simulating distribution routings. Other additions to the functionality of ERP systems are in areas of decision-support. ERP vendors are recognizing that having data is not the same as knowing what to do with them. The growth of best-in-breed supply-chain software system (discussed in the following subsection) has only reinforced the need for ERP systems to grow in the aspect of decision-support.

Competition from dedicated supply-chain software vendors is not the only challenge

facing ERP vendors. A main criticism of ERP systems is the amount of resources required to implement these systems. In terms of cost and time, many companies implementing ERP systems have found out that the change process can be extremely painful. Realizing that the cost and time of software implementation are preventing many mid- and small-sized companies from jumping on the ERP bandwagon, many ERP vendors are focusing on developing and marketing easy-to-implement ERP packages rather than rushing to add more functionality to their already complicated systems.

Although ERP systems are not generally classified as supply-chain systems (unlike dedicated supply-chain management software systems described in the following subsection), their value to supply-chain management cannot be undermined. One of the tenets of supply-chain management is the coordination and streamlining of information and funds across the entire supply-chain. As a transactional backbone, ERP systems definitely satisfy this criterion as a supply-chain enabler.

1.4.2 Dedicated Supply-Chain Planning (SCP) Software

These dedicated SCP[‡] tools do not try to span every aspect of business transactions. Instead, they attempt to match the supply and demand of a business using sophisticated forecasting methods for demand planning, production planning, supply planning and scheduling, and some analytical tools. Their emphasis are not just on data-entry and data-management but how these data can be utilized for decision support.

The best-in-breed of these SCP tools are able to gather data from point-of-sale and

[‡]In many of the literature reviewed, the acronym SCM (supply-chain management) has been used instead for these systems. I have preferred to use SCP, in order to distinguish supply-chain planning software systems from supply-chain management.

synthesize these data together with actual supply-side information (such as inventory levels, production schedules, availability of the factors of production, etc.) to give an optimum production and distribution schedule. Through the use of computerized intelligence that these tools make possible, players in the supply chain are able to conduct their activities with the best and latest information from everyone else. As such, the costs of operating a business became completely synchronized, ensuring supply and demand fell into equilibrium before the products reach the market. SCP tools come in various guises. Below is a list[20] of some typical functions of these tools:

1. **Forecasting and Demand Management** – Using statistical methods, levels of activities that affect product demand are predicted.

2. **Advanced Planning** – Using constraint models that allow for both capacity and material optimization, production plans over months or years are made.

3. **Dynamic Scheduling** – Similar to advanced planning but for a much shorter time scale. Scheduling for actual plant floor activities are carried out.

4. **Supply-chain Optimization** – More advanced algorithms incorporating artificial intelligence techniques allow for holistic approaches to the issues of demand, production, scheduling and logistic problems.

5. **Warehouse Management** – Actual simulation and planning of optimum lay-out of warehouse lay-out as well as managing the inflow and outflow of materials.

6. **Transportation Management** – Optimization and consolidation of goods movements between manufacturing, distribution centers and retailers. Advanced packages include freight sourcing and selection.

7. **Electronic Commerce** – Relatively new addition to the SCP stable of tools. Nevertheless, many vendors are already using it as a selling point for their software, touting its capability of data-transmission through the Internet, as well as the tracking and control of goods movement.

8. **Sales Force Automation** – Vendors are highlighting this as the tool for Available-to-Promise. Through electronic link-ups, sales personnel are able to relay sales information directly to manufacturing. At the same time, they are able to check how fast a particular product will be available for delivery.

SCP software have been extremely successful in terms of sales. In 1996, $420 million of sales were achieved worldwide by the vendors. This is expected to be followed by $700 million in 1997. By the year 2000, sales of SCP software are expected to hit $2 billion. The top 10 SCP vendors for 1997 were SAS, i2, Manugistics, Logility, IMI, Numetrix, ADP-GSI, BDM, Renaissance Software and Taylor Industrial Software.

Compared to ERP systems, it is generally acknowledged that SCP systems can be implemented a lot quicker. Also, unlike ERP systems where the benefits are difficult to quantify, the benefits for SCP systems are generally transparent and easily quantifiable. One such example is Herman Miller[21], a furniture maker in Zeeland, Michigan. After implementing i2's Rhythm, Herman Miller took one week off its inventory, sliced one to two weeks off its lead time, increased cash flow to $124.5 million from $29.9 million, boosted plant capacity by 20% and seen its share price soared.

Many SCP systems feed on data from ERP systems. Most of them are also capable of utilizing data from legacy systems and other sources. One of the interesting question that is captivating both IS and logistics personnel is how to make value the tradeoffs between

choosing ERP versus SCP systems.

1.4.3 Electronic Data Interchange (EDI) System

EDI is a method of using standardized document formats to exchange common business information. These document formats, or "sets" are recognized nationally and internationally by businesses and organizations using EDI. Compared to ERP or SCP systems, EDI systems have been in used longer. Standards for EDI type data transmission can be traced to the late 1970s and early 1980s[22]. Today, EDI sets exist for almost every type of business transactions. Some examples of these sets include purchase orders, bills-of-lading, invoices, and acknowledgments.

In addition to EDI sets, other components of an EDI system include cross-industry and industry-specific communication standards, an EDI software system that serves to format out-going data for electronic conversion as well as translate in-coming data, and an EDI communications network. Three types of communication network are currently used: point-to-point configurations, third party networks, and value added networks. Typically, large consumers or suppliers can leverage against smaller businesses to push them into implementing a compatible system for EDI.

As a communication tool, EDI has many benefits to supply-chain management. Through the speed of EDI communication, companies can implement an inventory policy that allows for just-in-time delivery. EDI also facilitates the sharing of information with suppliers which can lead to a long-term lower cost position for the EDI user. On the demand side, EDI allows customers to relay information to producers such that products are made only when needed. Hence, shortening customer lead time and improving services. In a study conducted by

Barnes[23] in 1987, EDI links were found to improve customer-supplier relationships through enhanced communication and the sharing of information. Hence, EDI systems are important enablers of supply-chain management.

1.4.4 Home-Grown Systems

Home-grown software systems, whether merely database or more sophisticated optimization algorithms, complete the cast of software systems relevant to supply-chain management. They can be simple, adopted spreadsheet programs with specialized macros or can be complex codes using heuristic or genetic algorithms. Today, in the rush for ERP and SCP tools for supply-chain management, these systems are commonly referred to as legacy systems.

Such systems, because they are driven by internal needs, rather than by external factors (such as marketing or perceived competitive disadvantages of not using commercial applications), are usually highly specific and relevant to the user's business. These systems evolve as the business grows and change as the business takes on newer forms. Hence, they become an integral part of many companies' operations. It does not matter whether these systems are based on a main-frame set-up or a client-server architecture, discarding them for commercialized off-the-shelf packages can often be a difficult task.

One of the key issues that has gripped many vendors is how to make their software more flexible and friendly to differing legacy systems. This is unequivocally difficult as no two legacy systems are the same. However, it is interesting to observe many companies willingly jettison their unique legacy systems for commercial applications that are general and broad. Whether this reflects a trend of companies towards outsourcing IT capability or the strength of commercial vendors in marketing their software remains a moot point.

Chapter 2

Literature Review

2.1 Supply-Chain Software Systems: Expectations and Reality

A literature search on recent writings on ERP and SCP tools will undoubtedly yield articles that either sing their praises or denounce them for their inadequacies and implementation difficulties. For ERP systems, the latter frequently outnumbers the former. SCP systems, on the other hand, tend to elicit the former rather than the latter. Nevertheless, they are both growing at an amazing rate. ERP systems grew between 30-40% [29] in the past couple of years. By the year 2001, annual ERP revenues should approach a staggering $20 billion. Demand comes not only from first time users seeking a transaction and supply-chain management system but also from companies seeking to phase out their host-based MRP II systems. AMR, a Boston-based market research firm, estimated that as of January 1997, only less than 20% of the 60,000 to 70,000 MRP II systems have been replaced by ERP systems.

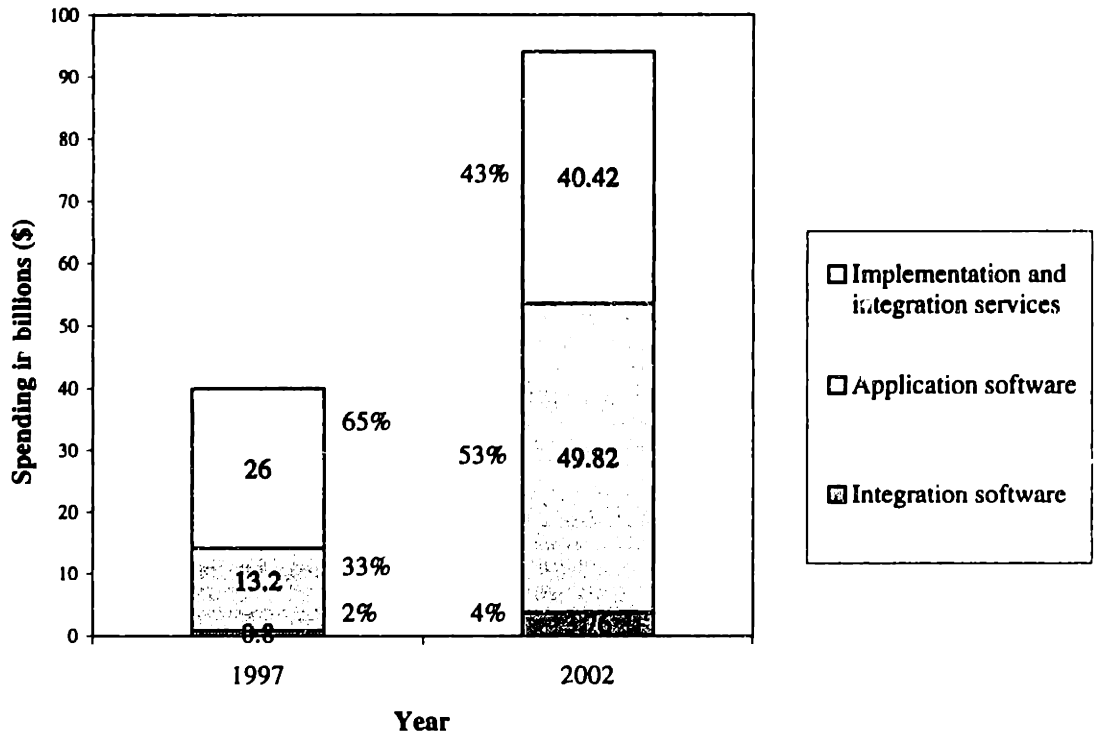


Figure 2.1: ERP Project Spending Worldwide [26]

Fig. 2.1 shows that in 1997, the licensing cost of ERP software accounted for only 33% of the total spending of companies in setting up their ERP system. In contrast, more than 65% was spent on implementation and integration services. As the vendors become more in-tune with the buyers' increasing preference for easy-and-quickly implementable systems, it is estimated that by the year 2002, the percentage spending of companies on implementation and integration services will decrease to 43% while the percentage spending on software will increase to 53%. However, in terms of the magnitude of total spending on implementation and integration, the estimated increase from 1997 to 2002 is 55%.

The projected growth of the ERP market indicates that there is a firm belief among companies that these systems can bring bottom-line benefits. However, any successes of these systems are often moderated or even marginalized by the pains of implementing and using them. Forrester Research[14], an information technology research firm based in Cambridge, Massachusetts, found in interviews with Fortune 1000 companies, that 44% of these companies spent at least four times more on the costs of implementation (such as systems integrators and IT consultants) than they did on the licensing cost of the software itself.

Many of these complaints have been directed at the largest ERP vendor, SAP America. The Wall Street Journal[27], once described installing the highly popular R/3 system (a staggering number of more than 7000 companies world-wide are already using or installing it) as "the corporate equivalent of a root canal". Implementing R/3 may require companies to restructure their accounting system, set up databases that will interface with R/3 and even rework their corporate structures. This often results in huge implementation costs in addition to the software license. For example, the total costs of Owens-Cornings's R/3 system was $15 - $20 million (the system crashed shortly after it went live*).

*To "go live" is the IT jargon for starting up a system to be operational for the first time

The magnitude of these complaints can be gauged through the emphasis placed by SAP on ASAP (Accelerated SAP) and Ready-to-Run R/3 [30]. These systems are designed to attract the burgeoning mid-size market that simply cannot afford an expensive and protracted implementation process. With RRR R/3, the targeted implementation time frame can be just 20-25 days. R/3 4.0, to be released in 1998, will also follow the new focus of SAP on ease-of-implementation. The newest release promises to break up the cumbersome set-up into more manageable pieces.

Implementation cost over-runs cannot be simply attributed to the software vendor alone. In his paper, Slater[39] identified the following 5 critical areas that were often overlooked by companies in costing for an ERP system:

1. **Training** – An ERP system requires the skill level in a company to be raised. Workers not only have to learn how to operate the software but must also be trained to understand the rigors associated with data entry and its importance to the entire supply-chain.

2. **Integration and Testing** – Many companies do not anticipate the complexities associated with integrating an ERP system with other software systems already in operation - such as SCP systems. Testing is also another important provision as it involves significant system down-time.

3. **Data Conversion** – Many companies also do not provide enough resources for the conversion of data from their old legacy systems to the new ERP systems. Managers or ERP project leaders will often underestimate the costs of data conversion as no one likes acknowledge their old data as being of low integrity or consistency.

4. **Data Analysis** – ERP systems will provide companies with quantitative information

but they will not tell companies what to do with these information. Data from an ERP system might have to be combined with data from other sources within a data warehouse for analysis purposes. The costs of customized data warehouses can be especially expensive.

5. **Consultancy Fees** – Consultants that are brought in for setting up an ERP system often do not share the same objectives and business knowledge as the operational managers. If the company itself do not know the extent of support they need from the consultants, the costs can escalate tremendously. Disengaging consultants can be just as costly as engaging them.

Given the propensity of actual ERP spending to exceed planned expenditures, it is not surprising that many companies desire ERP costs comparisons to serve as benchmarks. However, not only is it almost impossible to obtain detailed cost structures of another company's ERP spendings, but it is also difficult to find another almost identical company in IT or operational level for the comparisons to be of value. There is also a general lack of consensus on what data would be the most appropriate. Some companies include hardware upgrades as part of the ERP process. Others view them as general IT investments. Some companies use metrics that look at the implementation cost per dollar spent on the software itself. Others argue that it is more appropriate to consider the cost per user.

It has not been all bad news. Companies which have been able to keep a close eye on the costs of their implementation and focus strongly on the investment objectives can reap many benefits. One example of a successful ERP implementation is CSR Timber Products[33], a subsidiary of CSR Ltd., one of the world's largest building and construction materials companies. Among the achieved benefits that could be directly attributed to CSR's ERP system were: payback of less than one year, 60% reduction of finished goods inventory, productivity

improvements in factories, improved customer delivery, and reduction of distribution centers from thirty-three to eight.

2.2 Supply-Chain Planning with ERP: Is it Viable?

Spurred by the in-roads of SCP vendors into the supply-chain management market, ERP vendors are increasingly trying to add decision-support functionality to their transaction-based system. Yet, as of May 1997, Tony Friscia[24], the president of AMR, noted that missing from most ERP packages are several, if not all, of the following key functional capabilities that can be found with best-of-breed SCP tools: demand planning, distribution and deployment planning, advanced order management, warehouse management, transportation planning and electronic commerce.

Friscia suggested that given the depth of requirements that best-in-breed SCP systems satisfy, ERP vendors will not be able to take over the supply-chain software market for the near future. In his talk at the Harvard Business School on February 10th 1998, Ken Sharma, the co-founder of i2 claimed that SCP systems have at least 3-5 years head start on ERP vendors in terms of optimization and scheduling capabilities. Another criticism of ERP's shortcomings in supply-chain management software came from Forrester Research[28]. Gormley and Cameron, senior analysts of packaged applications strategies at Forrester Research felt that ERP applications do not yet deliver on key supply-and-demand planning needs. Their main criticism centered around ERP's inability to respond to changes in data of supply and demand which constrains and spurs production. For example, ERP is unable to comprehend constraints such as plant capacity in its materials requirements planning.

Recognizing that their shortcomings in functionality have enabled best-in-breed SCP

vendors to take a foothold in the market, ERP vendors are employing varying approaches to catch up. SAP is developing its own supply-chain, sales force automation, and data storage linkage to its already extensive manufacturing, financial and human resources ERP application[25]. Oracle, on the other hand, prides itself as a best-of-breed integrator, putting together the best of ERP with the best of SCP. For example, in November 1997, Oracle announced a technology-integration and sales pact with i2 Technologies.

Some other ERP vendors have chosen to acquire smaller SCP vendors as a means of adding knowledge and capability into their ERP packages. One of the most notable was PeopleSoft's acquisition of Red Pepper in September 1997. After acquiring Red Pepper, PeopleSoft were able to market its combined ERP-SCP package as ERO, for Enterprise Resource Optimization.

SAP's SCOPE[†], to be launched between mid- and end-1998 will challenge the opinions of the many current literature that ERP vendors are unable to provide supply-chain functionality to match best-of-breed SCP vendors. SCOPE will also challenge the assumptions that an SCP solution offered by an ERP vendor will only be compatible (without any external interfaces) with itself and not with other ERP systems. SCOPE was a result of SAP's massive research and development expenditure (totaling $500 million in 1997). It was shown to the public in an SAP conference in March 1998. In the sneak preview, SAP not only emphasized SCOPE's architecture and logic capability but more importantly, took a step closer to matching the best-of-breeds on their own turf. SCOPE was designed such that it can integrate with other ERP systems not necessarily R/3 (SAP's flagship ERP system).

[†]Supply-chain Operations, Planning and Execution

2.3 Mix-and-Match or Integrated Package?

The preceding section explored whether ERP packages currently have the capabilities to provide SCP-type functionality. This section will discuss whether it is better for companies to chose and piece together independent best-of-breed SCP packages or whether it is better to procure an ERP-type integrated package with limited supply-chain management functionality.

Stein[25] suggested that extended ERP packages have both advantages and disadvantages. One of the main advantage is the ability of users to run their front- and back-end operations on a single inter-linked system. This has many implications on cost-savings in terms of software license, software implementation, manpower as well as the training required for disparate systems. Also by running an integrated system, companies do not need to worry about the compatibility of the various systems that it is running.

There may be additional cost-savings that a company can reap if it does not have to create its own data-warehousing systems to interface between disparate systems. In addition, the cost of ownership of an integrated system will be significantly less than a collection of best-of-breed systems. It is cheaper and more cost-effective rely on one particular vendor for system support and maintenance rather than many vendors supporting different systems. When a company decides to upgrade its system, the cost of upgrading components of an integrated system will also be cheaper than upgrading components of a disjointed system. A company adopting the mix-and-match approach will have to concern itself with the issue of whether the new upgrade will be compatible with its other best-of-breed systems.

On the down-side, procuring a single integrated package also commits the company to

the fortunes of one ERP vendor. Since the process of ERP implementation can take several years, this is not a decision to be taken lightly. A cumbersome integrated system may also take up too much computing power or memory such that system overload is more likely to occur. As a result, certain critical transactions may be slowed down. In addition, as discussed previously, supply-chain functionality of ERP systems are extremely limited at present. Hence, in terms of the capability to optimize and to forecast supply and demand, procuring an integrated ERP package can put the buyer at a disadvantage when compared to a competitor which chose a collection of best-in-class applications.

However, the statement above regarding ERP's limited supply-chain functionality may not hold true much longer. Many analysts do not doubt that ERP vendors have the resources to catch up with the SCPs in terms of functionality. Already, there are companies adopting a similar approach to National Instrument[25], which picked Oracle's new SFA product over several best-of-breed rivals. National Instrument did not believe that they have lost any functionality by choosing an integrated ERP-based system over best-of-breed SCP systems. According to its vice-president, the costs and maintenance required to support third-party interfaces would be difficult to justify considering these interfaces are not required for an integrated system like Oracle.

Today, the trend seems to be to commit to a single vendor. For example, Northern Telecom (Nortel)[25] is looking to Baan for an integrated package that will include the ERP transaction backbone as well as sales-force automation (SFA) and other supply-chain technology that Baan acquired in early 1997. With the integrated package, Nortel hopes to be able to get its sales personnel equipped with pricing and availability details while on-site with customers. Also, using the supply-chain technology, Nortel would be able to run production simulations to configure a production schedule, identify bottlenecks, and allow

its employees to alter due dates or resources. Hence, manufacturing of Nortel's products can be carried out at the right time to meet its customers' demands.

Fujitsu and Pillsbury are other companies that would prefer a single integrated operating platform than piecing together various systems for different purposes. Fujitsu claimed that as a result of its many factories operating different supply-chain platforms, its ability to plan on a global scale was hindered. Pillsbury is also in the process of dismantling a variety of customized and packaged software that it has built over the years in favor of an integrated system from SAP, which it will use in Japan, Europe and North America. It also intends to incorporate its EDI system to SAP's integrated financial-ERP and order-management modules. The goal is to provide key information such that its business units around the world can plan strategically and in a timely fashion without the need to sift through a myriad of applications.

Bruce Richardson, the Vice-President of Advanced Manufacturing Research (AMR) in Boston, is a strong proponent of the integrated approach. During a presentation given at an SAP event in San Francisco on March 10th 1998, he claimed that of the companies that he had studied, on average, a dollar spent on an individual best-of-breed SCP system was matched by five dollars spent on developing the interfaces between the software and other components of the company's supply-chain management systems.

Another selling point of an integrated ERP approach such as SAP's R/3-based systems is the fact that some of these integrated systems are fast becoming the de-facto standard in many industries. Robert Rubin[30], CIO at Elf Atochem, a chemical maker, chose SAP over a best-of-breed software strategy because he believed that an ERP package will be more flexible to changing business needs. In addition, he also believed that SAP will dominate the chemical industry and become the de-facto software. Today, it is common to find big

vendors such as SAP, Oracle and PeopleSoft openly using the names of their clienteles to attract businesses to adopt their systems.

2.4 Coordination with Supply-Chain Partners

ERP and SCP tools enable companies to coordinate and optimize their internal supply-chains. EDI enables companies to communicate and coordinate with their external supply-chain partners. With the advent of the Internet, some SCP tools are beginning to move into areas previously monopolized by EDI systems. E-commerce is considered by many SCP vendors as their answer to external supply-chain data connectivity. Nevertheless, at the moment, coordination of software systems between supply-chain partners is weak at best[26]. This is exacerbated by the fact that most ERP and SCP systems do not provide good interaction with EDI systems. Many companies are simply unsure of how they can link their enterprise planning systems directly to the disparate applications of their suppliers and customers. Table 2.1[‡] shows an Ohio State University study on carrier transactions via EDI.

Year	% of total carrier transactions via EDI
1994	12
1996	19
1998	40
2000	56

Table 2.1: Ohio State University Study on Carrier Transactions via EDI

The uncertainty associated with EDI and its connectivity to ERP and other SCP systems

[‡]Source: Ohio State University, 1996 Annual Career Patterns Survey. Data for 1994 and 1996 represent actual numbers; data for 1998 and 2000 are forecasts.

has provided opportunities for companies that offer cross-application integration software to emerge and capture a viable niche market. One such software is Alliance, from startup vendor CrossRoute Software in California. Alliance was launched in October 1997 and uses the Internet or private IP networks to ensure a high level of cross-enterprise integration. It does so by letting commands entered in an ERP program trigger process changes and E-mail notifications in a business partner's application halfway around the globe.

Although the current version of Alliance requires some configuration by the user, by the summer of 1998, off-the-shelf packages that offer connections to ERP applications from SAP, Oracle and PeopleSoft will be available. There are other cross-application vendors such as Cross-Roads Software in California and Oberon Software in Massachusetts which are developing off-the-shelf connector packages that require minimum customization by the user.

Some quarters claimed that applications such as the Java-based Alliance, may eventually lead to the end of EDI. Wilder and Stein[26] stated that although EDI has provided cross-enterprise business links for many years, it is batch-oriented, rigidly formatted and prohibitively expensive for smaller companies. EDI simply do not provide real-time updates for companies seeking information about inventory or factory-floor data of the supplier-chain partners. EDI is essentially a two-way mode of communication. It does not allow a user to retrieve information on his or her own by direct-connect without the other party replying.

According to John DeBiel Jr., the vice-president of Revlon's[27] transportation department, EDI messages that were once channeled from trucker to shipper are now posted on the Internet. Thus, enabling Revlon's customers to check at their own time for constantly upgraded information. The Internet has also allowed companies such as NCH Corp., a $750 million manufacturer and direct marketer of specialty chemicals, and electrical-electronic

parts to rate shop for carriers automatically via a specially-configured program.

Another issue of ERP or SCP connectivity in coordinating the flow of information, goods and cash is the power to leverage against one's supply-chain partners. Kaman Industrial Technologies, an industrial equipment distributor based in Connecticut, is hoping to use such cross-enterprise integration applications like Alliance to do business online with its 1,700 suppliers. However, it does not expect its biggest customers such as Anheuser-Busch, Disney or General Motors to replace their EDI systems as they have made huge investments in EDI. Without the support of these big trading partners, adding a cross-enterprise integration system may not provide sufficiently justifiable payback. Adding a system that does not provide significant returns is merely adding costs.

2.5 Quantifying the Benefits of SCM Systems and Setting Goals

In an era where transportation and logistics are increasingly being viewed as important tools for creating and driving competitive advantages, logistics managers are urged to think like their CFOs[35][36], with a strong focus on costs and returns. Through effective supply-chain management, a company's free cash flow can be driven up through several key factors familiar to the CFOs[37]: sales growth, costs reduction, and the efficient use of working and fixed capital. Free cash flow translates directly to an increase in share-holder value. Hence, investments in supply-chain management systems should be made only when the benefits are clear and quantifiable. However, as revealed in the literature, this is often not the case. The problem is two-fold: How and what to quantify?

Rick Hendershot[31], a management consultant with IBM who has worked on managing

software technology for many supply-chain management improvements, noted that in many cases "teams don't know how to quantify planned business processes and improvements. Often, the debate turns subjective, where arguments are won through personality and clout, not facts and knowledge." As a result, projects undertaken may be ladened with low yield and high costs. Without a strong focus on results, software systems such as ERP often run late. Jim Johnson, chairman of the Standish Group International Inc., a research advisory company in Dennis, Massachusetts estimated that 90% of SAP projects exceed their original time schedule[38].

While it is clear that being able to quantify the benefits of IT in general and supply-chain management systems in particular is a key imperative towards reaping their benefits, there is no consensus in the literature towards any particular performance metric. It is estimated that only about half of the IT organizations use a broad ROI type of performance metric that analyzes tangible benefits (such as inventory reductions) against tangible costs[40]. Meta Group Inc., a Stamford, Connecticut-based IT research firm found that most companies simply assumed the benefits of IT systems as given. In his paper[40], Maglitta suggested three alternative approaches towards describing the benefits of supply-chain management software systems: business value-added, intangible value and net present value.

Although quantifying the benefits of software systems are difficult, Prof. Brynjolfsson at MIT managed to make some headways in terms of quantifying the benefits of computer hardware in general. In 1994, he examined the returns on investment of computer hardware for 380 large firms[41]. He found that the gross ROI averaged more than 50% per year for computers (including supercomputers, mainframes, minis and micros). Such figures are impressive compared to the typical 10% ROI for other types of investments. However, no such figure was available for quantifying ROI of software systems.

Chapter 3

Premises and Objectives of Study

Chapter 1 and Chapter 2 were important in order to lay the foundation for the premises and objectives of the study which will be discussed in this chapter. From Chapter 1, it was demonstrated that the goals and applications of supply-chain management are revolutionary yet realistic. Supply-chain management has carried the ideas of process-based management beyond the boundaries of a single company. Contrary to what some skeptics are claiming - that supply-chain management resembles a centrally-planned economy, the proliferation of cross-boundary information exchange is undoubtedly moving us towards the state of perfect information, a key tenet of market-based economy.

Hence, the questions should not the relevance of supply-chain management but how returns from investments related to its principles can be maximized. Prior to making any long-term strategic or mid-term tactical decisions regarding investments or changes in operations, companies often require appraisals of these investments such that expected benefits can be compared to expected costs. By looking specifically at how companies are using the enabling technologies of supply-chain management, we can isolate specific software investments which are quantifiable and look at their returns, which may be more intangible. In

Chapter 1, four groups of supply-chain software systems were identified. Hence, the focus of this thesis will be on these four systems currently in operation in many companies today.

Chapter 2 presented some current issues that are predominant in writings on the enabling technologies of supply-chain management. These writings point to a general lack of understanding or consensus in the industry with regards to the following key areas:

- Costs and duration of system implementation
- Objectives of system implementation and use
- Corporate policies toward SCM systems
- Traits of the best systems

3.1 Costs and Duration of System Implementation

An understanding of the costs and duration of system implementation is extremely important as technology, especially software technology, is ever-evolving. In the mid-1980s, Morgan Stanley & Co. economist Stephen Roach[41] first introduced the idea of the "productivity paradox" of information technology, in which studies showed that investments in technology do not appear to be paying off. Subsequent studies by Brynjolfsson in the 1990s countered that the "productivity paradox" of IT may no longer hold true. However, Brynjolfssons' studies do not focus specifically on software technology. ERP systems in particular can be painstakingly long to implement. Often, the implementation of SCM systems are carried out as part of business or operational changes taking place within a company. In such circumstances, software implementation may take even longer.

Therefore, an important part of the research will focus on why and what lead to the costs and time over-runs in software implementation. The research will also attempt to

answer the questions of how these over-runs can be avoided and highlight the ways in which companies are tackling this problem.

3.2 Objectives of System Implementation and Use

As discussed in the Chapter 2, some companies assume the benefits of implementing SCM systems as a given. While the first bullet point focuses on minimizing the price to pay for a system, this point emphasizes what companies hope to achieve with their SCM system and how this is actually reflected in the benefits that they reap. In their recent research, Brynjolfsson and Hitt[42] found that the objectives set by companies actually played an important role in determining the outcome of their IT investments. They classified "IT extroverts" as those who viewed IT primarily as a tool for increasing revenue through improving customer satisfaction, identifying and gaining new customers, improving the responsiveness of the company and enhancing the company's products and services. On the other hand, they classified "IT introverts" as those who focused on improving management control and management information, while emphasizing cost reduction and building an IT infrastructure. In their research, they found that the "extroverts" have a 3% higher productivity than the "introverts" and a productivity growth over 5 years which was 7% higher.

It would be interesting if a study on SCM systems were able to show how the benefits reaped by companies implementing these systems are correlated to the objectives that these companies set. Are there similar "extroverts" or "introverts" where SCM software are concerned? More importantly, how are companies quantifying the objectives of their SCM systems? As discovered in the literature review in Chapter 2, quantifying and isolating the benefits accrued to SCM systems, especially ERP systems, can be difficult if not impossible.

Nevertheless, it is clear that having a good idea of the system objectives is crucial to the success of SCM systems. Quantifying these successes, both at the developmental stage and at the final stages are the gray areas that need to be addressed.

3.3 Corporate Policies Toward SCM Systems

Corporate policies towards IT in general and SCM systems in particular are also key areas that can determine the outcome of success or failure for these systems. Corporate policies not only determine the amount of financial or resource commitment towards a certain project but also the direction of the project, its scope and the combination of outsourcing and internal development. In addition, some companies do not view SCM systems as a stand-alone project. Rather, the implementation of the SCM system is also part of a wider corporate re-engineering program. For ERP systems, this is generally the case. Corporate policies towards SCM systems also affect top management sponsorship. Facilitation of cross-functional teams by senior and top management personnel can make the difference between a successful implementation project and one that fails.

Given the implementation of SCM systems also requires companies to change many of their operational ways, corporate policies towards training and the management of change are also critically important. When analyzing corporate policies that encourage or discourage the effective use of SCM systems, we will analyze the role that external and internal drivers play. Are companies specifically using a system just to keep up with a large competitor? Also, what are the difficulties of using SCM systems such as EDI to establish the flow of information across supply-chain boundaries?

3.4 Traits of the Best Systems

This is another interesting question that is linked to the first, second and third point. There have been much debate as highlighted in Chapter 2 over which approach, a mixture of best-of-breed software or an integrated ERP-based system, will offer the most in terms of functionality of the system against the costs of implementation and use. What do companies view as being the best traits of an SCM system? Is it better for companies to value the speed of implementation over a comprehensive system set-up across the entire company? Do companies value functionality that was specifically customized for their industry over a general and flexible system that can be applied to all businesses?

It will also be interesting to explore if the best systems bring about changes in the way companies operate such that the best traits of these systems are the positive changes that they induce in the work-place: for example, discipline of data entry and ease of on-time data recovery. In short, the traits of the best systems can determine the benefits that will be reaped by the procuring company. As stated ,traits of the best systems refer to factors that go beyond simply the technical capabilities of these systems.

3.5 Summary

In summation, the four points discussed above all point to a single unifying premise: that companies generally do not have an agreement on how to ensure the greatest returns on investment from their SCM systems. Costing of SCM projects are generally lax. Although this may be by necessity rather than by design. Objectives desired of the systems are generally non-quantifiable. Corporate policies vary from companies to companies and there

is generally no agreement on how to value the traits of competing systems. Hence, it is the goal and objective of this thesis to identify the current issues and imperatives required for the optimum use of supply-chain enabling technologies. The imperatives to be identified and recommended will be derived from the four key areas discussed in this chapter.

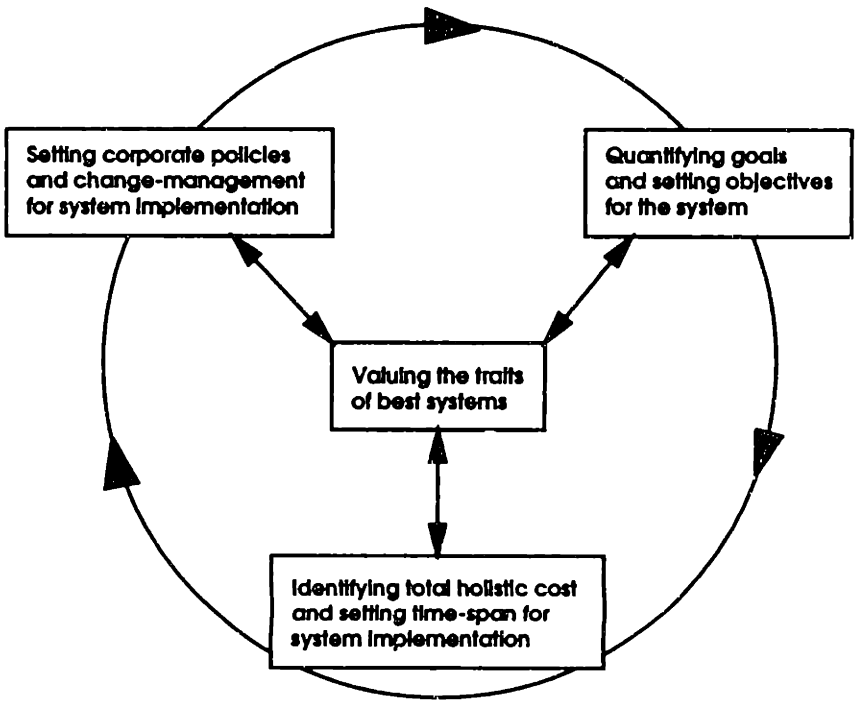


Figure 3.1: Key Factors of Consideration for Maximizing the Returns on SCM Systems Investments

Figure 3.1 shows a schematic of the four key areas of study of this thesis and their inexplicable links to each other. By identifying the best practices of today's industry in these four areas, a set of recommendation and key imperatives will be constructed. The study will also identify gaps of understanding in today's industry and set the stage for further research into these areas.

Chapter 4

Research Procedure and Data Analysis

4.1 Methodology

A thorough literature review of current journals were initially conducted to support the premises of this study. More than 16 journals ranging from logistics and transportation related journals to journals for information technology and manufacturing systems were reviewed. The literature review also provided the foundation for the planned telephone-interviews with corporate managers.

Prior to constructing the interview questions, Alreck[43]'s highly instructive and authoritative book on survey research was consulted. In the book, Alreck provided instructions on how survey questions can be constructed in order to eliminate biases on both the interviewer and the respondent. Instructions were also given on sample design and data analysis. From careful consideration of survey methods suggested in the book and from analyzing our own requirements and constraints, it was decided that a phone survey would be the most

appropriate.

A telephone interview was chosen as the primary mean of data collection for the following reasons:

- Higher likelihood of reply compared to mailing or faxing
- Flexibility of phone survey to real-time changes in the depth of questions asked
- Companies are more comfortable giving anecdotal answers than hard numbers
- "On-the-spot" answers allow us to identify gaps in understanding of best practices
- Time constraints ruling out the mail survey or on-site interview method

The telephone survey was structured such that it will take between 30-45 minutes of the respondent's time. As the survey depends completely on the interest of the respondents, duration of the interviews may vary significantly from one respondent to another. Nevertheless, the average time spent with respondents are about 35 minutes. More than 300 phone calls were made and as a result, 20 companies were contacted.

4.2 Data Composition

Of the 20 companies contacted, 7 are in the food industry, another 7 are in the chemical industry, 3 are in the high-tech or electronics industry, and one each in the apparel industry, personal care industry and the grocery industry. All the participating companies are represented at the Council of Logistics Management. The telephone interviews were usually conducted with a Director or Vice-President of logistics-related functions. At other instances, the interviews were conducted with an executive in-charged of software implementation.

The following companies participated in the telephone interview:

Food

1. United Grain Growers, Canada
2. Basic American Foods
3. Dole Packaged Foods
4. Nalleys Fine Foods
5. Ralcorp
6. Idahoan Foods
7. Nestle Frozen Foods

Chemical

1. Occidental Chemical Co.
2. Monsanto Co.
3. EI Dupont de Nemours
4. BASF
5. Air Products
6. Rohm & Haas
7. Eastman Chemical Co.

Electronics and High Tech

1. Honeywell Inc.
2. Packard Bell
3. Hewlett Packard

Grocery

1. Hannaford Bros.

Personal Care

1. Lever Brothers

Apparel

1. Sara Lee Corporation, Personal Products Division

In addition, 2 vendors: i2 and PeopleSoft also took an active part in the study by providing written feedback that will be discussed in more detail in the following chapters. Input from SAP was obtained through the conference entitled, "ERP: The Next Generation," organized by SAP in San Francisco from March 9th - March 11th, 1998. Input from Gillette, a personal care company, was obtained through a presentation and subsequent question and answer session with the company CIO, Mr. Pat Zilvitis, during his lecture at MIT.

4.3 Approach to Data Analysis

The largely anecdotal interview data collected from participating companies will be analyzed and discussed in the following chapters. These data will be grouped and examined under the headings suggested in Fig. 3.1.

These anecdotal data will be compared to identify best practices in each industry. As an agreement on proprietary information were made with all participating companies, data presented will not be attached to any specific company but will be an integrated industry-wide number. For those industries that are only represented by a single company, their data will be grouped together under *miscellaneous industry* such that their individual input cannot be identified. No proprietary information was asked of the vendors, and information from them will be identified to the specific vendor.

As stated previously, this study will examine the best practices and imperatives in the selection and implementation of supply-chain enabling systems. At this juncture, it is apt to define how best practices and imperatives will be identified. Given that each company is in a different stage of software implementation and use than another, direct comparisons between companies may be both difficult and not very meaningful. Nevertheless, the best practices and imperatives for maximizing the benefits from supply-chain enabling systems are identified as best possible through the following ways:

1. Comparisons of quantifiable cost-savings and revenue-enhancements

Companies that participated in the study will be asked to share quantifiable benefits that can be directly attributed to the software applications. These figures are then compared to numbers given by companies in the same industry to determine the best returns on the software procured. Actions or factors identified by the company (with the highest returns) as reasons for its successes can be nominally determined as best practices.

In the event that this is not possible, another method can be used to identify some best practices of firms in selection and implementation of supply-chain systems. Participating companies are also asked for the expected as well as actual benefits accrued from implementing the systems. Comparisons of which companies actually achieve or are close to achieving benefits expected will provide indications of some best practices in software selection and implementation. This approach must be carried out with the awareness and assumption that no company is overestimating or underestimating the benefits that can be derived from their software systems. For the three companies that are sole representative of their industry segment, comparisons among companies are meaningless and hence, comparison of expected versus planned benefits may be the only viable alternative.

2. Comparisons of non-quantifiable anecdotal benefits

It may also important also be important to consider the more intangible benefits such as improvements in customer satisfaction. Here, the method of identifying best practices and imperatives are as mentioned in the preceding subsection. The only difference is that instead of comparing quantifiable benefits, it is non-quantifiable benefits that are compared. Comparing non-quantifiable benefits are undoubtedly more subjective. Therefore, I have ranked this method lower in terms of importance than the preceding method above.

3. Analysis of impediments and worst practices

By interviewing companies regarding the impediments that they faced and practices that they regretted, recommendations can be suggested as to how these impediments can be overcome and the bad practices avoided.

Hence, this is an indirect way of arriving at best practices and imperatives for the selection and implementation of supply-chain software systems. It is a method that involves proving something by disproving its opposite. Such an indirect method obviously has less value than the previous two direct methods of identifying practices that reaped tangible and intangible benefits.

4. Recommendations from vendors based on their customers' experience

Recommendations from the vendors based on their customers' experience can be an important source of information. The vendors would have 1) marketing information about what their customers need, and 2) information derived from providing support in implementation and consultancy to their customers.

However, inputs from vendors may be somewhat devalued by the fact that they are general in nature and do not refer to any specific industry in particular. In addition, vendors wou'd understandably tout the relative benefits of their systems with respect to those of other vendors.

5. Recommendations derived from literature review and past studies

Recommendations derived from the literature review will be used to augment the findings of the study where applicable. It is also feasible that the study might shed some light on recommendations that were unsubstantiated in the literature, thereby reinforcing them. In general, the articles and writings in the literature reviewed tend to focus on one or a few practices that were considered beneficial. However, they do not relate the synergies of these practices to each other and only consider these practices in isolation.

Literature on change management has been well researched and written. Hence, when reference are made to this aspect of supply-chain software implementation, they will only be stated and not dwelled on in depth.

Chapter 5

Valuing the Traits of Software Systems

5.1 Chapter Brief

> "When an army goes forth and crosses a border, it should burn its boats and bridges to show the populace that it has no intent of looking back," Sun Tzu - The Ancient Art of War.

This ageless saying is today the generally accepted wisdom among many corporate CIOs and system managers when asked why they have persisted with their systems although better systems are already in the market. Pat Zilvitis, the CIO of Gillette noted that although the SAP implementation across Gillette will take an estimated 5 years, turning back is not possible just because there is a newer system with more functionality and shorter implementation time frame. Therefore, given the long time commitment that is usually associated with ERP systems (although SCP systems generally require a shorter time for implementation), selection of software systems should be given the utmost priority.

In this chapter, the reasons for companies to choose either an integrated approach or a mix-and-match approach to the enabling software for supply-chain management will be identified and discussed. Traits most important to companies in selecting their systems and the desired improvements from these systems will also be discussed. In addition, the correlation between system choice and system satisfaction will be examined. Finally, trends found among companies satisfied with their software systems will be presented.

5.2 Current Issues

In the selection of software systems, companies also consider the issues associated with implementation, such as resources to be committed and time required. Hence, understanding what constitutes the traits of software systems most suitable to different companies' operational needs are issues and imperatives of both selection and implementation.

As discussed in Chapter 2, the question of whether ERP vendors are capable of venturing into the turf currently occupied by best-of-breed SCP vendors is one of the issues of contention. Given the resources of major ERP vendors to either develop or acquire supply-chain software technologies, capability may be just an issue of time. Similarly, SCP vendors are not likely to rest on their laurels. Hence, the more pertinent issue should be whether a mix-and-match approach of assembling a group of best-of-breed SCP systems is better or worst than adopting an integrated approach from a single ERP vendor. Section 2.3 highlighted some of the current literature on this issue, and discussed advantages and disadvantages of both approaches.

The dilemma facing companies contemplating software systems for the supply-chain operations can be summed into the following issues:

1. Costs of acquisition and implementation *versus* Costs of ownership

The costs of acquiring an integrated ERP system can be greater than acquiring individual best-of-breed supply-chain software systems. If the costs and duration of implementation are taken into consideration, then the chasm of costs widens even further.

However, ERP vendors have countered by claiming that the costs of ownership are much less for an integrated system than for a mix of best-of-breed systems. By adopting an integrated system, companies need to deal with only one supplier for system support. In terms of implementation costs, upgrades are also likely to be cheaper with an integrated system. Companies upgrading specific parts of their system need not worry about the compatibility of the new upgrade with other systems that they operate. On the other hand, companies upgrading a component of their mix-and-match systems have to be concerned about ensuring the compatibility of the new upgrade with the rests of their systems.

2. Higher Functional Advantages of Specialization *versus* Lower Cost Advantages of Generalization

Best-of-breed systems allow the procuring company to select the best functions required and hence, the best packages that will work for the company's specific needs. For example, a chemical company may select X for warehouse or distribution management because X is reputed to be the most advanced and reliable system for warehouse and distribution management. Similarly, it may then proceed to select Y for supply-chain optimization and Z for forecasting.

On the other hand, some companies may not have the capabilities or the resources to piece together many disparate systems. In addition, their operations may be too varied

for specialized systems to handle optimally. For example, a food company may desire a warehouse management system that comes with transportation planning. However, the company may not be willing to spend on two separate systems and may feel that a more general ERP-based integrated system can suit its needs better. The company may also choose a broader-based integrated approach because it feels that it is already operating very efficiently and does not envision much more improvements with specialized systems.

3. Ease of use *versus* Complex functionality

Although companies implementing ERP systems have often complained about the large amount of customization work required and the difficulties associated with running the many complicated functions of these systems (such as data entry), they have nevertheless petitioned ERP vendors for even more functionality. Among users, it is unclear whether ease of use or complex advanced functionality is more important.

Questions that are important to these companies will be: Does an integrated ERP package offer greater ease-of-use over a mix of best-of-breed systems and does a mix of best-of-breed systems offer more functionality than an integrated ERP package? Which is more important to their companies, both now and in the future?

5.3 Study Questions

Companies interviewed were asked to rank how important certain traits of a software system were to them in their selection process. They were asked if these traits were very important, important or not important as a selection criteria. The following selection criteria were posed:

1. Basic functionality of the system
2. Flexibility or multiple uses of the system to changing business needs
3. Ability of the system to be upgraded
4. Ease of transition from or degree of compatibility with existing legacy system
5. Reputation of the software system or vendor
6. Required skill level for personnel using the system or the ease of use
7. Speed of system implementation
8. Industry-specific software application
9. Vendor's support and maintenance
10. Amount of resources to be committed to the system

The company representatives were also asked to justify their selection of an integrated ERP-based supply-chain software system against assembling a mix of best-of-breed systems offered by SCP vendors or vice-versa. A mix-and-match approach can also include an ERP system as the transaction backbone. Another question posed was what they think should be improved in the next release of the software system that they are currently implementing or using.

Lastly, for this category of questions, the company representatives were also asked if they were satisfied with their systems.

5.4 Study Findings

5.4.1 Chemical Companies

Fig. 5.1 shows how the seven chemical companies view the various system traits that were outlined in Section 5.3. From Fig. 5.1, it can seen that most important to these chemical

companies are: i) The amount of resources to be committed to the software system, and ii) The flexibility of the system to changing business needs. Least important are: i) Ease of transition from existing legacy system, and ii) Vendors' support and maintenance. Several reasons for chemical companies to prioritize the various traits of a software system as detailed in Fig. 5.1 can be identified.

First, chemical companies present different problems to supply-chain specialists and software vendors because unlike discrete manufacturing companies, chemical manufacturing is often a continuous process. Hence, issues of inventory levels hold a different concern to chemical manufacturers than to other manufacturers of more discrete goods. The more pressing issue is the swift channeling of finished chemicals to their distribution centers or customers. The "push" nature of chemical production requires that inventory levels be managed not through limiting the manufacturing processes but through the effective distribution of finished products.

As a result, some of the chemical companies interviewed stressed the importance of both forecasting as well as network optimization. Forecasting draws information from customer demand through distribution terminals of the company. Transportation and distribution activities are then optimized through a supply-chain optimizer or network planner. The optimization process should be focused on not only the channels of transportation but more importantly the nodes, where bottlenecks can occur. For one chemical company, the importance of a supply-chain optimizer is made even greater by the seasonal nature of its demand. This explains the high importance placed on the flexibility of the system to meet various business requirements of the company.

Second, a few of the chemical companies interviewed claimed that in general, the chemical industry is still relatively new to utilizing supply-chain software systems for supply-chain

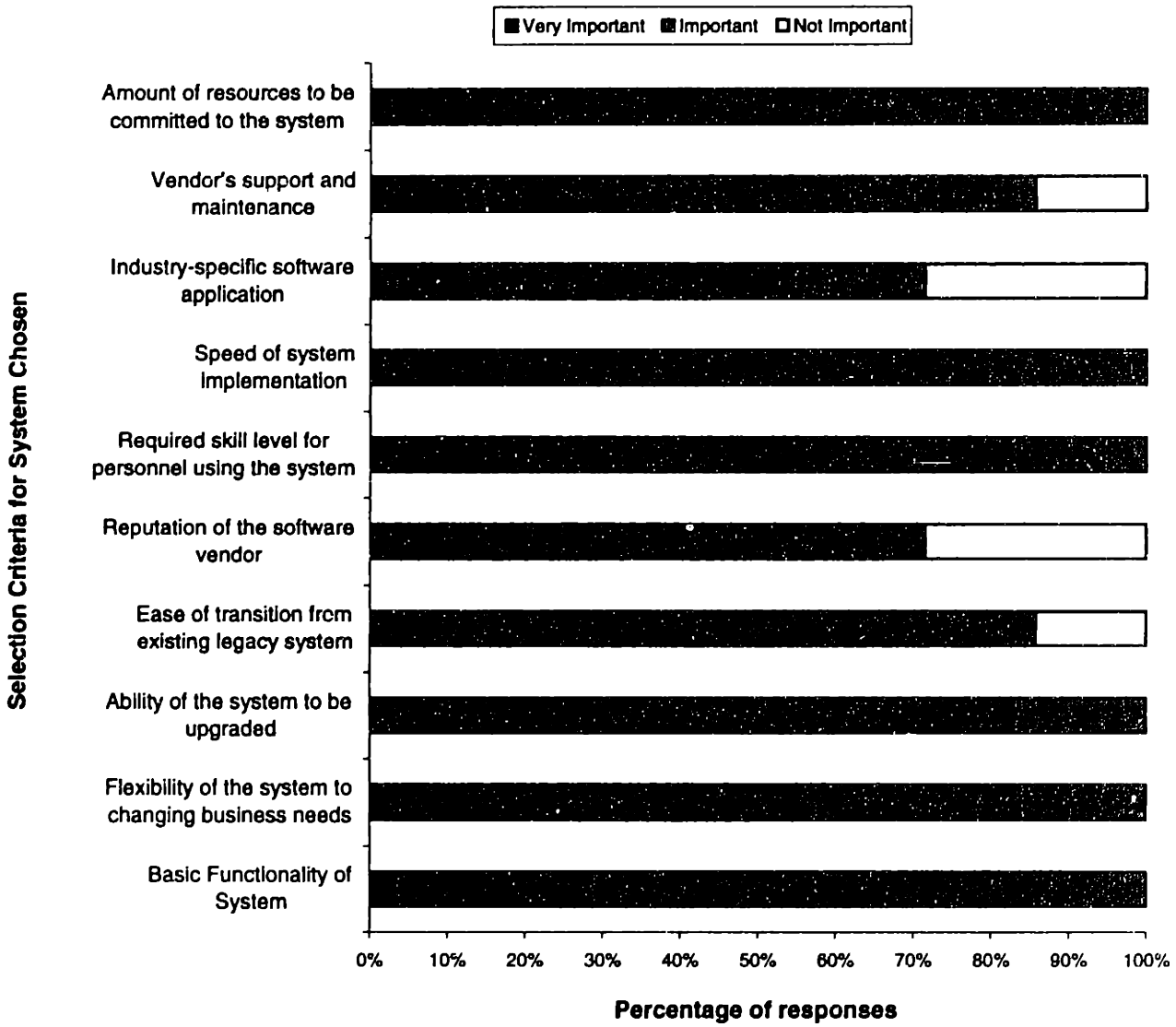


Figure 5.1: Factors Considered in the Selection of Software Systems by Chemical Companies Interviewed

management. In one company, the respondent professed to simply using Microsoft Excel worksheets prior to procuring dedicated supply-chain software systems. Many companies simply did not possess sophisticated legacy systems dedicated to supply-chain management.

Hence, the relative lack of knowledge and experience among the chemical companies explains why they do not consider the ease of transition from an existing legacy system as an important issue. It also explains the reason for a high number of companies interviewed that rank the amount of resources to be committed to the system as very important. Due to their relative inexperience, these chemical companies are especially wary about committing too much resources to software system implementation. One company actually chose a vendor from the same state simply because of cost benefits associated with the proximity of the vendor to the company.

All the companies interviewed adopted a mix-and-match approach towards supply-chain software procurement. More than half opted to build best-of-breed systems around their ERP systems (either already operational or in implementation). Given that chemical companies consider the amount of resources to be committed to the system implementation as either important or very important, it can be inferred that going with a mix-and-match and best-of-breed approach has cost benefits over an integrated approach (using only one vendor) for these companies.

Two common reasons given for adopting a mixture of best-of-breed systems are:

1. **The functionality required is available now for best-of-breed systems.** Some companies just cannot afford to wait for ERP-vendors to catch up in terms of providing the advanced functionality required. This is actually the biggest reason for companies to go for best-of-breed approach. Almost every company interviewed expressed that current ERP

systems do not provide them with the requirements that they need. The lack of suitable off-the-shelf packages even led one company to develop its own application, with the help of external consultants.

2. Companies are confident that compatibility of various systems will not be much of an issue in terms of cost. Some of the companies interviewed stated that they do not expect the costs of putting together best-of-breed systems to be more than those of implementing a full-range integrated system.

One of the most common complaints from dissatisfied chemical companies is not reaping enough benefits due to the fact that recommendations from the software system are not workable. For example, one user's system recommended a highly profitable shipping lane. However, that shipping lane is not viable because it only works for one product line and the firms' customers require several different products, not necessarily at the same time. Hence, software logic and algorithm architecture are not sophisticated enough to account for the various contraints.

On the same note, one company felt that it would be better if vendors will actually offer more industry specific templates for data input. The company feels that much time and effort can be saved if chemical industry-specific templates were available. Another company interviewed would like to see the interface and integration points of the software systems be more user-friendly and idiot-proof. In the same vein, another company complained about the lack of an intuitive Graphical User Interface (GUI) of the system it acquired. A better user-interface will relieve the tedium of data-entry of that these software systems require.

5.4.2 Food Companies

Fig. 5.2 shows how the seven food companies view the various system traits that were outlined in Section 5.3. From Fig. 5.2, it can seen that most important to these food companies are: i) Basic functionality of the system, and ii) The flexibility of the system to changing business needs. Closely behind in terms of importance are i) The vendors' support and maintenance, and ii) The reputation of the software vendors. Least important are: i) Ease of transition from existing legacy system, and ii) Industry specific software application. Several reasons for food companies to prioritize the various traits of a software system as detailed in Fig. 5.2 can be identified.

In general, food companies seemed to be in-tuned with the requirements of managing their supply-chains while at the same time accepting that they are not experts in software development or use. This is typified by the comments of one company representative that, "If you focused on doing 20% of the things you want to do right, you will achieve 80% of your targeted goals." Most food companies seemed to agree with him as 80% feel that the basic functionality of the system they purchase is the most important criterion of consideration in software procurement or development.

Such a focused knowledge of what their software had to do coupled with an outsourcing mentality of using the best vendors possible, have made food companies place great importance on the vendors' support and maintenance and their reputation. Only one company interviewed did not feel that these two factors are important as the company chose to develop its own client-server type supply-chain application. Reputation is extremely important because according to one company, "It is a big investment and we want to be sure that it's not a fly-by-night company."

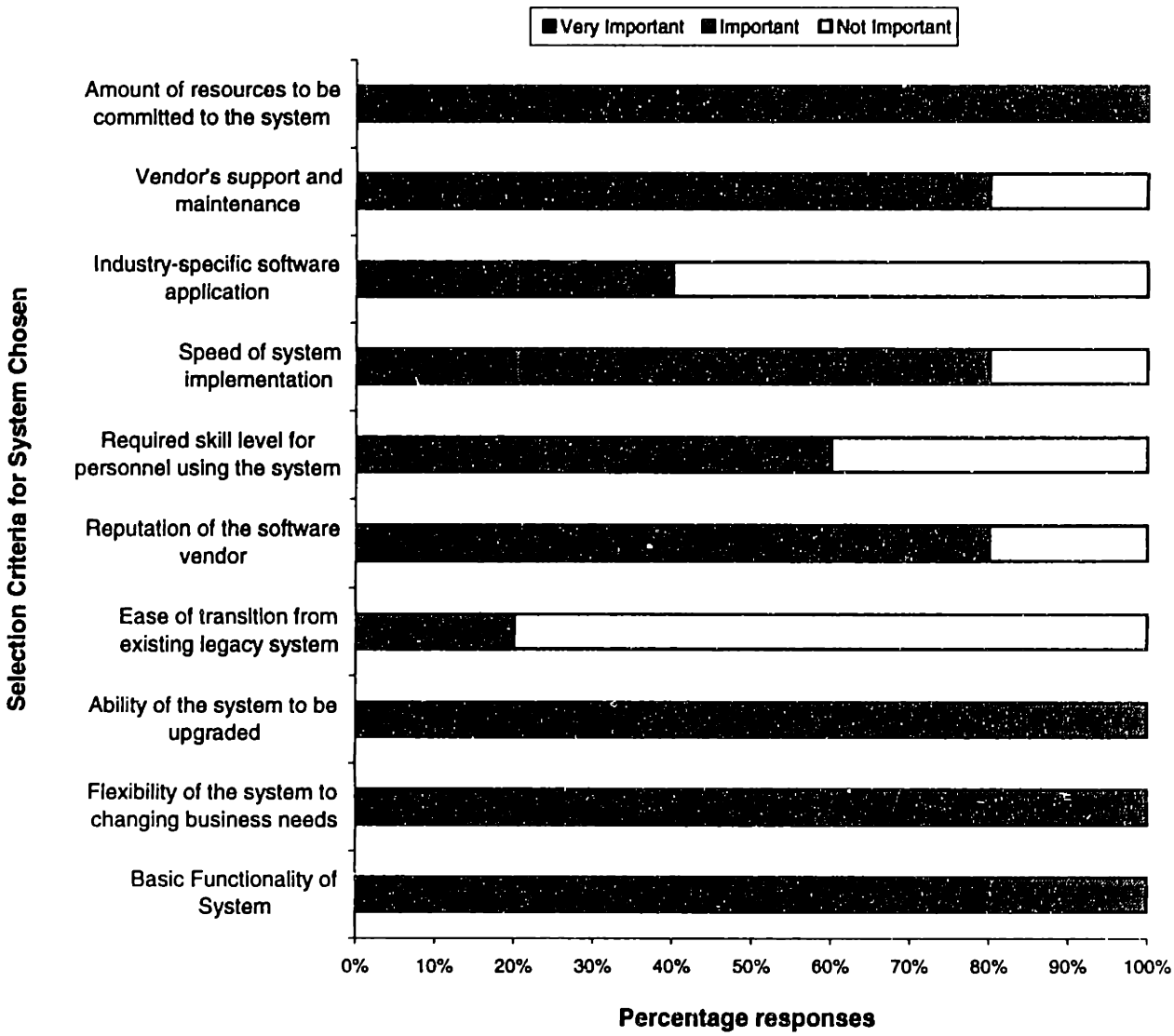


Figure 5.2: Factors Considered in the Selection of Software Systems by Food Companies Interviewed

Similar to chemical companies, food companies do not view the ease of transition from existing legacy systems as important. In fact, more than 80% felt that it was not an important issue. Most feel that whether they like it or not, they have to get off their outdated legacy systems. In addition, some of the companies interviewed are confident that the chosen vendors, based on their experience and reputation, would have little difficulty in helping these companies make the transition from their legacy systems.

Of the seven food companies interviewed, three chose a purely integrated approach centered on a single ERP system, two others preferred a mix-and-match approach, with best-of-breed SCP systems sitting on top of their ERP systems. One company chose to use only an SCP system while another food company developed its own application. Several reasons can be identified as to why three of the food companies preferred an integrated approach and two others chose a mix-and-match approach with an ERP system as its transactional backbone:

1. Given that most of the food companies are already aware of the benefits associated with supply-chain management, they are not new to utilizing software systems to aid effective planning and scheduling of their supply-chain functions. As one company representative pointed out, his company is already very efficient and couldn't see many other improvements. They felt that getting an extra 10% improvement with a best-of-breed solution was just not worthwhile. The main issue was getting the biggest "bang-for-the-buck".

2. Several companies also expressed their opinion that in general, the food industry is not very sophisticated in terms of its software requirements. Therefore, the functionality required can be satisfied by ERP-based solutions. This is further reinforced by many of these companies' perceived need for a transactional based system. One company actually recounted how since the MIS was also the company's controller, it was not difficult to see

why a transactional-centric system was chosen.

3. Related to the two points above, a few of these companies also feel that since they are already implementing an ERP system, it is more cost-effective and prudent to adopt an integrated approach. Savings can be made from having to handle only one implementation project and outsourcing to only one group of dedicated IT consultants.

With regards to improvements desired for the system that they are implementing or already implemented, food companies typically wish for better functionality and data connectivity. Sales force automation was identified by one company as an area that would be very attractive in the company's drive to push inventory even lower. The need for forecasting data to tie in with sales, marketing and planning was reiterated by two other companies interviewed. Other functionalities desired by three other respondents were associated with information exchange between companies. In general, these companies desire functionality that supported VMI, EDI and Internet-based data exchange.

5.4.3 Electronics and *Miscellaneous* Companies

Since there were only three companies represented in the Electronics and High-Tech industry and another three *miscellaneous* companies, it is not very meaningful to discuss them in comparison with each other. Therefore, I have presented the chart of all 20 companies interviewed instead. Please refer to Fig. 5.3 for the chart of how the 20 companies interviewed rank the different selection criteria for a software system. Nevertheless, the discussion in this section will focus on the remaining six companies not yet discussed.

Of these six companies, four are adopting a best-of-breed SCP approach while the re-

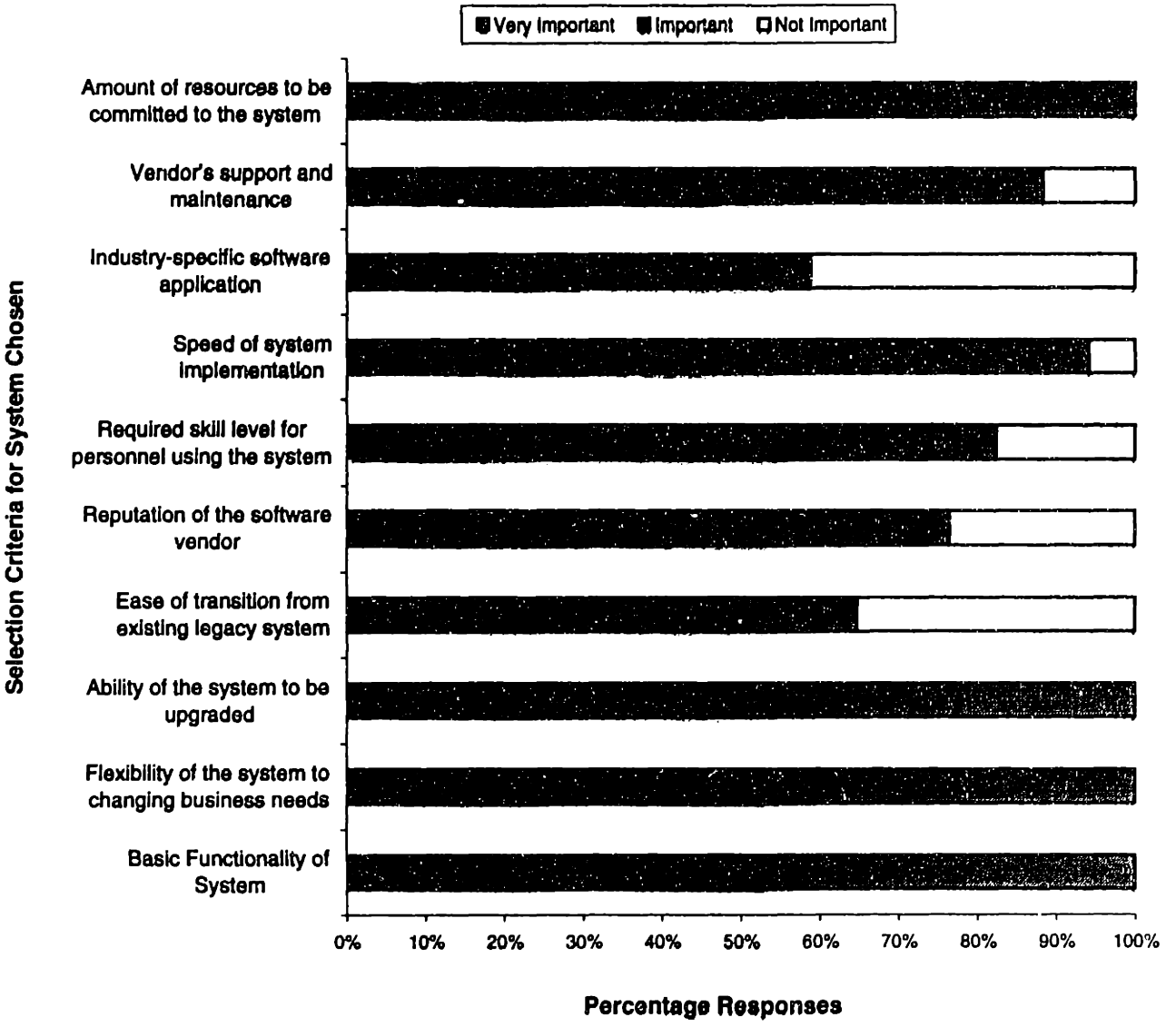


Figure 5.3: Factors Considered in the Selection of Software Systems by All Companies Interviewed

maining two are adopting an integrated ERP approach. Among the reasons stated for adopting a best-of-breed approach that were not mentioned by the two previous industries are:

1. The flexibility associated with a best-of-breed approach. One company was very comfortable with its legacy system and is in fact, in the process of enhancing it. Changing to an ERP-based system may duplicate some of the functions of its legacy system and the company was not willing to switch completely from its home-grown system to an off-the-shelf ERP system.

2. Another company tried to look at ERP systems for its purposes but felt that ERP systems are too centered on manufacturing companies. Since the company felt that it wasn't a manufacturing-centric company, it did not feel that an ERP-based system will suit it well.

3. Two other companies just simply did not feel that they need a transactional system. ERP systems are usually criticized for their lack of functionality. It was interesting to find that they can be faulted for their main functionality too.

For desired improvements in future applications, one company pointed out that in the event that a user realized something that the system didn't, the ability to perform manual override would be highly advantageous. Another complaint by the same company was the difficulty associated with setting up an optimization recipe. The many steps involved was deemed to be too difficult and tedious. In short, user-friendliness was a highly important to the company. This was also echoed by another company under this category. The remaining companies just felt that functionality could be improved - especially in the areas of forecasting and decision support.

5.5 Vendors' Perspective

Traditionally, ERP vendors and SCP vendors typically differ on what they think are important to their customers. One focused on creating a cross-enterprise information infrastructure while the other concentrated on functionalities that make use of these available data. However, this is changing as ERP vendors become more in-tune with market demand and begin making inroads into markets previously monopolized by SCP vendors. The launching of SCOPE by SAP showed that ERP systems are beginning to emphasize the speed of implementation, flexibility of the system to changing business needs, and ensuring applicable functionality of the system, even to the extent of making them industry-specific.

The two vendors (i2 and PeopleSoft) that participated in the study considered almost all the selection criteria posed to the companies interviewed as important or extremely important. The only exception was the reputation of the vendor, where one company self-effacingly noted as not important. i2 is a market-leader in SCP systems while PeopleSoft is a key player in the ERP industry. With the purchase of RedPepper, PeopleSoft also become a key player in the SCP industry today. The similarity in the way the two companies viewed the importance of certain traits of their systems added weight to the notion that vendors' are increasingly converging on the degree of importance they place on the various characteristics of their software systems.

When questioned on what factors they think are important to companies when choosing their system, the vendors listed the following points (not in order of importance):

1. Results-oriented nature of their products
2. Track record of customer successes
3. Expertise in planning and in the specific industries

4. Size and reputation of the vendor
5. Breadth and depth of the available products

5.6 Summary of Practices

As stated previously, the companies interviewed were also asked to judge on the whole, their degree of satisfaction with their software systems. Please refer to Fig. 5.4 for a graphical breakdown of the level of satisfaction of companies with respect to their procured software system.

Overall, 70% of the companies interviewed were either satisfied or very satisfied with their software system. Only 20% were mildly dissatisfied or dissatisfied (Please refer to Fig. 5.5). Among the four companies that were either mildly dissatisfied or dissatisfied, one was using a mix-and-match combination of several specialized SCP systems while three others were using integrated systems that revolve around a transactional-based system. It is too early at this stage to state that the dissatisfaction voiced by the four companies was due to the system itself, and that one approach was better than another. Nevertheless, in terms of system traits, we can identify several important trends among companies that were satisfied with their system:

1. Satisfied companies were keen to emphasize the flexibility of their systems to meet changing business needs. They did not simply want a system that will let them approach only the current aspects of their business, but one that is adaptable as business grows, customer demand changes and market shifts.

2. Satisfied companies desired systems that were tailored specifically for their needs and

the nature of the business that they are in. Excessive functionality can be an equal bane as shortage of functionality. Having the proper functionality which matched their industry requirements also enabled greater ease-of-use, a feature that many companies desired. All the companies that chose to develop their own applications have been found to be very satisfied with their efforts.

3. Satisfied companies did not view the reputation of the vendors as important as the support that were available from these vendors. The implied quality of a vendor's product (from its reputation) was regarded as less important as the help from the vendor in tailoring the product for the company's needs and extending sufficient support during software implementation.

4. Lastly, the companies which expressed satisfaction with their software systems viewed the amount of resources to be spent on system implementation and use as either important or very important. This disciplined approach to costing will be discussed in more detail in the following chapter.

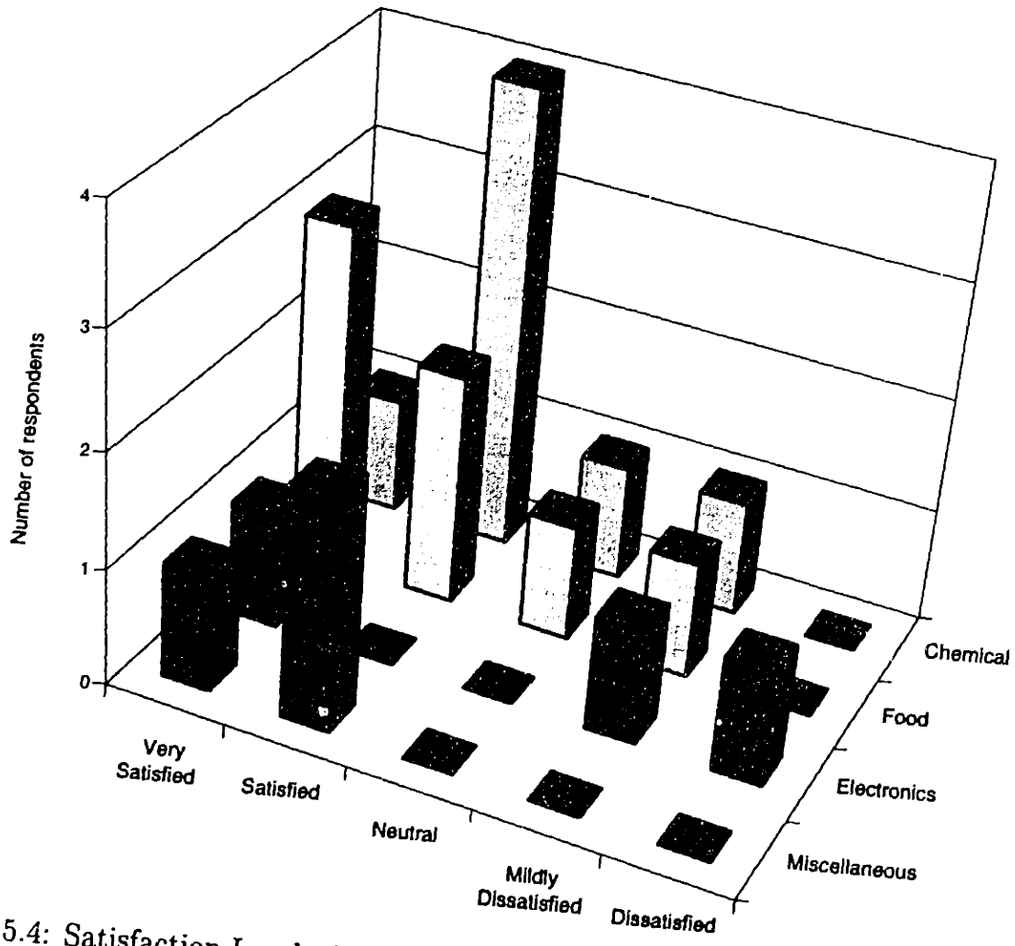


Figure 5.4: Satisfaction Level of Companies Towards Their Supply-chain Software Systems

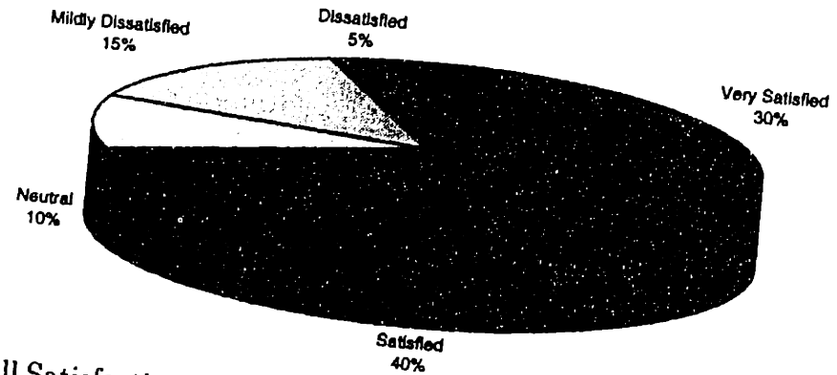


Figure 5.5: Overall Satisfaction of Companies Towards Their Supply-chain Software Systems

Chapter 6

Project Costing and Setting Time-Line

6.1 Chapter Brief

> "Statistics are like bikinis. What they reveal is suggestive, but what they conceal is vital," Aaron Levenstein

The same can be said of a majority of budgets and project-costings of supply-chain software systems. Often, projected costs reveal only a hint of the most necessarily expenditures. However, as the cliche goes, the greater harm lies in the details.

In this chapter, the project costing of companies in procuring and implementing supply-chain software systems will be examined. Reasons for costs overruns will also be analyzed and classified under internal and external factors. Actions by companies that were able to keep within their pre-planned financial and time expenditure will also be identified and discussed.

6.2 Current Issues

As stated in Chapter 2, ERP implementations often exceed their budgeted costs. In addition, they also tend to take much longer than expected. In Chapter 2, the five areas identified by Slater[39] as commonly overlooked by companies in costing for an ERP system are: training, integration and testing, data conversion, data analysis, and consultancy fees. It is unclear whether SCP systems also suffer from the same malaise of cost and time overruns that afflict many ERP implementations. What is clear is that companies which anticipated all the likely costs of their system implementations are more likely to succeed quicker and better than companies that failed to anticipate the costs likely to surface in the implementation process.

Kapp[47] pointed out that successful companies which managed to rein in costs and implemented their systems according to the pre-set time schedule, tend to be those which first strived to understand their business processes, then to simplify these processes and finally, to automate their procedures. He called this the USA principle; for understand, simplify and automate. The importance of understanding the business processes and objectives desired from the implementation of a software system will be discussed in more detail in Chapter 7. In this chapter, the discussion will be mainly focused on other issues leading to costs and time over-runs and how companies can prepare themselves to avoid such pitfalls. Clearly, it is difficult to disentangle the misalignment of software system with business processes from the resulting cost over-runs. However, it was thought that by discussing it in the subsequent chapter, more attention can be paid to this important aspect of software implementation.

The issues associated with companies exceeding their pre-set time and cost schedules are complex and difficult. Did companies underestimate the extent of preparation necessary for the successful implementation of their software system? Or, were the software marketed

by vendors so broad that most systems require extensive customization before they can be used? As several companies noted, if the true costs of total system implementation were known, senior executives might be less enthusiastic about sanctioning the expenditure required. Therefore, in order to get their plans approved, were system executives consciously negligent in underestimating implementation costs?

Such issues could be avoided if companies were able to contrast the total cost of system implementation with figures for the total benefits that will be accrued with the system. However, as will be discussed in Chapter 7, quantifying the benefits from supply-chain software systems can be even harder than anticipating the full costs of system implementation. This vicious cycle of not being able to quantify either cost or benefits comprehensively is one of the key impediments facing companies seeking to maximize the returns on their supply chain software systems.

6.3 Study Questions

Companies interviewed were asked to compare their total implementation costs with planned or expected costs. The total implementation costs were defined as the total of software costs, hardware costs, consultancy fees, installation and implementation labor, training and even restructuring of operations required to run the system. Since it is unlikely that companies will be willing to disclose actual figures of their implementation costs, they were asked to give the percentage or multiples of these costs above or below that originally expected.

In addition, companies were also asked if they could identify areas where costs have exceeded the original amount or whether they could give reasons for additional time and financial expenditures which occurred during the software implementation.

It is expected that most companies will only give anecdotal information about their costs and time over-runs. Therefore, in the following section on findings from the company interviews, data reduction may be highly difficult. Hence, the information collected will be described instead of quantified. It is more important to understand why cost and time overruns occur rather than to actually quantify the numbers exceeded.

6.4 Study Findings

6.4.1 Chemical Companies

Of the seven chemical companies interviewed, four stated that they had exceeded either their budget or the original time scheduled for the software implementation. Two were on budget and schedule and one could not yet determine whether cost or time will exceed that originally planned. Please refer to Fig. 6.1a. Two companies which exceeded their budget and schedule adopted a mix of best-of-breed SCP systems. Hence, it can be concluded that for chemical companies, cost over-runs were not restricted to ERP-type projects. Supply-chain management systems such as those offered by SCP vendors were also susceptible to cost over-runs.

Even one of the two companies which were able to keep their implementation on schedule and on budget did so only through cutting back its original desired scope. The company had to lower its expectations of the system and to incorporate less functions than those it had originally planned. The company representative attributed the diminished scope of the project to the need for accommodating unanticipated training, necessary to get the company's employees competent with the new system.

The other company that was on target with its planned budget and time schedule made use of the fact that its business units were able to share a lot of centralized resources. It used two implementation teams and both were in-house. One team worked on the technical side, while the other concentrated on the business processes. The company emphasized understanding what is technically possible and devoted a lot of time towards building a "re-structuring map"- detailing business processes from materials to services to manufacturing and distribution planning. In total, the company spent a third of its total implementation time just on understanding the system and preparing for its implementation.

Of the 4 chemical companies which were implementing or already running an ERP system, the average time required to set up their ERP systems were 3 years. One company implemented its supply-chain optimization system at the same time in order to eliminate duplicating functions. For example, setting up the supply-chain optimization system together with the ERP system eliminate the need for reconfiguring data architecture and data interfaces later on.

For supply-chain systems offered by SCP vendors, the variations in implementation time can be very significant such that it is not meaningful to calculate an average figure. The time frame ranged from 3 months to 1 year to 3 years as most companies have differing scope in terms of functionality and the number of business units where they would like to implement the system.

At the company that took 3 years to implement its supply-chain system, several lessons can be learned. The company representative admitted that its supply-chain software acquisition was driven by the IT group within the company. Business and manufacturing units were then charged a specific amount (an internal transfer cost) for the use of the system. In view of the large time and financial investment into the implementation project, it is surprising

to find that business input was not sought prior to the procurement and implementation.

The company had many plants scattered around the world and ensuring data quality and compatibility was particularly difficult. Important business questions such as how yield would be calculated by the many plants were not considered prior to the system implementation. The company claimed that costs to install the software were pretty accurate. However, it was the costs of other important factors, such as changing business processes to suit the discipline and data quality required by the system that the company failed to anticipate. As a result, the total implementation costs were more than a staggering 15 times that of the software license.

For another company, costs and time exceeded those originally planned because the business unit in which the system was being implemented was essentially an alpha test site. For the ERP implementation, the primary reason for costs over-runs were due to the implementation team not being fully committed to the project. The implementation team had other responsibilities at the same time. For the firm's supply-chain scheduling system, the unexpected costs were associated with getting its employees trained to use the system. The company cited the transition period between using the old system and running the new system as the time period where costs were most likely to surge upwards. According to the company's representative, planning ahead to minimize this period of uncertainty will reduce the costs of system implementation substantially.

Another chemical company implemented a demand forecasting system and a logistics network optimization system in less than 12 months (although the two systems were implemented separately). For the system in which the respondent was directly involved with, the increase in expected costs was essentially due to a lack of business knowledge and understanding on the part of the software vendor. The vendor had little experience in dealing

with chemical companies and as a result, underestimated the cost and duration of the implementation process. The vendor was selected based on its technical expertise. However, most of its employees' experiences were based on their previous customers and not on working knowledge of running business operations.

The last chemical company developed its own application with order entry, forecasting, distribution and delivery scheduling, and billing. It could not identify any packages which matched its requirements. The design and development of the system took one year, with the company acquiring the assistance of several external consultants for their technical expertise. However, total implementation of the system, including the difficult migration from the old legacy system took 3-4 years. On the whole, the costs of the system were slightly above that planned as a result of the increase in scope and the company underestimating the tasks and rigors associated with the migration from the old system to the newly developed one.

6.4.2 Food Companies

Six of the seven food companies interviewed stated that their implementation costs were greater than the original budgeted figure. The remaining company could not yet ascertain whether costs will be on target, fall below or go above the planned number. Please refer to Fig. 6.1b. Although all of the six companies which went above their implementation budget were in different stages of their system implementation, the amount of costs exceeded ranged from slightly 4% more to a more worrisome 2 times higher. As was the case with the chemical companies, these increases in costs were not associated to ERP implementations alone.

For the company that was unable to ascertain whether costs will be above or below that originally planned, it outsourced its information technology (IT) group to an external

vendor. The outsourcing was a result of a corporate-wide reengineering program which took place within the company. The company's strategy was to mix-and-match, by combining a forecasting system with an ERP system from a different vendor. At the time of the interview, the company seemed to be pleased with its oursourcing arrangement. However, it was not stated whether there were any complications associated with the vendor not understanding the business processes of the company.

Another food processing or manufacturing company which chose a mix-and-match approach also decided to outsource its IT group. Some of the problems it encountered were due to a lack of support or mis-direction from its vendor. For example, it was given a version of the supply-chain system for testing. On conclusion of the testing procedures, the vendor returned with a newer version. The vendor in this case, was more concerned about ensuring a steady stream of profits rather than consider the budget allocation of its customers.

Unlike the chemical company which developed its own supply-chain application, the food company that developed its own application spent significantly more time on development than on implementation. On average, development of two key systems for forecasting and inventory management took 1 year while their implementation took only about 1-2 months. The company representative estimated that for the forecasting system, its costs were exceeded by about 30%. The implementation costs for the inventory management application were closer to the expected costs. However, it was unclear if these figures were accurate as the company representative noted that the costs of implementation for some items were considered as operational costs. Therefore, the actual cost overruns might be greater than the 30% mentioned.

At the company which chose an integrated approach from its ERP vendor, the excess in implementation costs was the result of engaging a less than competent third party consultant.

The company had to dismiss its first consultant as the consultant did not have sufficient know-how and expertise in the specific supply-chain management areas that the company needed improvement. The company was also disappointed with the consultant's lack of direction and projection in advancing the implementation through its various stages. As a result, the total implementation costs were 20% more than planned as the company had to restart the first 3 months of its implementation project.

For another company which adopted a similar integrated approach with a single system handling general accounting, distribution planning and inventory management, the actual costs of implementation were twice as high as the expected costs. However, any direct comparisons between this company and the other companies in the food industry will not be very meaningful as the company is already into its sixth year of implementation. The company attributed the increase in costs mainly to training of its employees in order to realign their skills to the level required. In addition, since the package was installed in several stages, the company had to customize many of the individual applications to better suit its needs. As a result, further increases in costs occured when newer applications and upgrades from the vendor were placed together with the customized applications and complications of compatibility developed.

6.4.3 Electronics and *Miscellaneous* Companies

Of the three electronics and high-tech companies, only one was willing or able to disclose if costs were above or below the expected number. As for the *miscellaneous* companies which participated in the study, two exceeded their initial estimates for implementation costs and one stayed on-budget. Please refer to Fig. 6.1c.

One of the electronics and high-tech companies exceeded its implementation costs slightly. However, the increase in costs was within the original expectations. The extra costs were due mainly to the company underestimating the construction of a data warehouse and supporting systems required to run the supply-chain systems to its full capability.

For the *miscellaneous* company that stayed on track with its budget, a best-of-breed approach was adopted without implementing an ERP system at the same time. The company implemented a best-of-breed system which will enable it to carry out supply-chain planning (including forecasting and advanced planning), stock appointment and inventory management. Eventhough the company managed to stay on budget, it cited an increase in scope as one of the main problems encountered during the implementation process.

The two other companies classified under this category also suffered from an increase in their implementation costs. Both had elected to use best-of-breed SCP systems. One company was in the process of implementing a warehouse management and transportation suite while the other was implementing a sophisticated data collection and demand forecasting tool. For one company, although the implementation time was only 2 years, costs were 2.5 times greater than the originally planned figure. The company attributed the increase in costs to a number of factors. First, workers were not adequately trained to implement the system as effectively and promptly as possible. Second, ensuring data structure was suitable to the procured system was also difficult. Not only did business processes had to be more disciplined in terms of data entry but the data warehouse itself had to be set up such that it provides a seamless flow of information into the software system.

6.5 Summary of Practices

From Fig. 6.1d, it can be seen that of the 20 companies interviewed, 65% exceeded their budget or allocated time for their software implementation. This figure is more than 4 times the 15% that were able to stay with their pre-implementation budget and schedule.

The interviews showed that an increase in costs and duration of implementation, commonly associated with cumbersome and enterprise-wide ERP systems, can also afflict process-specific tools such as best-of-breed SCP systems. In Chapter 2, several critical areas that were commonly overlooked by companies in costing for an ERP system were identified by Slater[39].

From the interviews, two broad categories of factors which led to an increase in the costs and time estimates were identified. First, there were factors associated with the companies themselves. These factors include:

1. Not anticipating the training required to realign the company's employees to the rigors demanded by the new system
2. Not anticipating the training required to train the company's employees to carry out the implementation effectively and efficiently
3. Underestimating the business process changes and rigors required to use the new system to its optimum potential.
4. An increase in scope during the implementation process as a result of the company being unclear on the original objectives desired of the system

5. No ownership by the business units on the software system. Implementation was essentially an IT endeavor.

6. Software implementation was carried out without full resource commitment and dedication. Companies may find it ironic that they have to spend in order to save.

7. Some companies may lack a clearly defined cost accounting process that prevents them from identifying certain costs associated with the implementation process. For example, these costs may have been classified as operational costs instead.

Second, there were also factors associated with the vendors and external consultants engaged to complete the implementation processes. These factors are:

1. Limited industry-specific business knowledge on the part of the vendors. This resulted in additional time and expenditure on getting the vendors acquainted with the requirements of the companies.

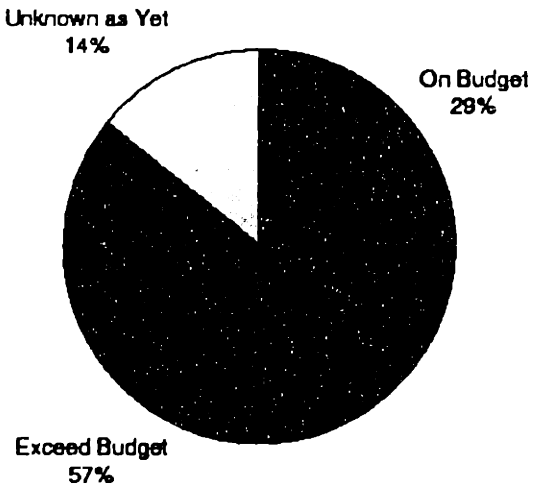
2. Agency costs associated with engaging external consultants. The consultants have an interest to prolong the implementation period as much as they can.

3. Lack of support and transparency of direction on the behalf of the vendors. By not disclosing new developments, vendors can prevent companies from stalling on procuring the vendors' currently available systems.

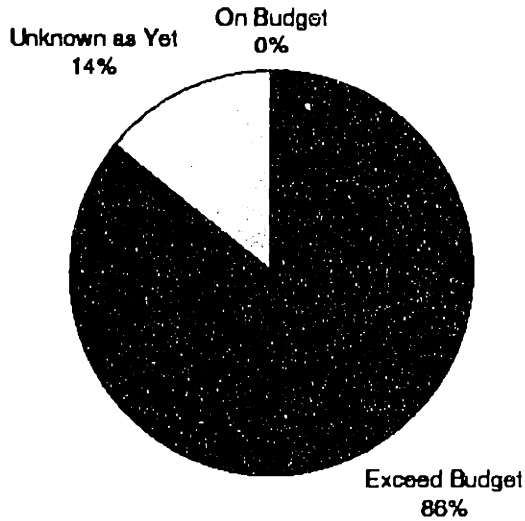
4. A combination of the company underestimating the needs for data interfaces between systems and vendors/consultants not capable or willing to support the development of these interfaces whole-heartedly.

Some common actions by companies which were able to maintain their pre-planned financial and time expenditure were identified as the following: (Note, however, that these actions by themselves do not necessarily guarantee that a company will be able to stay close to their anticipated costs and time-line)

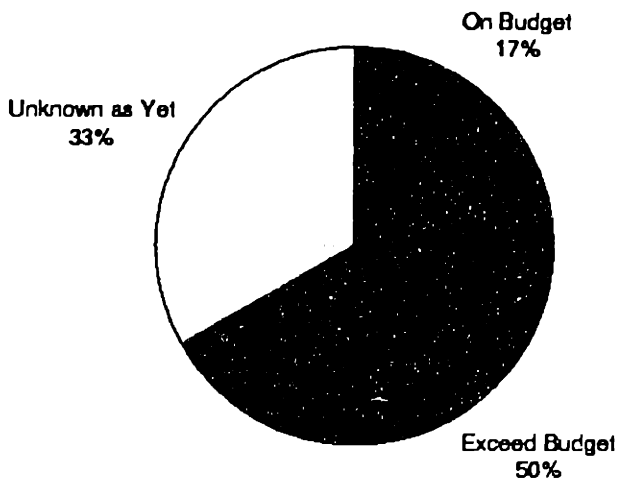
1. Typically, when several supply-chain systems were being implemented, the company will identify several areas where centralized resources may be shared.
2. The company was able to focus implementation on the supply-chain process-centric systems instead of being preoccupied with creating a data infrastructure system such as an ERP system.
3. If a transactional ERP system was being implemented, supply-chain software systems such as SCP systems were implemented in tandem to ensure data compatibility.
4. The company understood the technical realities of the system well, fully appreciating the system's weaknesses and strengths.
5. The company were willing to spent substantial amount of time planning and charting the course of implementation. All business processes affected were identified prior to the implementation process.



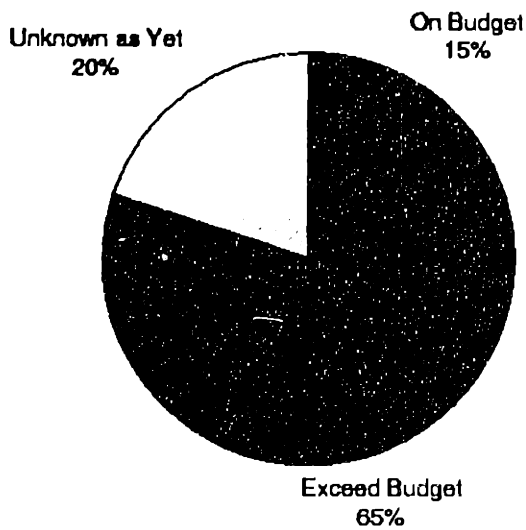
(a) Chemical Companies



(b) Food Companies



(c) Electronics and Miscellaneous Companies



(d) All Companies

Figure 6.1: Responses of Companies Interviewed on Their Implementation Budget

Chapter 7

Objectives of System Implementation

7.1 Chapter Brief

> "Not everything that counts can be counted, and not everything that can be counted counts." - Sign hanging in Einstein's office at Princeton

It is important for companies to understand the objectives desired of supply-chain software systems in both the selection and implementation processes. Companies which do not have a clear certainty of their objectives often do not know how to match the traits of their desired systems* to the functions that they require the systems to perform. As a result, they may end up paying more for a system that does not match their needs†, requiring more support, maintenance and training than anticipated, and fail to provide the benefits that they had hoped for. Not fully understanding the objectives of system implementation can also cause companies to be unable to quantify their system's achievements. Withouth being able to quantify these achievements, it is difficult to gauge if a system has served its purpose

*Discussed in Chapter 5
†Discussed in Chapter 6

or otherwise.

In this chapter, the objectives of system implementation will first be sought and examined. These objectives were then compared to the returns that companies have had. An analysis will then be carried out to see if there exists any correlation between certain objectives of system implementation and the system's returns. In addition, the role of performance measures for goal-setting and quantifying achievements will be discussed and their importance to the success of software implementation will be analyzed.

7.2 Current Issues

As Stein[25] noted, to maintain their competitive advantages, companies today require systems that go beyond the ERP framework. Furthermore, according to Gormley and Cameron[28], as of end 1997, ERP applications do not yet deliver on key supply-and-demand planning needs such as those by SCP applications. However, many companies still bought ERP applications and expected decision support capabilities without fully understanding the level of sophistication provided by these systems. The misalignments of system objectives with system capabilities were not confined to ERP systems alone and may afflict SCP systems too. In the subsequent section on the study findings, a few examples of such misalignments and their following disappointments will be highlighted.

Brynjolfsson and Hitt's article[42] on how the varying objectives of companies toward their IT systems can affect the outcome of their IT returns was particularly instructive. As stated in Chapter 3, they were able to identify companies with a set of certain objectives having better productivity growth than those with a set of other objectives. It would be interesting if the same can be observed for companies implementing supply-chain software

systems. Some of the pertinent questions that may be raised are:

1. How do the supply-chain objectives of various companies affect their expected and actual returns?
2. How do companies carry out these objectives with regards to their supply-chain software systems?
3. Knowing their objectives, how likely are companies to match these objectives with the capabilities of their systems?

From these issues of identifying and subsequently matching the supply-chain software objectives of companies to the capabilities of these systems, a secondary but equally important set of issues can be explored. After identifying the objectives of their supply-chain software systems, companies need to be able to quantify the expected and actual benefits of these systems such that their returns can be compared to ascertain if the pre-set objectives were achieved. Quantifying the benefits of supply-chain software systems has been one of the most discussed issues in the literature today. This is due to a lack of consensus towards an understanding on the topic and the degree of importance of this issue towards the successful implementation and use of supply-chain software systems. The issue of quantifying the benefits of supply-chain systems was briefly discussed in Chapter 2, where some methods in the literature were highlighted.

The interests in quantifying performance of supply-chain software systems were also heightened by many companies' desire for benchmarking. Benchmarking is a highly important tool in today's competitive business environment. It allows companies to pinpoint improvements in their business processes (from simple activities such as order-entry to complex functions such as customer satisfaction and asset management) and compare them to

the industrial best-of-breeds[51]. There are various benchmarks that a company can use to quantify its IT achievements. Schwartz claimed that one of the most effective benchmarks to measure IT productivity is the revenue per employee as a function of IT spending per employee.

Ultimately, being able to assign performance measures to the returns of ERP or SCP software systems will enable companies to determine how much to spend on these systems. Investment decisions for supply-chain software systems based on unclear intangible goals may lead companies to expend large amount of resources only to be disappointed with the actual returns of their systems. In the worst case scenario, without being able to quantify the benefits that may be achieved, companies may enter into the pitfall of thinking that a little more spending may eventually bring about the desired outcome. Before they realised the amount they have spent on achieving very little benefits, their competitors have already pushed ahead with more advanced systems.

7.3 Study Questions

Companies interviewed were posed the following questions in terms of understanding the objectives of their supply-chain software systems and quantifying the benefits accrued to these systems:

First, the companies interviewed were asked to describe the benefits expected with their supply-chain software applications. These companies were also asked if the benefits from these software were understood as a financial impact on the company - in terms of costs or revenue impacts. In addition, interviewed companies were requested to state other non-quantifiable benefits which they expected to achieve.

Next, the companies were asked to state the main purposes of their selecting and implementing supply-chain software systems. In other words, what were the main drivers or motivation for their supply-chain software implementation? In addition, they were requested to rank how important certain purposes were to them in their procuring of supply-chain software systems. They were then asked if these objectives were very important, important or not important. The following objectives of software systems were posed:

1. Reduce cost
2. Improve flexibility
3. Give executives more control
4. Target new customers
5. Improve IT infrastructure
6. Improve timeliness
7. Improve management information
8. Coordinate with suppliers or buyers
9. Improve customer service
10. Improve quality

The companies were then queried about the actual benefits that they achieved after their software systems have been implemented. As in the previous questions regarding expected benefits, interviewed companies were requested to provide quantifiable and non-quantifiable actual benefits that were accrued as a result of their software systems.

Finally, the companies were asked if they assigned any specific performance metric to their supply-chain software systems. Were they using any measures to quantify the improvements desired? Or, does the system have to meet any specific goals such as ROI, EVA or returns per employee?

7.4 Study Findings

7.4.1 Chemical Companies

Table 7.1 shows the quantifiable and non-quantifiable benefits that the chemical companies' representatives expected from their supply-chain software systems. As most companies were either reluctant or not able to quantify these expected benefits, only anecdotal information were given.

Of the seven chemical companies interviewed, four companies managed to achieved most of the objectives that were expected from their supply-chain software systems. One was able to achieve parts of the expected benefits while two others were either unsure or unable to achieve their originally stated goals.

Fig. 7.1 shows the degree of importance placed by the seven chemical companies on several objectives of supply-chain software systems. From Fig. 7.1, it can be seen that chemical companies considered cost reduction as the most important objectives for their supply-chain software systems. This was followed closely by the objectives of improving customer satisfaction and improving timeliness of the company's operations. More than 50% of the respondents also considered improving management information and improving IT infrastructure, two closely linked objectives, as very important.

The objectives considered by most chemical respondents as not important were: providing executives with more control and attracting new customers. The non-importance of providing executives with more control was consistent with most companies' focus of using supply-chain software systems to empower their employees. Thus, decisions could be made responsively at the critical nodes, rather than at the apex of a functional hierarchy. Most of

Cost Benefits

1. Least cost transportation and allocation of finished goods to distribution locations.
2. Least cost transportation and allocation of factors of production within internal and external supply-chains.
3. Better scheduling reduces the cost of halting production for machine-changes or maintenance.
4. Effective and efficient inventory management. Lower inventory levels and faster inventory turns.
5. Identification and reduction of non-performing assets.

Revenue Benefits

1. Identification of better market and customer opportunities.
2. Improve responsiveness to customers' needs. Thus, preventing a customer from going to a competitor.
3. Improve services to customers. Hence, improving customer satisfaction and market share.
4. Software supports process improvement plan for revenue growth.
5. Improve market share because of better reliability and pricing flexibility of being low-cost operator.

Other Benefits

1. Improve productivity through better availability and use of information.
2. Improve overall quality of products through better discipline in data collection and management. For example, better tracking of inventory prevents goods from going bad on the shelves.
3. Decision-support of systems allows for the modelling of production scenarios. Hence, enabling the desired objectives to be optimized.
4. Ability to be more proactive when problems arise. For example, when a plant goes down, system will alert user of another least cost alternative.
5. Work life improvements with greater confidence in available information and system standardization.

Table 7.1: Anecdotal Benefits Expected by Chemical Companies from Their Supply-Chain Software Systems

the chemical companies were employing supply-chain systems for a number of reasons to be discussed in the subsequent paragraphs. However, sales force automation is not one of these objectives. Hence, it is not surprising to find that attracting new customers were considered unimportant by most of the companies interviewed. Another objective that more than 40% of chemical companies considered unimportant was quality improvement. These companies did not foresee supply-chain software systems playing an important role in improving the quality of their products.

Of the four chemical companies which managed to achieved most of their desired objectives, the following were stated as the main drivers of supply-chain software implementation by these companies:

1. To fulfill the needs of functional gaps identified such as demand forecasting and logistics network optimization.

2. To improve overall supply-chain costs and customer service by improving the processes of getting products to the end consumer.

3. To improve overall supply-chain efficiency and effectiveness by improving availability and integrity of data information.

Three out of four of the chemical companies that managed to achieved their expected benefits did so despite exceeding their originally budgeted costs. This might lead us to conclude that for some chemical companies at least, exceeding the costs of procurement and implementation did not preclude these companies from reaping their expected benefits. Therefore, understanding the goals desired from implementing supply-chain software systems may be more important than constraining costs of procurement and implementation.

Costs of implementation might have increased during the implementation process because companies might have realized that an increase in scope was required to obtain the desired benefits. As one company which managed to cut non-performing assets and operating costs by more than $ 80 million remarked, "Would the implementation still proceeded if the large initial costs were known?"

All the four chemical companies which achieved their expected benefits have a strong emphasis on functional requirements. Inevitably, forecasting, advanced planning and network optimization were all an integral part of the supply-chain software systems at these companies. Another important characteristics that these companies share was that three out of four of these companies were able to set a quantifiable goal for their supply-chain software systems and measure their achievements using a specific performance metric. The fourth company representative believed that such a metric exist but he was not able to state what it was. Two out of the three companies using performance measures used ROI to quantify the returns from their software investment while the third company used RONA.

One of the companies yet to realize the full benefits of its supply-chain software system was mainly concerned with platform commonality and standardization across its entire enterprise. The company stated that the Y2K problem was a key driver in its supply-chain software implementation. Although it managed to stay on-budget, the company did so at the expense of its original scope. In contrast, one of the companies which managed to achieve its expected benefits also desired a standardization of its data management and supply-chain practices but considered Y2K only as a solution that it can achieve with its new system. Y2K was not a driver for this successful company but managing its costs and improving its customer service.

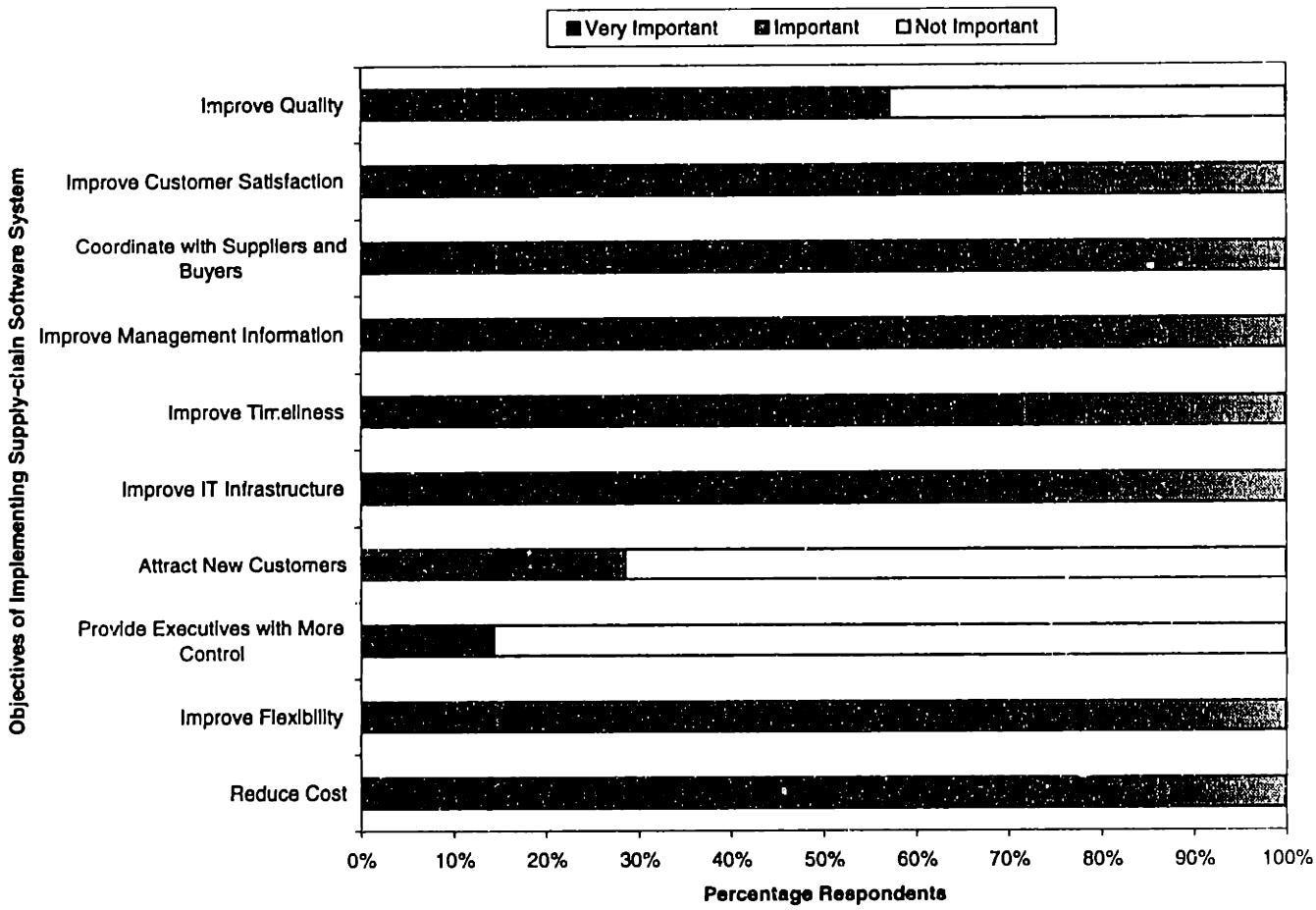


Figure 7.1: Importance of Certain Objectives to Chemical Companies in Implementing Supply-Chain Software Systems

The other 2 companies which were either unsure or unable to achieve their expected benefits did not use any specific performance metric to quantify their achievements. In mitigation, one of the companies claimed that although no metric was specified, targets were set. Nevertheless, when queried to state what these targets were, the company representative was reluctant to specify them. The other company wanted to use an ROI type metric but was unable to do so. Instead, it simply used anecdotal user experiences to judge whether improvements were achieved. For example, the company cited how better scheduling with the software system enabled its engineers to evaluate more options that they were never able to do before. However, the company was not able to quantify whether such improvements actually brought about bottom-line or revenue improvements to the company.

7.4.2 Food Companies

Table 7.2 shows the quantifiable and non-quantifiable benefits that the food companies expected from their supply-chain software systems. Similar to chemical companies, most food companies were either reluctant or not able to quantify these expected benefits. Hence, only anecdotal information were given.

Only one of the seven food companies stated emphatically that it has already managed to achieve the expected goals of its supply-chain software system. The six others have yet to achieve their objectives fully but for five of them, this was mainly because they were still either in the stages of software implementation or just beginning to reap their systems' benefits. Almost all indicated that in time, they still expected the full benefits to be achieved. As such, the six food companies did not state any dissatisfactions with the alignment of expected and actual benefits accrued to their supply-chain software systems. Food companies, in general, were more troubled with the lack of sophisticated functionality

Cost Benefits
1. Work force and administrative savings through automation of processes. 2. Software as part of reengineering process to eliminate the duplication of tasks. 3. Systems as low-cost replacements for mainframe machines in corporate-wide IT cost reduction. 4. Optimization of transportation and distribution functions. 5. Cost savings through quicker inventory turns and lower inventory levels. 6. Less resources required to plan and manage inventories.
Revenue Benefits
1. Service improvements (such as better lead time and service fill rate) attract more customers. 2. Less occurence of out-of-stock, minimizing revenue losses. 3. Better information allows the company to negotiate better rates from its customers (also a cost benefit). 4. Software helps to define goals and improvements for personnel to work towards improving revenue.
Other Benefits
1. Real time information assists more effective decision support. 2. Ease of information retrieval from a consolidated data warehousing system. 3. Tracking of margins of production more accurate and reliable. 4. Solve Y2K problem, with systems being Y2K compliant. 5. Simplification of work processes using new standardized enterprise-wide software. 6. Improve communication between work groups and functional silos.

Table 7.2: Anecdotal Benefits Expected by Food Companies from Their Supply-Chain Software Systems

in their software systems (discussed in Chapter 5), and the lack of support from their vendors. They were not particularly concerned with achieving expected goals as they were all pretty confident that their objectives will eventually be reached.

One exception was a food company which had the objective of integrating accounting, order entry and inventory management. The company adopted an integrated approach and failed to stay within its pre-implementation budget. It attributed the shorcomings in expected benefits and excess in budgeted costs to the lack of support from its vendor. In addition, the company representative also pointed out that the project was largely IT driven, and software implementation was carried out in a piece-meal fashion.

Fig. 7.2 shows the degree of importance placed by six[‡] food companies on several objectives of supply-chain software systems that were put forward to them. From Fig. 7.2, it can be seen that food companies considered reducing costs (similar to chemical companies) and improving management information as the most important objectives for their software systems. The next four objectives which were classified by all six food respondents as either very important or important were: improving customer satisfaction, improving IT infrastructure, improving flexibility and improving timeliness. As can be seen from comparing Fig. 7.2 and Fig. 7.1, food companies were generally more reluctant to state an objective as very important as compared to chemical companies. For example, although five food companies classified improving timeliness as important and one classified it as very important, five out of seven chemical respondents classified it as very important and two as important.

As was the case with chemical companies, most food companies did not consider attracting new customers as part of their supply-chain software objectives. Similarly, more than half of the respondents considered the objective of providing executives with more control

[‡]One food company did not reply to this question

as not important. Using supply-chain software systems to improve the quality of the companies' products were also considered not important by 50% of the food companies which responded to this question. Please see the subsection on the chemical companies for an explaination of why companies do not consider these few objectives as important for their supply-chain software systems.

Although none of the chemical companies which responded to this question considered coordination with suppliers and buyers as an unimportant objective, there were actually two food companies which considered this objective as an unimportant goal. Not surprisingly, these two companies were more concerned with implementing a financial-accounting data infrastructure and both were adopting an integrated ERP approach. One of these companies primarily wanted to increase its level of IT functionality and adopting a more advanced IT platform. It cited a lack of common or standard measurements and performance indicators as crucial impediments to aligning its business with those of its supply-chain partners. The other cited software compatibility issues as the main impediment.

An interesting observation of all the food companies interviewed was the lack of expected revenue benefits. In Table 7.2, some revenue benefits that the companies can expect were highlighted, but these were implied benefits deduced from the interviews conducted with the seven food companies. When asked explicitly if there were any revenue benefits expected, three companies stated outrightly that no revenue benefits were expected or understood. Four other companies did not mention revenue as part of the benefits expected. This is interesting considering that there were four food companies which cited service improvements such as better customer fill rate and improved responsiveness as part of their main expected system benefits. Apparently, representatives of food companies were reluctant to view such expected service improvements as convertable to revenue benefits for their com-

panies. This can be attributed to the highly competitive nature of the food industry. As a result, companies were not willing or able to charge a premium for their improved customer service.

Earlier, it was stated that food companies, in general, were optimistic about achieving their stated objectives. As such, it was not surprising to find that four out of seven were using performance metrics to quantify their progress and achievements. ROI was favored by three out of these four food companies. The other preferred EVA. Of the three companies that used ROI-type of performance metric, all expressed difficulties in accurately quantifying their ROI. Difficulties arose as a result of the following:

- The software system was only part of the whole investment. Therefore, benefits accrued to the system itself were difficult to identify and to separate from the other process changes.
- There were also difficulties associated with quantifying expected and actual benefits. For example, companies may not know how to quantify improvements in customer service in terms of ROI.
- Changes in business processes after system implementation can affect ROI, making it less meaningful to compare pre-implementation quantities (for example, customer and product line changes) with post-implementation quantities. Companies need to maintain a consistent baseline to evaluate if benefits were achieved.

The food company which used EVA to quantify its improvements did so because it felt its objective for the software system can be easily quantifiable. The company's main objective for the software implementation was to reduce its IT costs by moving away from mainframe

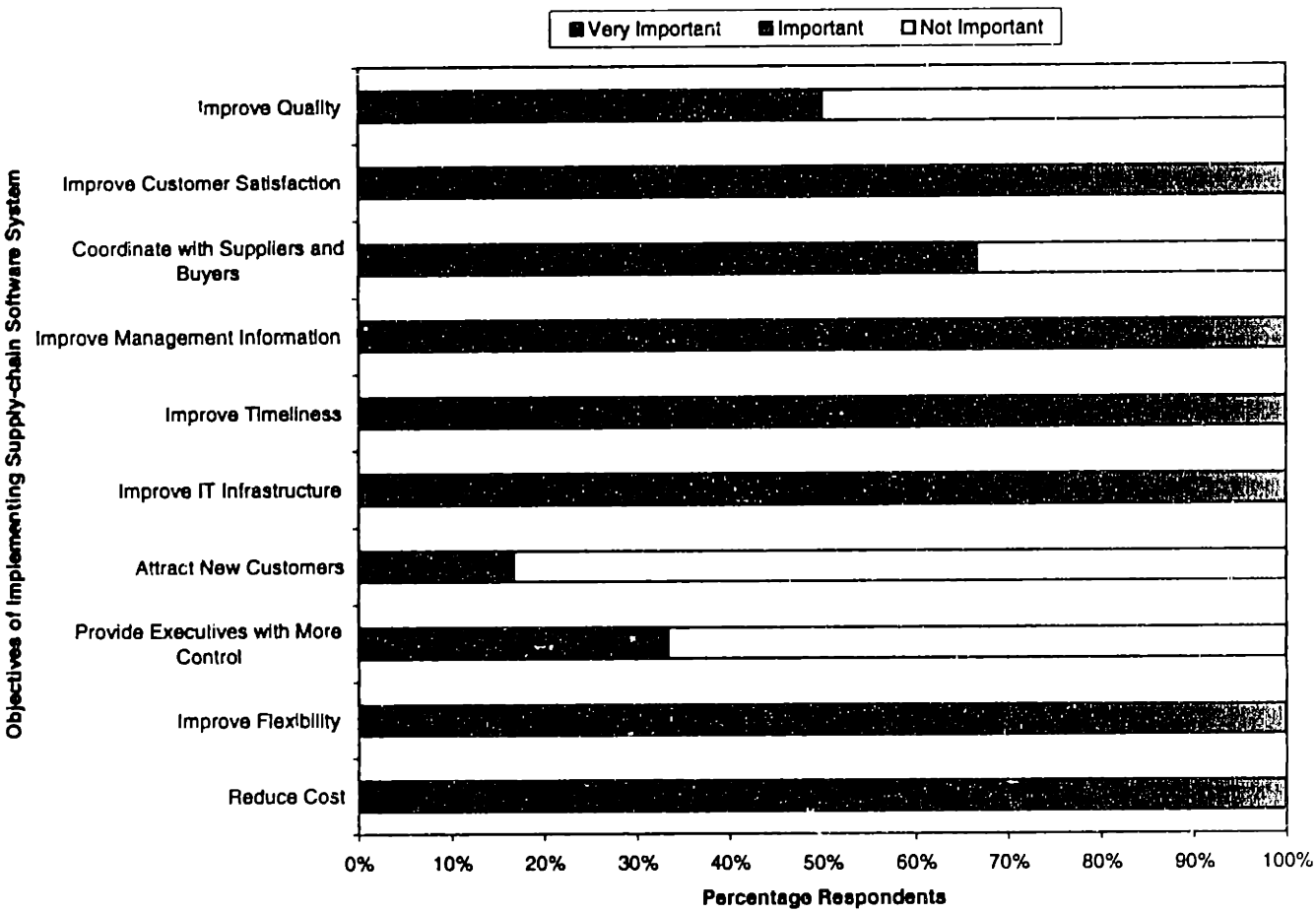


Figure 7.2: Importance of Certain Objectives to Food Companies in Implementing Supply-Chain Software Systems

computing. Hence, it was fairly easy for the company to quantify the IT costs pre- and post-implementation. For the three food companies that were using ROI-type metrics, each of their main objectives for implementing supply-chain software systems were: i) To save on operational costs and inventories, ii) To increase its level of system functionality, and iii) To integrate its worldwide financial systems.

For one of the three remaining companies which did not use any performance measure to set goals, their main objectives were to develop an IT platform by integrating accounting, order entry and data management. Another company that did not seek to quantify its achievements had similar goals, wanting to integrate the functions of all its supply-chain groups. The last of these three company stated that resolving the Y2K problem was its main objective.

Unlike one of the chemical companies discussed, this company realized that in seeking to resolve its Y2K problem, there were opportunities for improvements of its other functions. The company managed to achieve substantial improvements, improving its service fill rate by 4% and cutting the inventory of finished goods by 35%. Although the company did not use any performance metric as a target, it still understood its objectives and goals well. The company first seek to understand what it wanted to improve, then asked itself, what system will do the task. For example, it improved customer fill rate with a demand-forecasting system. As remarked by the company representative, "We don't buy a saw and walk around the house looking for something to saw".

While this company showed that significant improvements can be reaped even without using a holistic system performance metric, it will be interesting to note if better improvements can be achieved had the company initially set a performance target to work towards.

7.4.3 Electronics and *Miscellaneous* Companies

Under this section, the remaining companies which were interviewed will be discussed. Table 7.3 shows the quantifiable and non-quantifiable benefits that electronics and *miscellaneous* companies' representatives expected from their supply-chain software systems. Similar to chemical and food companies discussed previously, only anecdotal information were given.

Two electronics and high-tech companies responded to the question of how important certain objectives were to them in the implementation of their supply-chain software systems. Together with the three other *miscellaneous* companies stated in Chapter 4, their responses were given in Fig. 7.3. From Fig. 7.3, it can be seen that, for the remaining companies outside the chemical and food groupings, improving customer service was by far the most important objective (four out of five companies considered it very important while the last company considered it important). This was followed far behind by the objectives of improving management information, improving timeliness and reducing cost (only two out of five rated these objectives as very important). The objectives considered by these companies as not important were relatively similar to the responses given by the chemical and food companies. Providing executives with more control, attracting new customers and improving quality were all considered unimportant objectives by three out of the five companies in this section which responded to this question.

Of these six companies, two achieved their expected benefits while three others have yet to reap the full benefits of their implemented systems. The last company did not provide any information of whether expected benefits were achieved or otherwise. For the three companies yet to reap the full benefits of their implemented systems, one was generally satisfied with the benefits achieved so far. It attributed its delay in reaping the benefits expected to

Cost Benefits

1. Shorter lead time and lower inventory level with integrated financial planning system.
2. Eliminating disparate legacy systems across the enterprise by replacing them with an integrated system.
3. Inventory reductions through supply-chain planning, stock appointment and inventory management applications.

Revenue Benefits

1. Better understanding of customers' inventory schedules, allowing improvements in fill rate with forecasting.
2. Improved customer service with standardized system (e.g. order-entry). "Single face to customer" approach.
3. Improved order-lead time, bringing more customers to the company.

Other Benefits

1. Quicker cycle time for decision-making and faster planning process with consolidation of data into a single system.
2. Greater confidence in data as a result of higher system integrity and better data-entry discipline.
3. Quality of work life improvements with decision-support systems.

Table 7.3: Anecdotal Benefits Expected by Electronics and Miscellaneous Companies from Their Supply-Chain Software Systems

the problems it had getting data input ready for the system. The company had set an ROI standard for its software system and considered it straight-forward to calculate, as its system ROI was impacted directly by the savings in inventory carrying costs. Customer service and inventory savings were the two main thrusts for the company's SCP implementation.

Another company which have only partly achieved its expected benefits was also very satisfied with its SCP system. Although the company has yet to measure its inventory reduction and improvements in order lead time, it has managed to lower cycle time for decision making and planning by 80%. The company's main objective was to consolidate data into a single system, allowing its many divisions and business units access to real time information for the purpose of decision support.

The last company which has yet to achieve its expected benefits was not as fortunate as the other two companies discussed in the preceding section. It was also unsure of when its system benefits will be reaped. The company was implementing an ERP-based application with the primary intention of achieving cost savings. These cost savings were to come from eliminating its disparate home-grown systems and replacing them with an integrated system. The company used to adopt an ROI of 12% for its projects but at the time of the interview, the representative was unsure of what the figure was for the software project.

Looking at the two companies which managed to achieve their expected benefits, it was further reaffirmed that understanding the objectives desired of the supply-chain software systems and being able to align them with the traits of the procured systems was clearly important. For one company which managed to reap benefits above its expectations, the primary objective was to reduce inventory through demand signalling and forecasting improvements. The company felt that a best-of-breed SCP system would best suit its needs. Post-implementation, the company managed to reduce inventory by $150 million. Similar to

the case with a food company mentioned previously, this company also did not utilize any specific performance metric for its supply-chain software system. The other company which managed to achieve its expected goals wanted to provide better information in a faster and more cost-effective way. It elected to procure a best-of-breed system and used ROI as a mean for setting a specific target for its system.

All the remaining companies classified under this category either did not mention or did not expect any benefits associated with revenue increases. This seemed to be consistent with the responses of the food companies discussed previously. As before, although companies did identify some benefits associated with better customer service, they overwhelmingly did not anticipate such improvements to translate into greater revenues.

7.5 Vendors' Perspectives

The vendors which took an active participation in the study were asked to quantify some of the successes companies have had with their software systems. Table 7.4 shows the information given by these two companies. Their response were presented here with the intention of highlighting some of the possible benefits that can be reaped with supply-chain software systems today.

In terms of the correlation between a company's objectives and its ability to achieve the expected benefits, one vendor has the following observation: It noted that it has two types of buyers. One is more "Infrastructure-oriented" and seek to consolidate disparate systems throughout the enterprise into a single unifying system. The other is more "Performance-oriented" and seek improvements in key quantities such as supply-chain costs, customer service levels, etc.. The former tends to be caught in two-minds once it realized the im-

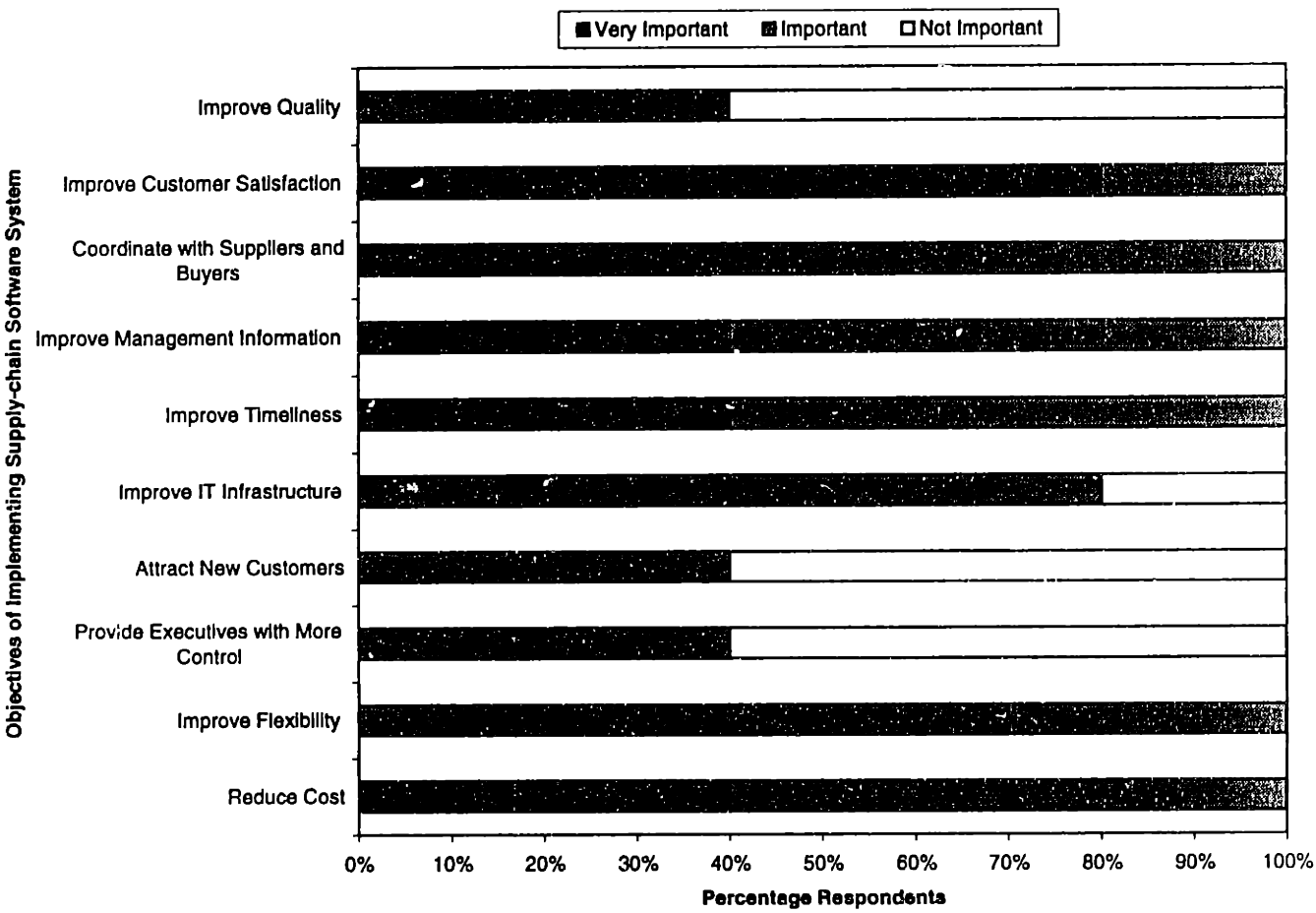


Figure 7.3: Importance of Certain Objectives to Electronics and Miscellaneous Companies in Implementing Supply-Chain Software Systems

Vendor A	Vendor B
Increase in customer service levels of 5-15%	Reduce global planning cycle times by up to 80%
Increase in throughput of 2-5%	Increase on time delivery against commitment by up to 75%
Decrease in planning cycle times by 95%	Increase on time delivery against request by up to 90%
Decrease in operating expenses by 10-50%	Reduce WIP or raw inventories by over 30%
Decrease in inventory of 10-60%	Reduce finished goods inventories by over 35%
Decrease in order lead times of 10-40%	Allow customers to reduce product life cycles to as low as 23 days
Decrease in production lead times of 10-50%	

Table 7.4: Benefits to their customers observed and quantified by the two vendors

provements possible with supply-chain systems while the latter is more focused and able to achieve its expected target more frequently.

From the findings associated with the three group of companies discussed previously, of the few companies which have yet been able to reap their expected benefits[§], four were "infrastructure-oriented" while two were "performance-oriented." Therefore, the findings seemed to agree with the observation of the vendor described in the paragraph above. Both vendors agreed that a clear business strategy and purpose for system implementation are highly vital for the success of their supply-chain software systems.

In terms of the performance metric that they would recommend companies to use, Vendor A suggested the following as most suitable:

- Time to ROI
- Impact on ROA, EVA, etc.
- Impact on shareholder value
- Quality of decision making

Vendor B, on the other hand, stated that it would encourage its customers to use EVA and customer response time as the targets to aim for.

7.6 Summary of Practices

As expected, objectives of system implementation were found to play an important role in determining the outcome of the benefits expected from supply-chain software systems.

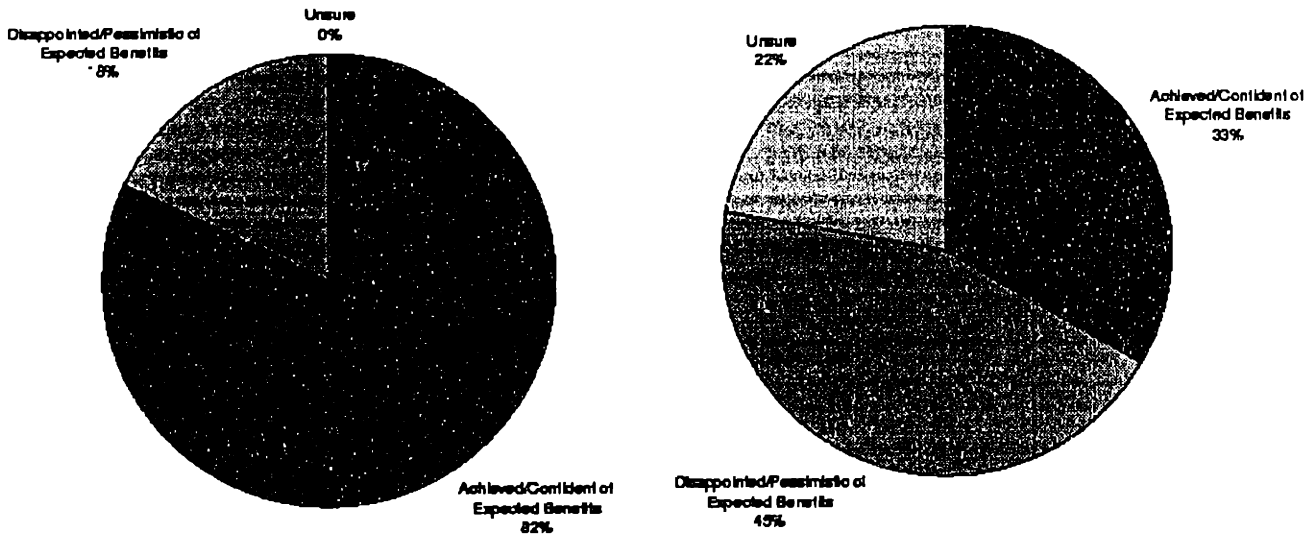
[§]Excluding those that were satisfied and were confident that in time, these benefits will be reaped.

Fig. 7.5 shows a combined representation of how all the companies interviewed rate the importance of certain objectives to them.

More than 60% of the companies which responded to this question considered reducing supply-chain costs and improving customer satisfaction as very important objectives for their supply-chain software systems. Such a high figure seemed to be consistent with the principles of supply-chain management: reducing supply-chain costs with a coordinated flow of goods, cash and information, and at the same time, maintaining the customers' interests as their systems' focus. More than 70% considered providing executives with more control and attracting new customers as unimportant objectives. Improving quality was also another objective that drew a large number of not-important answers.

There were also other companies which were more interested in lowering their IT expenditures and improving their IT infrastructure. These companies' objectives centred around consolidating their diverse operating systems across functional divisions and business units into one integrated system. Some of these companies were also implementing new systems as a solution to their Y2K problem. As such, they were not as focused on reaping costs or revenue benefits but on solving a nagging problem. Therefore, they generally did not require the use of any performance metrics as a yardstick for quantifying improvements.

Of the eleven companies classified as "performance-oriented," nine (82%) either managed to or were very confident of achieving their expected benefits. On the other hand, two (18%) were unsatisfied with the actual benefits reaped. In contrast, for the eight companies which were classified as "infrastructure-oriented," three (33%) managed to or were very confident of achieving the expected benefits planned, four (45%) were disappointed with the actual benefits reaped, and two (22%) were unable to state either. Fig. 7.4 shows the graphical representation of the achievements of "performance-oriented" companies versus



(a) Performance-oriented Companies

(b) Infrastructure-oriented Companies

Figure 7.4: Achievements of Performance-oriented companies vs. Infrastructure-oriented companies

"infrastructure-oriented" companies.

Of the twenty companies interviewed, thirteen used some sort of performance metric as a goal for their supply-chain software systems. Out of these thirteen companies, four (31%) were dissatisfied or uncertain of being able to achieve their originally planned benefits. Of the seven remaining companies which did not use any sophisticated performance metric for their systems, only two companies (29%) were either dissatisfied or uncertain of achieving their targeted benefits. Hence, overall, the findings on whether a performance metric was essential for achieving expected benefits were unconclusive. This can be due to several reasons, primarily, the difficulties associated with the use of these performance metrics and how accurately they can be quantified.

Of the thirteen companies which used performance metrics as a means of setting goals for their software systems, nine (69%) expressed some difficulties in estimating the values of these metrics. Although ROI was the overwhelming metric favored by the companies interviewed, other metrics (such as RONA) were also subjected to similar complaints. Many companies felt that isolating and discriminating any improvements directly due to a specific system were near impossible. Also, there were difficulties associated with quantifying certain improvements in terms of a general value such as ROI. For example, how can improvements in decision cycle time be quantified in terms of ROI? In addition, another common difficulty which companies faced was the change in business processes that often accompanied software implementation. With a different baseline resulting from changes in business processes, system impact on ROI can present many difficulties for meaningful comparisons.

Although data from the interviews did not point to any conclusive evidence that performance metrics can improve the probability of companies achieving their expected benefits (through greater discipline and sharper focus), the findings did at least point to the fact that

aligning implementation objectives with system capabilities was a critical imperative for the success of using software systems for supply-chain management. Irregardless of whether a performance metric was used or otherwise, all the companies which managed to achieve their expected benefits had a clear vision of their objectives.

For the four companies which achieved their expected benefits without the performance metrics, all were crucially aware of their desired goals. This is best exemplified by the fact that all four of these companies achieved their expected benefits with best-of-breed applications. These companies knew the specific functionality that they desired and matched them with best-of-breed capabilities. Their objectives were not sacrificed for cost-savings through the use of an integrated approach.

Another interesting observation derived from the companies interviewed was how most company representatives did not consider supply-chain software systems as being able to deliver revenue benefits for their companies. Although many company representatives cited service improvements as a key benefit which can be achieved from their supply-chain software implementation, they generally did not foresee such improvements as having a direct impact on the revenue of their companies. The companies which reaped revenue benefits from their systems commonly cite as reasons: i) the availability of better opportunities through improved information, ii) greater responsiveness to customers, iii) software as planning tool for revenue growth, and iv) improve market share as a result of better customer service and pricing flexibility.

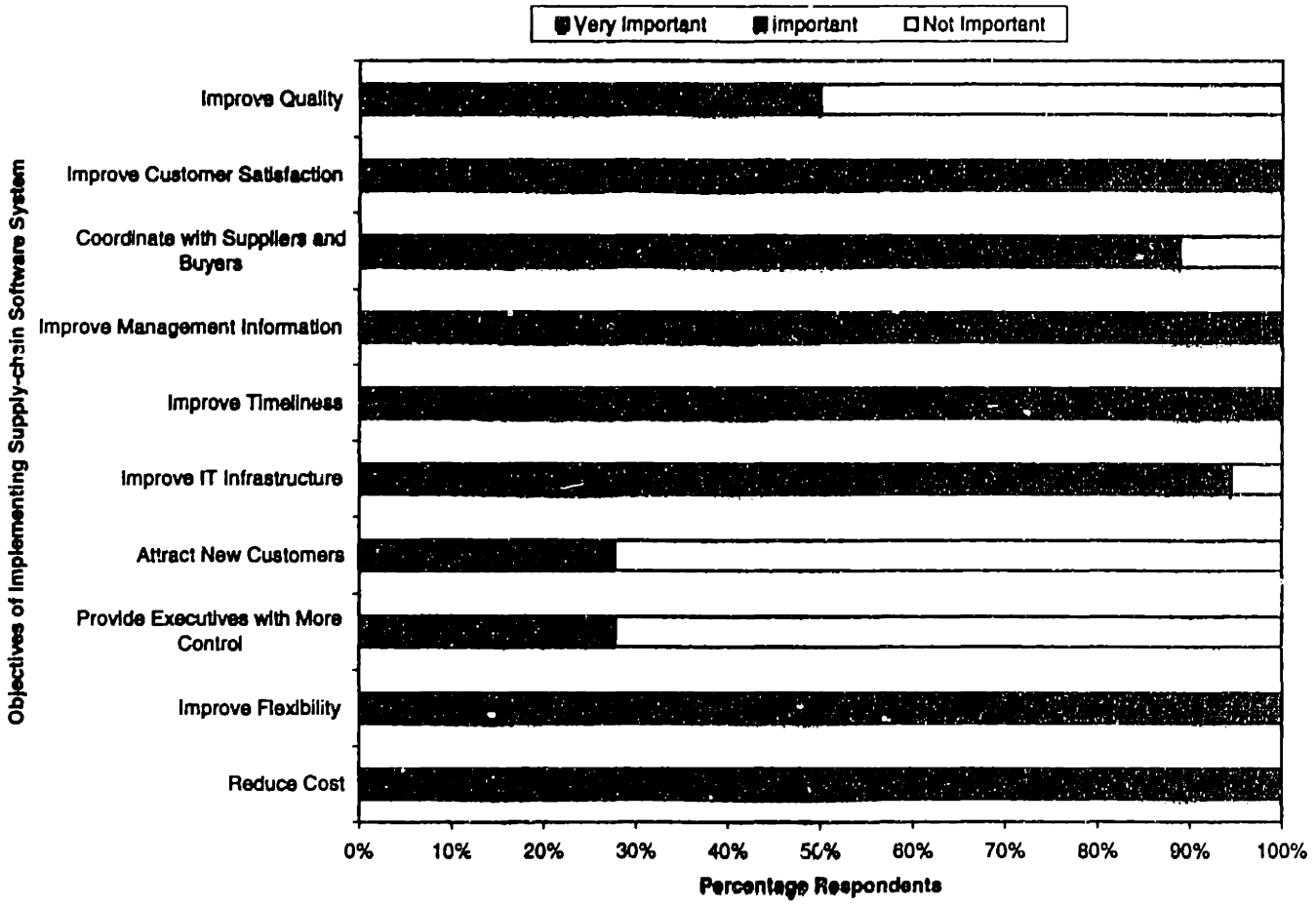


Figure 7.5: Importance of Certain Objectives to All Companies in Implementing Supply-Chain Software Systems

Chapter 8

Corporate Policies and Related Issues

8.1 Chapter Brief

> "Wise princes have always shunned auxilliaries and made use of their own forces. They have preferred to lose battles with their own forces than win them with others, in the belief that true victory is possible without alien arms," Machiavelli - The Prince.

In this penultimate chapter, the influence of corporate policies on the outcome of system implementation will be analyzed. The importance of corporate policies towards IT sponsorship and other issues such as change management, can impact the three imperatives previously discussed. How companies evaluate the traits or functionalities of their required systems, understand practices and circumstances of costs over-runs, and pursue relevant objectives of system implementation, will all be affected by issues related to a company's culture or business environment. As eloquently phrased by Machiavelli, the importance of

internal drivers versus external drivers will also be examined. For example, some of the issues that will be discussed are the use of outsourcing, and the importance of system ownership by business units. In addition, the impact of top management support and how such support manifest itself will be examined.

8.2 Current Issues

A main imperative raised by many contributors to IT and supply-chain management journals was the importance of top management support. Zerega[58] noted that in the case of Fujitsu Microelectronics (FMI), the implementation of SAP achieved cost savings of $2 million per year in IS, and cut order-fulfillment time from 20 days to 2 days. The FMI implementation team cited top management support as the single critical component underlying their speedy, 10 months SAP implementation.

By securing explicit approval from Fujitsu's board of directors, the implementation team was able to secure middle-management support and user participation. In addition, they managed to tie twenty percent of the bonuses promised to employees directly to the success of the implementation project. Executive support of IT staff also helped to reduce attrition, a major problem which afflicts companies during lengthy implementations.

The importance of top management support towards supply-chain software systems is unequivocally crucial. However, to address the issue adequately, it is necessary to go beyond quantifying the number of firms which considered top management support crucial to their implementation success. Some issues, such as how top management support could manifest itself to aid software implementation might be equally important. According to Pat Zilvitis, CIO of Gillette, to obtain top management support, implementations of IT projects have

to be from the perspective of top-down decision-making. However, to get end-users to truly understand the required functionality and change, they must be a bottom-up process. Others might contend that top management support should manifest itself through the resource commitment of senior managers. Hence, some related issues which may be pertinent are:

- How did implementation teams garner top management support? What were the essential project focus necessary?
- How did top management support affect the success of implementation teams? Through facilitation, direction or empowerment?
- How did the policies or decisions of top management with respect to other critical issues such as outsourcing and business unit ownership affect the success of software implementation?

Another important issue which attracted current debate was the viability of engaging third-party consultants and software implementation teams. Some companies have cleverly utilized third-party IT teams or consultants in areas which are less critical, such as the dismantling of their legacy systems. Thus, leaving their own implementation teams to stay sharply focused on the implementation tasks. Others have been less innovative and the even less fortunate companies were saddled with high costs in excess of their implementation budget due to excessive consultancy and third-party fees. This is a good example of the principle-agency problem - where the interests of these companies were not matched by those of their consultants.

According to Slater[39], when companies failed to plan for disengagement, consultancy fees could escalate tremendously. Therefore, it is extremely important for the goals and

objectives of consultants to be set out at the onset of the implementation process. As stated previously in Chapter 7, understanding and setting the objectives of system implementation may be one of the most important imperatives of the whole process. Setting objectives should not be confined to internal employees alone. Slater's paper also contained the suggestion that metrics be included in the consultants' contracts. For example, a specific number of the company's employees must be able to pass a project-management leadership test before the consultants' contracts were extended.

Although consultancy fees might exceed a company's estimates, most companies will still feel vindicated as long as after the implementation process, they acquired the know-how to continue operating the systems effectively without the consultants. Therefore, having their own employees working together with the consultants during the implementation process was highly important as it would facilitate the transfer of knowledge from external consultants to in-house managers. In addition, consultants often did not have the same understanding of the business as the company's own employees. Thus, having their own teams on board the implementation process also ensured that the consultants carried out the implementation process with careful adherence to specific business requirements such as customer preference, and operational boundaries. Therefore, end-users' involvement in the implementation process is definitely crucial. Ultimately, the success of the systems will depend on how well these end-users know and operate the systems.

Assigning ownership of software implementation to end-users from relevant business units was another critical issue which concerned corporate policy on IT implementation and use. How did policies which promote empowerment fare against policies which called for a top-down control structure? Hicks [31] argued that in many cases, end-users did not get a look at the system until at the end when millions have been spent, and they're "stuck in a marriage

arranged by higher powers". This has direct implications on the three imperatives discussed in previous chapters. By not involving the end-users, objectives of system implementation might be skewed towards unproductive areas. In addition, systems were acquired which might not contain the required sophistication of the business processes. Slater [54] also argued that scope-creep was most likely to occur when business end-users (non-IS personnel) were ommitted from the implementation process. Scope-creep, as discussed previously, could lead to unanticipated large cost increases.

However, leaving the entire software implementation to business managers with little technical background could be rather intimidating to them. Therefore, undeniably, corporate IT executives have a large role to play in such a technologically-heavy project. The need for both business knowledge and IT skills highlight the importance of cross-functional teams. Facilitating cross-functional teams is perhaps one of the most important form of top-management sponsorship that can lead to a more successful system implementation.

In addition, as stated by Cook[45], software was often just a tool to support process changes. In Chapter 1, it was also mentioned that supply-chain software systems should only be considered as the enabling technologies of business process changes such as re-engineering and improvements related to supply-chain management. Hence, the success of supply-chain software would largely depend on the success of related process changes. As such, the ability to handle change management is another important issue. How should corporate policies be formulated such that they facilitate the effective management of change with respect to supply-chain systems? How could managers ensure that their employees working on a specific function understand both the relevance of the function and how it fits into a specific business process? In Schonberger's article[48], two different but equally effective ways of implementing change were described. The Systemic Approach refered to formal project

approaches generally favored by big industries. On the other hand, the Dynamic Approach focused on on-the-spot transformations which could yield immediate results.

Cassis[46] noted that the best way to fight resistance to change was to make the users themselves catalyst of that change. One of the most effective ways to accomplish this was to have a corporate policy which required end-users to take full ownership of the system's success and to empower them to the change process. Cassis even argued that, it was the result of user-ownership, making users feel attached to their systems which enabled many Excel spreadsheets to be more successful than some of the most advanced planning and scheduling packages. Users who felt that they were part of the initial "birth" of their systems (when these systems went live at their company), were more likely to take special interest in configuring these systems to best suit their functional tasks. Although the excel spreadsheet might be functionally inferior, users felt in control of the environment and felt that they could make the system work for them.

Another important issue concerns the importance of supply-chain software systems as a tool for driving competitive advantage or for facilitating inter-company supply-chain management. Many vendors are of the opinion that companies were most likely to be spurred into action when they realized that their competitors were implementing some new systems to improve profitability. As such, it is not uncommon for vendors to use their vast customer base as a marketing pitch. Some companies might also be forced to implement supply-chain systems such as EDI because their biggest customers demanded it. According to Fabris[59], for many companies, tight supply-chain integration with other businesses was no longer a competitive advantage but a competitive imperative. Therefore, the implementation of supply-chain systems were externally driven. An important question would be whether externally driven software implementations are more likely to secure top management support

than internally driven initiatives.

8.3 Study Questions

Under this chapter, the influence of corporate policies on the outcome of system implementation will be analyzed. Companies were asked the following questions which were relevant to some of the issues raised in the section above:

First, companies were asked if choices for supply chain software were driven by the operations or plannings group within the business unit or if they were driven by an IT or IS group within the company. Companies were then asked to specify who or what group of executives ultimately decided.

Next, company representatives were queried on issues such as: i) The frequency of realigning their employees' skill level to match the new changes and, ii) The presence of company employees' on third-party implementation teams and their importance to the success of these projects. Most importantly, the company executives were also interviewed on the issue of top management support in system implementation. Companies were requested to describe how top management support manisfested itself and how it impacted the success of their implementation projects.

To determine the effects of external factors as motivation for the implementation of supply-chain software systems, companies were asked the following two questions: i) Whether they would be more incline or less incline to procure a system, knowing that their competitors were using the same system, and ii) Whether the supply-chain systems used by their supply-chain partners had influenced their choice of supply-chain software. In terms of us-

ing a supply-chain software system to align their business with their supply-chain partners, companies were also queried as to what they foresaw as being the main difficulties and impediments.

Lastly, company executives were queried on whether the new systems required them to run their businesses differently from what they have been used to. If so, what kind of difficulties did this present?

8.4 Study Findings

In the previous three chapters, sections on study findings have been described in terms of company groupings. This was due to findings which showed that companies in different industries exhibit significant differences on their software preference, their reasons for exceeding their implementation budgets and their objectives for implementing supply-chain software systems. However, in the analysis of interview replies for corporate culture and policies on supply-chain software systems, it became obvious that discussing the study findings through the breakdowns of issues would be more appropriate. Although they may be in different industries, many companies actually share the same input to different questions posed under this chapter. Nevertheless, there are certain interesting differences between the responses of companies in different industry groupings and these will be highlighted.

8.4.1 Internal Drivers: Stakeholders, Decision Makers, and Influence Brokers

Cross-functional teams: Contributions of business and IT units

Given the nature of supply-chain software systems - which combined the technological sophistication of state-of-the-art algorithms with revolutionary ideas of process-based management, the decision to procure a specific supply-chain software system over another should be driven by cross-functional teams. Such cross-functional teams should consist of both business managers and IT personnel.

Table 8.1 shows a break-down of the commonly cited roles and functions of business managers and IT personnel in the implementation process. From Table 8.1, it can be seen that both functional teams brought different elements and expertise to the implementation process which could be critical to its success.

Therefore, the results obtained from the interviews were intriguing as a significant proportion of companies did not state that cross-functional teams of business and IT personnel were co-drivers for the choice of supply-chain software systems. Overall, 12 (60%) of the 20 companies interviewed stated that the software decision was driven by input from both business and IT groups. However, up to 7 (35%) companies claimed that the software decision was primarily driven by the functional or business people. Only one company replied that the software decision was primarily IT driven.

Of the seven companies where choices of supply-chain software systems were primarily driven by their business or operational units, five are food companies. This is unexpected as out of the seven food companies, three chose integrated ERP systems while two others

Business Personnel	IT Personnel
To identify opportunities and areas of improvements that can be made	To evaluate functionalities and sophistication of software tools and ensure that they match the requirements.
To provide an understanding of the boundary conditions such as physical limitations of manufacturing or transportation operations.	To ensure compatibiliy of acquired system with other systems and IT infrastructure, such as ERP and legacy set-ups.
To provide the business nous through knowledge of heuristic improvements made through experience of operating the functional units.	To provide programming expertise and support, crucial in the configuration and modification of acquired systems.
To undertake on-the-site training as they would be responsible for the functions of the system after implementation.	To develop system interfaces and data warehouses, and also to ensure data integrity.
To acquire sense of system ownership as decisions were not made without them, the final end-users.	In certain cases, to run simulations and modelling of software systems under various operating conditions.

Table 8.1: Roles and functions of business and IT personnel in the selection and implementation of supply-chain software systems

chose best-of-breed systems which interfaced with their ERP systems. Typically, when implementing integrated ERP or, SCP systems which resided with ERP systems, IT personnel will usually be actively involved as these systems demand strong technical knowledge of the required data infrastructure. The incidence of such a high number of companies in the food sector which considered the choice for supply-chain systems as being driven essentially by their functional or business teams could be due to the following:

1. As one respondent stated, the food industry is relatively unsophisticated. Thus, they did not really need advanced algorithms to handle their comparatively basic operations (such as manufacturing and distribution). Many off-the-shelf packages were suitable enough for them. As a result, they did not require much modifications or configurations to their procured systems, which would have required greater input from their IT/IS department.

2. Food companies are also in a relatively mature stage of adopting supply-chain management principles to reduce their supply-chain costs. Therefore, improvements to be gained could be small for many companies. As such, the role of business executives in identifying areas for improvements were greatly enhanced.

3. The highly competitive environment of the food industry is another factor which stressed the importance of the operational departments in choosing supply-chain software systems.

4. Out-sourcing of their IT tasks is also a common procedure in the food industry. Many companies felt that there were much to be gained from depending on specialized external consultants for their IT concerns. Therefore, many of these companies sourced for IT expertise only after decisions have been made about which systems they wanted to procure.

Several interesting statistics were observed from the seven companies which emphasized the role of business units in choosing supply-chain software systems. First, all except one (which was neutral) were either satisfied (two companies) or very satisfied (four companies) with their supply-chain software systems. Clearly, emphasizing the role of business units in the selection process was an effective way of promoting ownership of these systems by their respective business units. Since the software decisions were made by the end-users, a lack of commitment or discipline to the new system was never an issue. As such, this translated into the greater likelihood of business executives being satisfied or very satisfied with their newly implemented systems.

Another interesting but less flattering figure is the fact that of these seven companies, *all* exceeded their initial pre-implementation budget and schedule. Among the commonly stated reasons for the increase in costs were the unexpected rigors and problems associated with setting up the system, and unanticipated increases in the costs of outsourcing certain tasks to third-party consultants. Therefore, there seemed to be a downside to depending primarily on business managers for the choice of software systems. If the input of IT groups had been sought, perhaps some of the rigors and outsourced tasks would have been better anticipated and carried out. Actually, for several companies, this was unavoidable due to their policy of outsourcing their IT groups. Although there might be clear advantages to outsourcing as IT systems become increasingly complicated, this finding indicated that there are definitely advantages to keeping an IS/IT department within a company to assist in the evaluation and implementation of supply-chain software systems.

All except one of the chemical companies stated that their choices for supply-chain software systems were driven by cross-functional teams of business and IT departments. For the company which was the exception, its choices for supply-chain software systems were

driven basically by its IT department. In this case, the company admitted that it was a mistake to leave out the input from its business units for such an important decision which will ultimately affect those respective units. As a result, the systems procured did not have the required business and functional focus. In addition, the lack of ownership on the part of the business units also resulted in the software systems not being given the required discipline and priority by the affected business units in the implementation process.

Given the large investments which will be made in the procurement and implementation of supply-chain software systems, it is not surprising to find that almost all the companies interviewed stated that the ultimate decision for the choice of supply-chain systems laid with top or senior management within the company. The final decisions were commonly stated to belong to executive level steering teams, the vice-presidents of operational groups, and directors of MIS. There were only two companies which mentioned that final decisions were made at the lower operational level. Interestingly, these two companies also stated that external drivers, such as the systems of their competitors, could be influential in the selection of their supply-chain software systems. The influence of external drivers will be discussed more in the subsequent section.

Importance of internal departments in third-party implementations

In most cases, especially with the need to establish complex data infrastructure with a combination of SCP and ERP systems, external third-party consultants were often engaged to provide the required technical knowledge. However, many contributors to supply-chain and IT journals noted that it was critical for companies engaging external consultants to also include their own employees in the implementation teams. This was critical because vendors often did not have the business experience that the company's own operational employees

have. In addition, including operational employees or the company's own IT personnel in the implementation team would also ensured that the knowledge gained from the process did not leave with the consultants.

Almost all the companies seemed to agree that their own employees played critical roles in implementation teams which included or were led by external consultants. Of the 15 companies which commented on this issue, 14 insisted that their own personnel or business managers take an active part together with third-party consultants in the implementation process. The one company which did not, suffered the consequences. According to the company representative interviewed, it was a regretful mistake as the company was left in the dark after their consultants left. The IT consultants sold them a system but subsequently dropped that system from their portfolio. As a result, the company had to deal directly with the original vendor. This was made more difficult as the vendor was not responsive to the queries made by the company.

Importance of top management support

Of the 16 companies which commented on the question of whether top management was supportive in the implementation process, 14 companies replied positively. All 14 companies felt that the support of top management was crucial to the success of their software implementation project. Nevertheless, the form of top management support varied from company to company. Below are some of the ways in which top management has supported the supply-chain implementation projects of their companies:

1. Committed sufficient financial resources to the implementation project. The implementation project was given high priority in terms of financial commitment.

2. Committed sufficient manpower resources to the implementation project. Top management ensured that the implementation team were dedicated and assigned to work speficially on the implementation project full time.

3. Created communication channels, such as a special newsletter, to keep everyone informed of changes and improvements in the implementation process.

4. Facilitated meetings between functional teams which were affected by the implementation project in specific and the greater re-engineering process in general.

5. Took special interest in the project. Some top managers, including presidents of companies actually met up with their implementation teams on a regular basis.

6. Empowered cross-functional teams to carry out the necessary changes and assessed their improvements only when necessary, such that these teams did not feel inhibited by an authority overlooking their shoulder all the time.

Since such a high percentage of respondents felt that top management support of their software implementation was evident and crucial to their successes, it was not possible to differentiate how much advantage such support brought to companies which had it versus companies which did not. However, from the overwhelming majority of respondents which considered such support crucial, its importance cannot be denied.

For one of the two companies which felt that their top management support could be better, the main complain was that funds were being reduced. The company representative felt that it was ironical for funds to be reduced on a project which would eventually lead to greater savings in supply-chain costs. This comment seemed innocuous initially, but closer examination of the interview responses from other companies revealed that a few other representative suggested top management support was inevitable as a result of the large

sum of money being spent. It was implied that projects which costed less were in general, given less priority and support than projects which costed more. Given that in the case of supply-chain software systems, how much a company pays does not correlate to a specific factor of how much it will gain, this may turn out to be a regretable attitude. For example, expensive infrastructure-orientated projects may be given greater support and priority over process-orientated projects which may reap greater returns. Therefore, the importance of being able to quantify expected improvements or set specific objectives must be reiterated again.

8.4.2 External Drivers: Competitors and Supply-Chain Partners

Competitors

In this subsection, the influence of competitors on supply-chain software decisions will be discussed. Nine (60%) out of the sixteen companies which responded to this question claimed that they would not be influenced at all by the systems being installed or used by their competitors. The others (40%) stated that knowledge of systems being installed or used by their competitors, would make them more inclined to at least examine the merits of these systems and even to procure them, if their benefits were known.

Hence, competitors were not only external drivers in the stages of improving operations and reducing costs but they were also external drivers in the process of software selection for further improvements. Here, the differences between the chemical companies and the food companies interviewed provide an interesting insight.

For the chemical companies, which are all established industry leaders, the consensus among the five respondents was that systems chosen by their competitors would have no influence on their decisions at all. On the other hand, among the food companies interviewed, many of which are relatively smaller and in a more competitive environment, four out of six admitted that they would be more inclined to procure a system if they knew that their competitors were using it. The other two companies replied that their competitors' choice of supply-chain software systems would have no influence on their decisions. As stated by one of the food companies, it would be more inclined to procure a system if it knew its competitors were using the system because most of its competitors are larger and more capable of extensive sourcing and evaluation of supply-chain software systems. Hence, from this finding, it seemed that vendors which adopt the strategy of highlighting their customer-base might have more success in a highly competitive industrial environment and with smaller companies than they would in a less competitive environment and with bigger companies.

Supply-chain Partners

The influence of supply-chain partners on the choice of supply-chain software systems for the companies interviewed was less contentious. Fifteen (94%) out of sixteen companies which responded to this question stated that their decisions were not influenced at all by their supply-chain partners.

There may be several plausible explainations. First, few companies were looking to interface and integrate their systems with those of their supply-chain partners. EDI was the only common system which allowed electronic information exchange in many of the companies interviewed. Second, the technology which enables companies to draw on information of their supply-chain partners quickly and let them stimulate changes across the entire supply-chain

was still not widely available. Vendors are only beginning to expand electronic commerce capabilities to their ERP or SCP systems. Third, the companies felt that it was the issue of data availability which mattered most and interfaces between disparate systems could be easily built.

Among some of the difficulties stated by interviewed companies in using supply-chain software systems to align their businesses with their supply-chain partners were:

- Trust in communications - that information will be available timely and accurately. Some companies were concerned that their supply-chain partners might not apply the same rigor to the process of information sharing as them.
- Lack of a common measurement and indicator of performance and improvements. Some companies were unsure of what information to share and how common improvements could be measured.
- Lack of communication links. Some companies were concerned that some systems do not have proper mapping on to EDI document formats or "sets".
- Common system difficult to achieve when there were numerous supply-chain partners. Ensuring that everyone is on the same level of sophistication was difficult enough.
- Changing long-held paradigms such as producing to capacity and pushing inventories downstream.

8.4.3 Identification and Evaluation of Impediments

Under this section, the issue which will be examined specifically is the process of change, the kinds of difficulties which it brought forward and how companies attempted to manage it.

There has been many studies conducted and books written about the management of change and its impacts. Changes associated with a new process, or new methods and paradigms of operations could be difficult for many members of a large organization. If such changes involve the use of an advanced technology, the difficulties which arised could be greatly multipled.

As can be seen from Fig. 8.1, nine (60%) of the fifteen companies which responded to the questions stated in Fig. 8.1 claimed that the primary difficulties of changes in their business practices were those associated with changing the culture and mentality of their employees. Three companies considered the primary difficulties were those associated with upgrading their employees' skill levels and learning the new technology. Three other companies did not consider there to be any business process changes. As one of the company representatives stated, it was just a better and faster way of doing similar tasks.

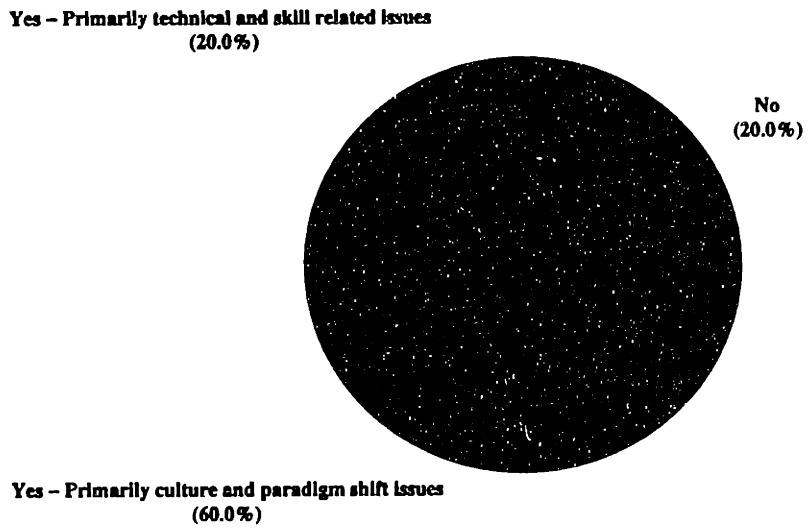


Figure 8.1: Does the new system require you to run your business differently than what you were used to? If so, what were the main difficulties?

Changing corporate culture and paradigm

For the nine companies which experienced difficulties associated with corporate culture and paradigm shifts, some of the difficulties mentioned were:

- Getting employees to be more disciplined in data entry.
- Getting employees to understand the various processes linked by the new technology. For example, procurement personnel need to understand how their actions can affect the manufacturing units.
- Standardizing processes that used to be diverse and spread out across different geographical regions. For example, getting all the divisions and subsidiaries to adopt the same procedure for order entry.
- Adjusting business policies to be more aligned with the changes in business processes. For example, policies on sourcing might be one of diversifying rather than consolidating.
- Adjusting to the new opportunities presented by the software systems. For example, with new system, companies could examine more options for the same problem than before.

As stated in the chapter on software costs, for many companies, most of their cost overruns occured during the stage of transition from an old system to a newer one. Therefore, managing the process of change is definitely important for a successful system implementation. In an environment which is undergoing changes, one of the commonly cited factors

which can ease the transition is the creation of an unchangeable constant. For some companies, this was achieved by creating focus and setting the deliverables well ahead of the implementation process, such that the improvement was seen by their employees as a continuous process, and not a revolutionary one with the arrival of the software system.

A majority of companies also mentioned that the availability of funds, manpower and sufficient time were also critical during the process of change. Hence, commitment and support of top management was crucial to ensure the presence of these resources. Another major issue discussed previously was to involve every affected member of the change process during decision-makings. If employees felt a sense of ownership, they would be afflicted with the "inventor's fever", and would be more enthusiastic and keen about the changes taking place.

Changing skill requirements and technical ability

Issues of changing culture and mentality were not the only difficulties faced by companies in the process of change. As stated previously, three companies actually felt that the issues of acquiring skill and technical capability were more pressing. Directly, the implementation of supply-chain software systems required companies to train their employees to handle the new functions provided by these systems. Indirectly, many menial tasks might have been automated by the software systems such that some of these tasks might have been made redundant. For example, one company cited some of their clerical clerks had to become deployment analysts as a result of the new system taking over their previous tasks.

Of the fifteen companies which responded to the question of how often employees were retrained, almost all responded that training was need-based and continuous, and no specific

schedules were set for it to occur. Two companies replied that they adopted a "train-the-trainer" approach where a few employees were specifically trained to subsequently act as the experts to transfer knowledge on-the-job to their fellow colleagues. Only one company gave a specific schedule for employee training, citing two years as the normal duration between trainings. Interestingly, the company noted that a high learning curve was the main difficulty that it faced in the process of change management.

8.5 Summary of Practices

In this chapter, the roles of internal and external drivers, and how companies handled the transition between and after software implementation were discussed. From the interview findings, it seemed that the way companies approach issues such as motivation and change management depended on a several variables. These included the size of the company, the amount of available resources, the strength of competitors and the degree of market competition.

Companies were found to differ on several issues, such as whether changes brought about from their software implementations impacted their skill requirements or their corporate culture more. On the other hand, there were also issues in which the agreement was almost unanimous, such as the need for top management support, and how training was based on need rather than on a predetermined schedule.

The intention of this chapter was not to find an all encompassing corporate policy which will suit every software implementation. However, by highlighting the differences in practices between companies, it was hoped that sufficient insights were given to companies at the initial stage of devising their software implementation strategy. The issues covered here are

only the tip of the iceberg as it is beyond the scope of this thesis to examine every aspect of corporate policy on supply-chain management software technology. Nevertheless, from the findings, some of the factors which companies will have to consider in formulating a technology policy for supply-chain software systems are:

- Cast of characters - internal and external, what are their roles?
- Support of top management - in what forms and how can it be effective?
- Ownership of system by end-users - how can it be achieved?
- Are there provisions for transfer of knowledge during the implementation process?
- What are the changes needed? And how are these changes managed?

Chapter 9

Conclusion

The findings of this research have managed to shed some light on how a strategy towards the implementation of supply-chain software systems can be formulated. We are entering into an era when the distrust of IT investments may be coming to an end. Software systems such as supply-chain planning systems are increasingly helping companies to make better use of their available information, not merely storing these information for a latter date. Most importantly, a large part of the success of these systems must be attributed to the fact that underlying these systems are highly promising and proven concepts such as supply-chain management.

As the findings show, despite the combination of a sound process-based management ideal and technologically-advanced software systems, failure to reap the benefits of vast investments still occur. The reasons can be classified broadly as external versus internal and technological-related versus policy-related. From the discussions of the previous chapters, it was shown that these reasons did not necessarily apply to all companies. Nevertheless, by breaking up the companies into their industry clusters, similar trends could be observed. For example, food companies were more likely to use ERP-based systems while chemical

companies were more likely to select SCP-based systems.

Fig. 9.1 shows a diagrammatic representation of some internal, external, technology- and policy-related factors cited by companies as reasons for them not enjoying the full benefits expected from their supply-chain software systems.

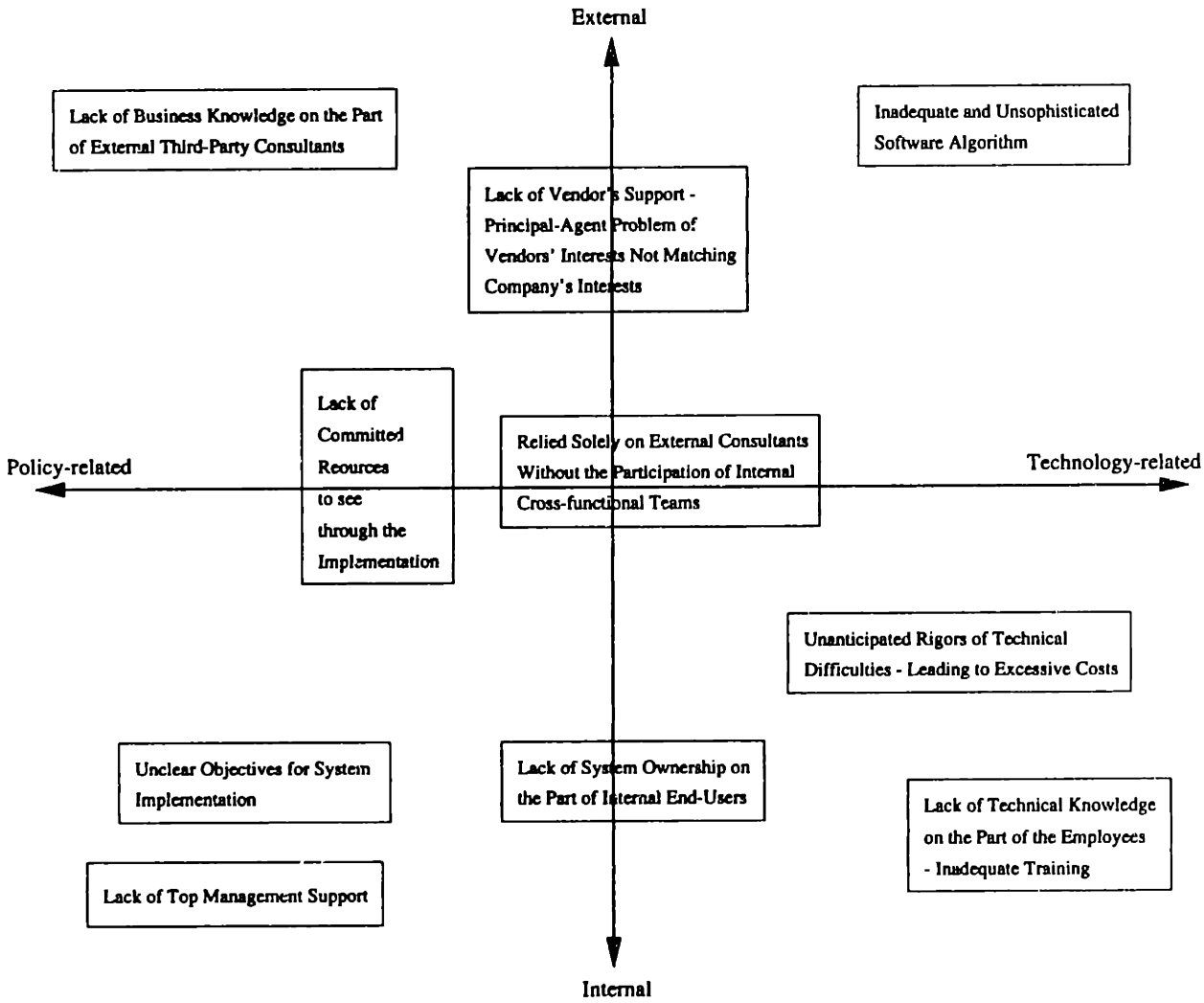


Figure 9.1: Some reasons cited by companies as impediments to them reaping the full expected benefits of their supply-chain software systems

This study revealed several interesting insights and statistics which would be useful to

companies seeking to implement supply-chain software systems. Given below is a brief listing of important findings under the four key chapters. Note: These are only brief summaries of findings and only those which I felt were the most important are highlighted.

Valuing the Traits of Software Systems

- 70% of companies interviewed were satisfied or very satisfied with their software systems. Therefore, the "productivity-paradox" of IT debated in the 1980s may be finally put to rest.
- Of the unsatisfied companies, 75% used a one-vendor, integrated approach centred on an ERP system while 25% chose a mix-and-match approach by combining best-of-breed systems (Note: These systems may still interact with a transactional ERP system)
- In deciding whether an integrated or mix-and-match approach would be used, companies often consider: i) The amount of further improvements possible, ii) The sophistication of their businesses and whether complex functionalities or ease-of-use were more important, and iii) The costs of each approach - costs of implementation versus costs of ownership.

Project Costing and Setting Time-Line

- 65% of companies interviewed exceeded their budget or time allocation. Both ERP and SCP systems could lead to cost over-runs.
- External and internal factors led to these excess costs. Most companies cited training, business process changes, scope-creep, lack of discipline and rigor, lack of resource

commitment, lack of business knowledge and consultancy costs as the most likely areas of excess costs.

- Successful companies knew how to share implementation resources, were well-focused to prevent scope-creep, and understood the technical realities of their systems well. Capabilities of consultants were also well evaluated prior to their engagement.

Objectives of System Implementation

- Companies could be classified under *"performance-oriented"* and *"infrastructure-oriented."* 82% of the former either achieved or were confident of achieving their expected software benefits. In contrast, the figure was 33% for the latter.

- The importance of performance measures for satisfactory implementations were unclear. 60% of companies interviewed used performance measures. Of these, 69% were satisfied with or optimistic about expected benefits. In contrast, the figure was 71% for the 40% which did not use performance measures. In addition, companies which achieved expected benefits often exceeded planned costs.

- More than 60% of the companies interviewed considered reducing supply-chain costs and improving customer satisfaction as their primary objectives. However, most companies did not consider improving customer satisfaction as having an impact on their companies' revenues. Improving customer satisfaction was not a competitive-advantage but a *competitive-imperative.*

Corporate Policies and Related Issues

- 60% of the companies which responded to the question of whether and how the new system changed their business operations stated non-technical issues such as culture and paradigm shifts as the most important difficulties. 20% stated technical and skill-related issues as the primary difficulties.
- Cross-functional teams were critical to the success of the software implementation as both business and IT personnel can contribute differently to the project. It is extremely important that end-users have a sense of ownership on the implemented software. Equally important is the participation of a company's own employees on third-party implementation teams.
- Internal drivers were definitely more important and more influential than external drivers of supply-chain software implementation. 88% of companies interviewed felt that top management support was crucial to their implementation success.

Fig. 9.2 shows a proposed road-map derived from this study for companies which seek to be successful in their supply-chain software selection and implementation. This study undoubtedly highlighted the importance of coupling sound policies and management strategies with in-depth technical capabilities. Without a sound corporate policy, implementation processes can be fraught with the difficulties of cost overruns and benefit shortfalls. Similiarly, without advanced and suitable enabling technologies, supply-chain ideals for most companies would not have proceeded far beyond the starting blocks. The importance of technology and policy were reinforced by the findings presented in this study.

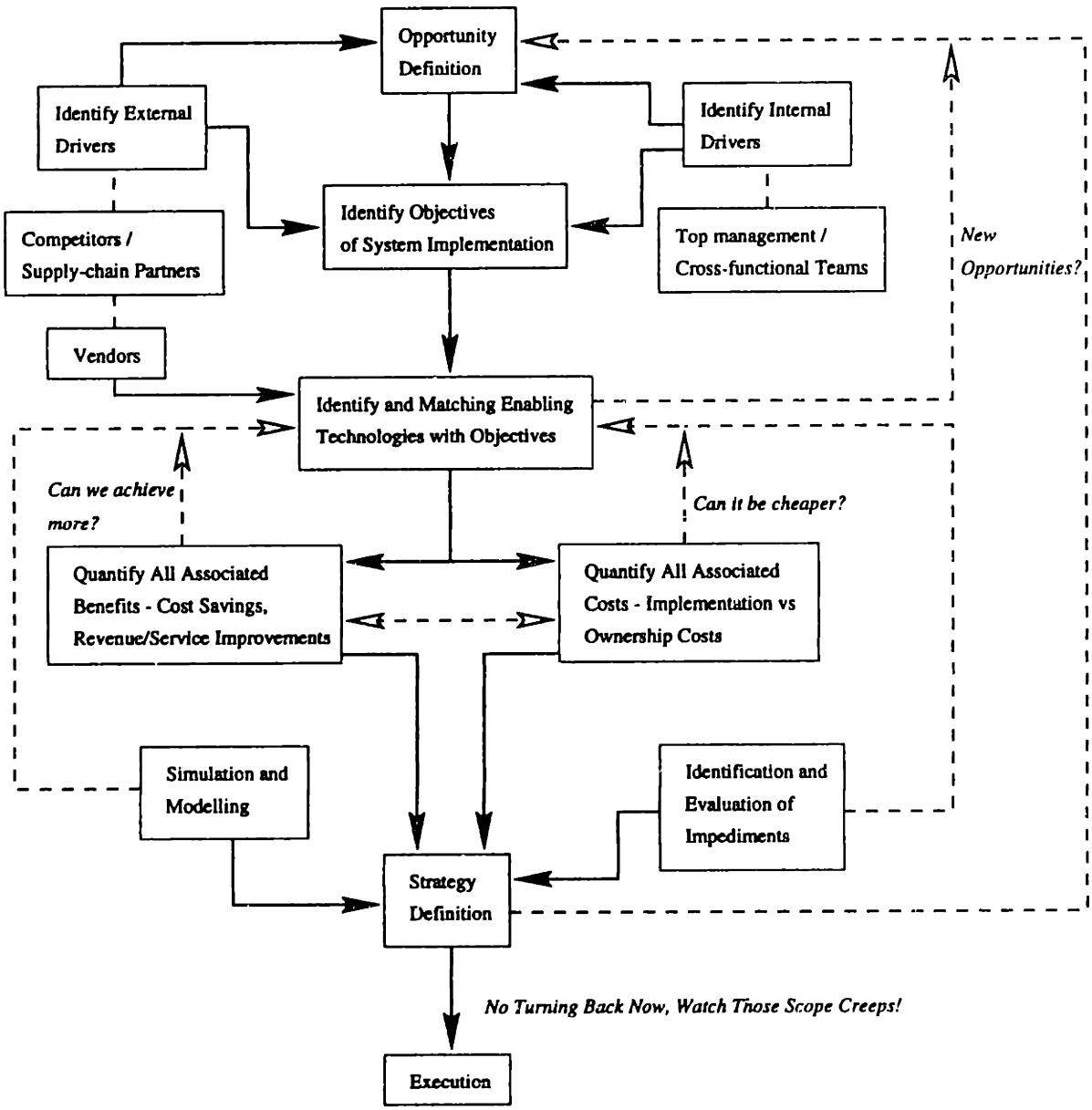


Figure 9.2: Supply-chain Software System Implementation Road Map

References

[1] Gooley T., "Selling Logistics!" *Logistics Management*, November 1996, pg. 43-47

[2] Chen J., "Achieving Maximum Supply-Chain Efficiency," *IIE Solutions*, June 1997, pg. 30-35

[3] Franciose M., "Supply-Chain Integration: Analysis Framework and Review of Recent Literature," *MIT*, 1996

[4] Quinn F., "What's the Buzz," *Logistics Management*, February 1997, pg. 43-46

[5] Hammer and Champy, "Reengineering the Corporation," *Harper Collins*, 1993

[6] Cooper, Ellram, Gardner and Hanks, "Meshing Multiple Alliances," *Journal of Business Logistics*, Vol. 18, No. 1, 1997, pg. 67-89

[7] Myers R., "Measure for Measure," *CFO*, November 1997, pg. 45-56

[8] Fisher M., "What is the Right Supply Chain for your Product?" *Harvard Business Review*, March-April 1997, pg. 105-116

[9] Hill S., "The Correct Time, Please," *Manufacturing Systems*, August 1997, pg. 12-18

[10] Gooley T., "It's About Time," *Logistics Management*, August 1997, pg. 53-56

[11] Barr S., "The Big Picture," *CFO*, July 1996, pg. 37-42

[12] Cottrill K., "The Supply Chain of the Future," *Distribution*, October 1997, pg. 52-54

[13] Hicks D., "The Manager's Guide to Supply Chain and Logistics Problem-Solving Tools and Techniques; Part II: Tools, Companies and Industries," *IIE Solutions*, October 1997, pg. 24-29

[14] Michel R., "Reinvention Reigns," *Manufacturing Systems*, July 1997, pg. 28-92

[15] Laubenthal H., "A Framework for the Implementation of Intercompany Operating Ties," *MIT*, 1997

[16] Bowman R., "The State of the Supply Chain," *Distribution*, January 1997, pg. 28-36

[17] PRTM, "The Keys to Unlocking Your Supply Chain's Competitive Advantage," 1997

[18] Quinn F., "The Payoffs," *Logistics Management*, December 1997, pg. 37-41

[19] Rice J, "Spanning the Functional Boundaries through Horizontal Process Management," *Supply Chain Management Review*, Fall 1997, pg. 60-68

[20] Michel R., "Whatever it takes," *Manufacturing Systems*, July 1997, pg. 94-112

[21] Appleton E., "Supply Chain Brain," *CFO*, July 1997, pg. 51-54

[22] Lankford W. and Riggs W., "Electronic Data Interchange: Where are we today?" *Journal of Systems Management*, March/April 1996, pg. 58-62

[23] Barnes C., "The New Approach to Planning," *Bobbin*, June 1987, pg. 140

[24] Friscia T., "Are Supply-Chain Systems via ERP Viable?" *Manufacturing Systems*, May 1997, pg. 32

[25] Stein T., "Not Just ERP Anymore," *Information Week*, Dec 1, 1997, pg. 18-24

[26] Wilder C. and Stein T., "App Integration," *Information Week*, Oct 6, 1997, pg. 18-20

[27] McConville D., "Up and Coming, Supply-Chain Management is Finally Getting the Respect it Deserves," *Distribution*, June 1997, pg. 36-38

[28] Gormley T. and Cameron B., "Cracks in the System," *Manufacturing Systems*, Novemeber 1997, pg. 32

[29] Friscia T., "ERP - The Goldrush Continues," *Manufacturing Systems*, January 1997, pg. 22

[30] Stein T., "SAP's Fast Track," *Information Week*, Sept 1, 1997, pg. 14-16

[31] Hicks D., "The Manager's Guide to Supply Chain and Logistics Problem-Solving Tools and Techniques; Part III: End User Experiences," *IIE Solutions*, November 1997, pg. 34-38

[32] Allnoch A., "Efficient Supply Chain Practices Mean Big Savings to Leading Manufacturers," *IIE Solutions*, July 1997, pg. 8-9

[33] "ROI for ERP - Rapid Implementation is Vital," *Manufacturing Systems*, July 1997, pg. 18

[34] Thomas J., "Are You Ready to Measure, Manage and Change?" *Distribution*, January 1997, pg. 4

[35] Adcock G., "Logistics Managers Urged to Start Thinking More Like Corporate Chief Financial Officers," *Traffic World*, August 15, 1994, pg. 14

[36] Bonoey J., "Logistics and the CFO," *American Shipper*, April 1994, pg. 51

[37] Cooke J., "The Solid-Gold Supply Chain," *Logistics Management*, April 1997, pg. 57-58

[38] Williamson M., "From SAP to NUT," *Computer World*, November 10, 1997, pg. 68-69

[39] Slater D., "The Hidden Costs of Enterprise Software," *CIO Enterprise*, January 15, 1998, pg. 50-55

[40] Maglitta J., "Beyond ROI," *Computer World*, October 27, 1997, pg. 73-74

[41] Brynjolfsson E., "Paradox Lost?" *CIO*, May 1, 1994, pg. 26-28

[42] Brynjolfsson E. and Hitt L., "Breaking Boundaries," *Information Week*, Sept. 22, 1997, pg. 55-61

[43] Alreck P., "The Survey Research Handbook: Guidelines and Strategies for Conducting a Survey," *Irwin*, 1995

[44] Bendiner, J., "Understanding Supply Chain Optimization: From "What if" to What's Best," *APICS*, January 1998, Volume 8, No. 1

[45] Cook B., "Successful Installation and Implementation of Commercial Off-the-shelf Software: The Non-customized Approach," *APICS*, January 1998, Volume 8, No. 1

[46] Cassis S., "Understanding Advanced Planning Systems," *APICS*, November 1997, Volume 7, No. 11

[47] Kapp K., "The USA Principle: The Key to ERP Implementation Success," *APICS*, June 1997, Volume 7, No. 6

[48] Schonberger R., "Two Implementation Approaches: Systematic & Dynamic," *APICS*, May 1997, Volume 7, No. 5

[49] Hadavi K., "Delivering On-time Performance: What's Wrong with Planning and Scheduling Systems?" *APICS*, March 1997, Volume 7, No. 3

[50] Marche S., "The Seven Key Elements: To Implementing a Successful Production Scheduling System," *APICS*, March 1997, Volume 7, No. 3

[51] Schwartz K., "Benchmarking for dollars," *Datamation*, February 1998, pg. 50-57

[52] Hecht B., "Choose the Right ERP Software," *Datamation*, March 1997, pg. 56-58

[53] Appleton E., "How to Survive ERP," *Datamation*, March 1997, pg. 50-53

[54] Slater D., "Executive Sponsorship," *CIO Enterprise*, March 15 1998, pg. 25-32

[55] Freeman E., "Supply Chain: Modeling Makes the Difference," *Datamation*, October 1997, pg. 64-72

[56] Freeman E., "Manufacturing Applications: What's the Right Recipe?" *Datamation*, August 1997, pg. 60-64

[57] Wheatley M., "Lighten Up," *CIO Enterprise*, February 15 1998, pg. 35-42

[58] Zerega B., "Management Support a Must for Big Bang," *Inforworld*, September 8, 1997, pg. 100

[59] Fabris P., "EC Riders," *CIO*, June 15, 1997, pg. 71-75

Appendix A

Interview Questions

Note: Questions are not listed in order of appearance in the previous chapters. They were arranged such that they provide a smooth flow of conversation in the interview process. These questions were then broken down into the relevant chapters for discussion purposes. Not all questions were used in the discussions.

I. Company background

1. What business unit are you working in at your company?
2. What product or services do you make and sell?
3. How many different manufacturing locations does your business unit have?
4. How many different distribution locations does your company have?
5. How are the activities between the different manufacturing and distribution locations coordinated?
6. Are choices for supply-chain software driven by the operations or planning groups within the business unit or by an IT or IS group within the company?

7. Who or what group ultimately decides?

II. System Information

8. What supply-chain software does your company use?
9. How long was the implementation process for each of the various systems?
10. How did the total implementation cost compare to planned or expected cost? (Implementation cost = software, hardware, consultancy fees, installation and implementation labor, training, restructuring of operations, etc.)
11. What benefits are expected with the software applications mentioned? Were the benefits understood as a financial impact on the company, in terms of cost or revenue? When are the benefits expected?
12. What benefits have already been achieved? Were these benefits up to the expectation?
13. How satisfied is the company with the software system?
14. What were the problems encountered during the software implementation?

III. Procurement Criteria

15. In general, what were the selection criteria used for choosing a supply-chain software?

    Would you say the following are: Most Important, Important or Unimportant as a procurement criteria?

    * Basic functionality of the system
    * Flexibility of the system to changing business needs
    * Ability of system to be upgraded

* Ease of transition from/compatibility with legacy system
* Reputation of the software/vendor
* Required skill level for personnel using the system
* Speed of system implementation
* Industry-specific software application
* Vendor's support and maintenance
* Amount of resources to be committed to the system

16. What specific goals such as ROI, EVA, or other performance metrics does the software has to meet?

IV. Objectives of Software

17. In general, what were the main purposes of selecting and implementing supply-chain software?
18. Would you say the following are: Very Important, Important or Unimportant objectives for your company in procuring the software?
    * Reduce cost
    * Improve flexibility
    * Give executives more control
    * Target new customers
    * Improve IT infrastructure
    * Improve timeliness
    * Improve management information
    * Coordinate with suppliers or buyers
    * Improve customer service
    * Improve quality

V. Traits of Software

19. Why have you chosen an ERP system with supply-chain functionality over a group of best-of-breed systems or vice-versa?
20. What do you think should be improved in the next release of the system you are using or implementing?

VI. Corporate Policies and Culture

21. If your competitors are using the same system, will you be more incline or less to use the same system?
22. Did the supply-chain system used by your supply-chain partners influence your choice of supply-chain system?
23. Did the company insisted on having its own employees work together with the consultants or vendors during the implementation process?
24. How often does the company actively realign the skills of its employees to match the demands of newly implemented systems?
25. Was top management supportive in the implementation process? If so, in what ways and how critical was it to the system's success?

VII. Impediments and Other Success Factors

26. What do you foresee as the main difficulty when using a software system to align your business with those of your supply-chain partners?
27. Does the new system require to run your business differently from what you were

used to? If so, what were the difficulties?

28. What other factors do you think contributed (or will contribute) to the success of your implementation process