LULEÅ TEKNISKA UNIVERSITET

2000:111

BACHELOR'S THESIS

A View of How the Internet Can Influence the Way Sawmills Work with Just-In-Time

Anders Nerman

Ekonomprogrammet C-nivå

Institutionen för Industriell ekonomi och samhällsvetenskap
Avdelningen för Industriell marknadsföring

2000:111 • ISSN: 1404-5508 • ISRN: LTU-SHU-EX--00/111--SE

BACHELOR'S THESIS

A View of How the Internet Can Influence the Way Sawmills Work with Just-In-Time

Case Studies of Two Different Firms Related to the Forest Industry

Anders Nerman

Department of Business Administration and Social Sciences
Division of Industrial Marketing
Ekonomprogrammet

PREFACE

To conduct a bachelor's thesis is an exciting experience that requires hard work, and this study would not have been completed without the wonderful support that I have received.

First, I would like to thank my supervisor, Åsa Wallström, who has given a tremendous amount of time to help and support me in my work.

Further, I would like to thank the respondents of the two case study companies, that is Raw Materials Manager Patrik Gustafson, and Chief Executive Officer Bengt Sörvik.

Finally, I would like to thank Johan Bernin for the interesting and awakening insights, and also one of my Marketing Teachers, Tim Foster for inspiring me to challenge a subject such as the Internet in a business-to-business environment. Thank you all.

Luleå, May 29, 2000

Anders Nerman

ABSTRACT

In recent years attention has been devoted to reveal spectacular Internet achievements in consumer markets. Meanwhile, the potential of the Internet in a business-to-business supply chain environment has been investigated through an insignificant number of studies. The purpose of this bachelor's thesis is to study how the Internet can influence how sawmills work with Just-in-Time. In order to achieve this purpose, two case studies were conducted. The first case study involved the investigation of how a sawmill at Södra Timber AB works with Just-in-Time. The second involved an investigation at Nordpointer Information Systems AB and searched for an answer of how the Internet can be used when sawmills work with Just-in-Time. The required data was gathered through one telephone interview with each company. In order to reach the purpose of this thesis, two within-case analyses and a cross-case analysis were made. The outcome of this study shows that the Internet in various ways can influence how sawmills work with Just-in-Time. This specifically regards quality, inventory and transportation.

TABLE OF CONTENTS

1 INTRODUCTION

In this first introductory chapter a brief explanation of the background is presented to guide the reader towards a better understanding of the problem area. This will ultimately help the reader to grasp the importance of this investigation. This chapter also holds a description of what is to come in the following chapters.

1.1 Background

The importance of a marketing orientation for business success has been well documented. How management allocates scarce resources to the components of the marketing mix – product, price, promotion, and place – will determine a company's market share and profitability. The ultimate objective is that these allocations will lead to the greatest long-run profits. The *place* or *distribution* component represents a manufacturer's expenditure for customer service, which can be thought of as the output of the logistics system. Hence, customer service is the interface of logistics with marketing. While customer service is the output of the logistics system, customer satisfaction results when a company performs well on all components of the marketing mix. (Lambert & Stock, 1992)

However, in the forefront of customer service underlies a broad range of important activities. For example, managers of a production system often face problems of significant complexity. They have to co-ordinate production machinery and workforce to be able to make the right product, reach the right customer, at the right time, with the exact amount of items, and at the same time preserve and improve the production quality, and all this at reasonable costs. Just-in-Time (JIT) can offer new solutions to these problems within many industries. However, JIT is not only a method or a computer program to implement for efficiency and it is not possible to describe JIT in logical terms as can be done to many other systems. JIT is more of a philosophy that defines how to run a production system. (O'Grady, 1990)

Among many definitions, Kristensen, Dahlgaard, Juhl and Kanji (1999, p. 62) have defined JIT as "the successful completion of a product or service in each stage of production activity from vendor to customer just-in-time for its use at a minimum cost". This definition stresses that JIT has a number of strategic implications. Krajewski and Ritzman (1999) state that a basic purpose of supply chain management is to control inventory by managing the flow of materials. According to Womack, Jones and Roos (1990) the use of JIT requires each enterprise to make a careful evaluation of what aspects within the supply chain that are in need of optimization. For it is along the supply chain that JIT control and improves the flow of materials. (ibid) It is also important to be aware of that other closely related management philosophies may overlap the philosophy of JIT. Total Quality Management (TQM) which is a holistic management approach strongly committed to continuous improvement in all of an organization's processes, plays a significant role within the JIT philosophy. (Kristensen, Dahlgaard, Juhl & Kanji, 1999)

JIT is based on two principles: elimination of waste, and respect for and full utilisation of the capabilities of people. Potential waste is apparent at every stage of the production process. The most important kind of waste to eliminate with JIT is the imbalance between customer

demand and production. If the wrong product or too many products are produced inventory is generated which results in a waste of money. This imbalance may exist at each stage in production, including the relation between supplier and producer. During production waste may also arise for a number of other reasons, for example, waiting, transporting, processing and producing defective goods. (Kristensen, Dahlgaard, Juhl & Kanji, 1999) Moreover, JIT is a philosophy that calls for continuous re-examination of how manufactures go about making what they make – making the production cycle more and more functional, making it tighter from order to shipment – including interactions with suppliers. In short, it is a philosophy that attacks waste at every level. (Hutt & Speh, 1995)

A JIT system is the organisation of resources, information flows, and decision rules that can enable an organisation to realise the benefits of the JIT philosophy. Its goals are to produce goods and services as needed and to continuously improve the value-added benefits of operations. (Krajewski & Ritzman, 1999)

JIT originated in the 1950s at Toyota Motor Company in Japan, through continuous efforts to solve manufacturing problems. These efforts led to the development and use of a manufacturing control system referred to as *Kanban*. The Kanban, which means card, is a mechanism by which a workstation signals the need for more parts from the preceding station. (Lubben, 1988) It is basically the system of supplying parts and material just at the very moment they are needed in the factory production process so those parts and materials are instantly put to use (Lambert & Stock, 1992). A unique feature of the Kanban system is the incorporation of a pull production system. Pull production refers to a demand system whereby products are produced only in respect of the immediate demand. (Lubben, 1988)

The goals of supply chain systems such as JIT are multidimensional and include cost minimisation, increased levels of service, improved communication among supply chain companies, and increased flexibility in terms of delivery and response time. Throughout the 1960s, 1970s, and 1980s the ability of firms to achieve these goals was limited, since the communication and knowledge links in the existing supply chains did not bring together all of the key databases. Also, there was the reluctance on the part of firms in the supply chain to share data with each other. This hesitancy was due to a variety of factors, including the perceived threat of giving away competitive advantage to other firms, the sharing of sensitive information such as inventory levels and production schedules with other channel members, and the potential of loosing customers to other competitors. (Lancioni, Smith & Oliva, 2000)

Today, much of the reluctance to interface with other firms in supply chains is breaking down. The change in attitude is due to a variety of factors including JIT, Electronic Data Interchange (EDI), and point-of-sale data sharing programs. Each factor made traditional logistics managers realise that there is more to be gained by working with other supply chain firms than there is to loose. For example, one of the greatest barriers to JIT was the fear that sharing production information with vendors would hurt a company by revealing its production-planning schedule to the competition. The fear was groundless, because what mattered at the end of the day was keeping inventories low and reducing the resulting administrative costs of carrying inventory at manufacturing, plant, and dealer locations. (Lancioni, Smith & Oliva, 2000)

EDI, which is an inter-organisational information system, had the same effect on the fears of the data sharing in the supply chain. When using EDI, firms actually linked up their companies with computer-to-computer data exchange. (Lancioni, Smith & Oliva, 2000) Examples of such data today include shipping forms, invoices, purchase orders, inventory control sheets, financial documents, etc (Salehi-Sangari, 1997). However, the decision to implement EDI wasn't taken lightly, as there were serious aspects, which needed to be taken under consideration. EDI required an investment in computers and software, for both the vendor and the buyer, and further standardising issues made the switch to EDI a lot slower than with JIT. (Lancioni, Smith & Oliva, 2000)

Point-of-sale information programs were a major influence in altering among logistics managers the thinking that data exchange in the supply chain can be beneficial to all parties involved. This was dramatically demonstrated by the results experienced by large retailers such as Wal-Mart and Kmart, which were the first to link their point-of-sale information with the computers of their vendors. Here, the vendors were informed immediately of stock levels of their respective products sold through the stores of the buyers. If the stock levels required replenishment, then the vendors were immediately informed by the point-of-sales systems, which were direct links from the cash register scanners at the respective store outlets. If any item fell to its minimum level of stock, an order was issued for replenishment. The order was electronically transmitted to the vendor. It was filled by the vendor and sent directly to the store or central warehouse. (Lancioni, Smith & Oliva, 2000)

In today's business, one of the hottest topics is the Internet. The Internet is an electronic medium based on broadcasting and publishing which facilitates two-way communication via computers on networks. These exchanges are not face-to-face, nor time-bound, which gives individuals and organisations the possibility to communicate directly with one another regardless of where they are or when they wish to communicate. The World Wide Web is best conceptualised as a platform, which floats on the Internet. It is a media information storage system that links resources around the world. Browser software, such as Netscape and Microsoft Internet Explorer allows words or icons to display several media including text, video, graphics and sound on a local computer screen. (Berthon, Lane, Pitt & Watson, 1998)

1.2 Problem Area

It is predicted that more than 100 million households will be connected to the World Wide Web by 2002. But Lancioni, Smith and Oliva (2000) make inquiries for the use and potential of the Internet in business-to-business supply chain applications. This is a relatively recent phenomenon and there have been few, if any academic studies done on the subject. (ibid) However, needs for Internet solutions are apparent. Enterprises are moving from a retrieval-based information environment to a just-in-time one, and the reception of critical information by those who need it must be immediate and automatic. (Stear, 1997) An article in Dagens Industri (Nordpointer, 2000) stresses the importance of a new Internet-based geographical information system (GIS) that can support the flow of materials and therefore solve inventory problems and quality issues within sawmills in the forest industry. (ibid) Meanwhile, marketing practitioners and academics are getting aware of that more systematic research is required to reveal the true nature of commerce on the Web, for most of the attention has so far

been devoted to spectacular Web achievements in consumer markets. (Berthon, Lane, Pitt & Watson, 1998) With this background in mind, my problem area involves the use of the Internet in a JIT related environment.

1.3 Disposition

This thesis is divided into six chapters. Following this first introductory chapter, a second chapter presents previous studies related to the problem area. The third chapter holds a problem discussion, which ends with a stated purpose, and a delimitation of that purpose. The fourth chapter contains the methodological issues in connection to the investigation. Chapter five presents two different sections of gathered empirical data - one for each conducted case study. The sixth chapter holds three different sections of data analysis. The first two sections hold within-case analysis for each case study. The third section contains a cross-case analysis from the results of the two within-case analyses. Finally, the sixth chapter ends with conclusions.

2 LITERATURE REVIEW

This chapter provides the theoretical base for my investigation. It is divided in two major sections where the first holds important characteristics of the *JIT philosophy* and the second carries the role of the *Internet* in a JIT related context.

2.1 The Just-in-Time Philosophy

The goals of JIT are to minimize parts and materials *inventories*, maximize *production efficiency*, improve *quality*, and provide optimal levels of *customer service* (Hutt & Speh, 1995). As JIT operates with low levels of inventory, *close relationships with suppliers* are necessary. Further, JIT requires effective *transportation*. (Krajewski & Ritzman, 1999)

2.1.1 Close Supplier Ties

The supply chain for a firm can be very complicated and many companies may have hundreds, if not thousands of suppliers. Some firms may own their own distribution and transportation services. However, the value of supply chain management becomes apparent when the complexity of the supply chain is recognized. The flow of materials determines inventory levels and the performance of numerous suppliers determines the inward flow of materials. The performance of the firm's marketing, production, and distribution system determines the outward flow of products. Imagine the chaos if all firms' suppliers acted independently and never adjusted to changes in the firm's schedules. Hence, management of the flow of materials is crucial, but how much control does a firm have over its suppliers? (Krajewski & Ritzman, 1999)

One way to gain control is to buy controlling interest in the firm's major suppliers, which is called backward vertical integration. The firm can then ensure its priority with the supplier and more forcefully lead efforts to improve efficiency and productivity. However, purchasing other companies takes a lot of capital, which reduces a firm's flexibility. Moreover, if demand drops, the firm can't simply reduce the amount of materials purchased from the supplier to reduce costs because the supplier's fixed costs remain. (Krajewski & Ritzman, 1999)

Another approach is to engage into a close partnership with the supplier. Bergman and Klefsjö (1994, p. 248) defines a supplier partnership as a "mutual, ongoing relationship between a buying firm and a supplying firm involving a commitment over an extended time period, and entailing a sharing of information as well as a sharing of the risks and rewards of the relationship". Agreements can be secured with the first-tier suppliers that hold them accountable for the performance of their own suppliers. For example, customers can provide a uniform set of guidelines to be followed throughout the supply chain. Companies such as Ford and Chrysler have guidelines for quality, delivery, and reporting procedures to be followed by any company producing an item that ultimately becomes part of the automobile. First-tier suppliers then incorporate these guidelines in agreements with their own suppliers. This approach allows first-tier suppliers to manage its own suppliers without its customers having to do it for them. (Krajewski & Ritzman, 1999)

Because JIT systems operate with very low levels of inventory, close relationships with suppliers are necessary. Stock shipments must be frequent, have short lead times, arrive on schedule, and be of high quality. A contract might require a supplier to deliver goods to a factory as often as several times per day. It is therefore important to reduce the number of suppliers, use local suppliers, and improve supplier relations. (Krajewski & Ritzman, 1999)

A reduced number of suppliers put a lot of pressure on the remaining suppliers to deliver high-quality components on time. To compensate, JIT users extend their contracts with these suppliers and give them advance-order information. In addition, they include their suppliers in the early phases of product design to avoid problems after production has begun. They also work with their suppliers' vendors, trying to achieve JIT inventory flows throughout the entire supply chain. Manufacturers using JIT systems generally utilize local suppliers. Geographic proximity means that the company can reduce the need for safety stocks. Companies that have no suppliers close by must rely on a finely tuned supplier delivery system. Furthermore, close supplier relations can not be established and maintained if companies view their suppliers as adversaries when contracts are negotiated. Rather, they should consider suppliers to be partners in a venture where both parties have an interest in maintaining a long-term relationship. Such close co-operation between companies and their suppliers can be a win-win situation for everyone. Better communication of component requirements, for example, enables more efficient inventory planning and delivery scheduling by suppliers, thereby improving supplier profit margins. (Krajewski & Ritzman, 1999)

2.1.2 Inventory

Inventory is a stock of materials used to satisfy customer demand or support the production of goods or services. *Figure 1* shows how inventories are created through the analogy of a water tank. The flow of water into the tank raises the water level. The inward flow of water represents input materials such as steel, component parts, office supplies, or a finished product. The water level represents the amount of inventory held at a plant, service facility, warehouse, or retail outlet.

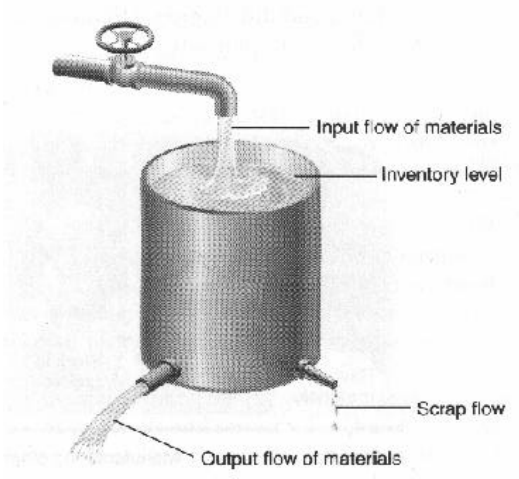

Figure 1. Creation of inventory (adapted from Krajewski & Ritzman, 1999, p. 455)

The output flow of water represents the demand for materials in inventory, such as customer orders for a finished product or requirements for component parts or supplies to support the production of goods or services. Another possible outward flow is that of scrap, which also lowers the level of useable inventory. Together, the rates of the input and output flows determine the level of inventory. Inventories rise when more material flows into the tank than flows out and vice versa. *Figure 1* also shows clearly why firms utilize Total Quality Management to reduce defective materials. The larger the scrap flows, the larger will be the input flow of materials required for a given level of output. (Krajewski & Ritzman, 1999)

According to Krajewski and Ritzman (1999) inventory exists in three categories, which are useful for accounting purposes:

1. *Raw materials* (RM) are inventories needed for the production of goods or services. They are considered to be inputs to the transformation processes of the firm, whether they produce a product or a service.

2. Work-in-process (WIP) consists of items such as components or assemblies needed for a final product in manufacturing. Work-in-process is also present in some service operations, such as service shops, mass service providers, and service factories.

3. *Finished goods* (FG) in manufacturing plants, warehouses, and retail outlets are the items sold to the firm's customers. The finished goods of one firm may actually be the raw materials for another. (ibid)

The goals of JIT are to minimize parts and materials inventories, improve product quality, maximize production efficiency, and provide optimal levels of customer service. At the core of any JIT system is the idea that parts and materials inventories are to be avoided; the goal is simply to minimize inventory. (Hutt & Speh, 1995) Rather than building up a pile of inventory, Krajewski and Ritzman (1999) say that users of JIT systems maintain inventory with lot sizes that are as small as possible and small lot sizes have three benefits:

First, small lot sizes reduce cycle inventory, the inventory in excess of the safety stock carried between orders. The average cycle inventory equals one-half the lot size. As the lot size gets smaller, so does cycle inventory. Reducing cycle inventory reduces the time and space involved in manufacturing and holding inventory.

Second, small lot sizes help cut lead times. This is the time it takes for replenishment. A decline in lead-time in turn cuts inventory because the total processing time at each workstation is greater for large lots than for small lots. Also, a large lot often has to wait longer to be processed at the next workstation while that workstation finishes working on another large lot. In addition, if any defective items are discovered, large lots cause longer delays because the entire lot must be inspected to find all the items that need rework.

Finally, the JIT system works best if the daily load on individual workstations is relatively uniform and small lot help achieve these uniform workstation loads. Large lots consume large chunks of processing time on workstations and therefore complicate scheduling. Small lots can be juggled more effectively, enabling schedulers to utilize capacities more efficiently. In addition, small lots allow workstations to accommodate mixed-model production (more than

one item) by reducing waiting line times for production. Although small lot sizes are beneficial to operations, they have the disadvantage of increased set-up frequency. In operations where the set-up times are normally low, small lots are feasible. However, in fabrication operations with sizeable set-up times, increasing the frequency of set-ups may result in wasting employee and equipment time. These operations must reduce set-up times to realize the benefits of small-lot production. (Krajewski & Ritzman, 1999)

New competitive realities are pushing strategic imperatives toward reducing inventories to just about zero. Strategists from heavy manufacturing to consumer goods are focusing on the dramatic impact improvements in inventory management have on both the top and bottom lines. On the top line, efficient inventory management results in increased revenues, through improved speed to market and customer satisfaction. On the bottom line, it reduces costs and improves asset management. Cost experts point out that inventory throughout the value delivery system – from original raw materials suppliers, through various parts and assembly work-in-process steps, to producer and dealer finished goods – is the single largest category of cost in the manufacture and sale of a car. These auto manufacturers are by no means alone. Furthermore, managing inventories is a critical corporate competency when trying to balance the conflicting demands created by shorter product lifecycles and the need for safety stock in order to meet customers' shorter and shorter delivery schedules. The loss of working capital in the first case, and the loss of customers in the second, can make the critical difference in profitability in an era of shrinking prices and margins. (Oliver, 1999)

In a strategic sense, inventory is the physical manifestation of the lack of information between demand and supply. Thus, improving information flow from point of purchase to the raw material supplier can be seen as the primary manner in which inventories can be pushed toward zero. While faster, cheaper, better supply chain concepts have been with us for some time, many manufacturers are working to tie their suppliers into the supply chain. Equal effort needs to be focused on distribution intermediaries and retailers. Such end-to-end systems can create values of improved customer satisfaction and lower costs, particularly inventory costs. (Oliver, 1999)

Oliver (1999) exemplifies how improved end-to-end systems can work: A customer lifts a portable computer off the shelf in a computer retail store. At the very second that purchase is rung up, the bar code information electronically signals the store's purchasing function for a replacement. That information is automatically sent to the computer manufacturer, who at the same time receives an order for replacement. The computer manufacturer also instantly alerts its suppliers with a series of electronic orders. When the manufacturer's computer chip supplier receives the order, it instantly issues electronic orders to its suppliers. And somewhere, just as the consumer is walking out the door with his or hers computer, a machine starts digging sand for the silicon for a new chip. However, this hypothetical example is interesting for enterprises to look in to, since the technological feasibility is getting very close. (ibid)

2.1.3 Pull and Push Methods of Materials Flow

The management of the flow of materials through a production system can be divided into two different pull and push methods. To differentiate between these two methods, let's

consider the production system of a Quarter Pounder at a McDonald's restaurant. There are two workstations. The burger maker is the person responsible for producing this burger. Burger patties must be fried, buns must be toasted and then dressed with ketchup, pickles, mayonnaise, lettuce, and cheese, and the patties must be inserted into buns to finally be put on a tray. The final assembler takes the tray, wraps the burgers in paper, and restocks the inventory. Inventories must be kept low because any burgers left unsold after seven minutes must be destroyed. (Krajewski & Ritzman, 1999)

The flow of materials is from the burger maker to the final assembler to the customer. One way to manage this flow is by using the *push method*, in which the production of the item begins in advance of customer needs. With this method, management schedules the receipt of all raw materials and authorises the start of production of a significant amount of burgers and when they are completed, pushes them along to the final assembler's station, where they might have to wait until he/she is ready for them. The packaged burgers then wait on a warming tray until a customer purchases one. (Krajewski & Ritzman, 1999)

The other way to manage the flow among the burger maker, the final assembler, and the customer is to use the *pull method*, in which customer demand activates production of the item. With the pull method, as customers purchase burgers, the final assembler checks the inventory level of burgers and, when they are almost depleted he/she orders six more. The burger maker produces the six burgers and gives the tray to the final assembler, who completes the assembly and places the burgers in the inventory for sale. The two workers can co-ordinate the two workstations to keep inventory low, which is important because of the seven-minute time limit. The production of burgers is a highly repetitive process, set up times and process times are low, and the flow of materials is well defined. There is no need to produce to anticipated needs more than a few minutes ahead. (Krajewski & Ritzman, 1999)

JIT is a demand pull system in which manufacturing planning begins with the final assembly line and works backwards, not only through the various manufacturing processes, but also to the vendors and subcontractors supplying materials and components. The aim is that by limiting production and assembly to what is actually needed, both materials and work-in-process inventories can be eliminated or significantly reduced. (Lysons, 2000)

Firms that tend to have highly repetitive manufacturing processes and well defined material flows use JIT systems because the pull method allows closer control of inventory and production at the workstations. Other firms, such as those producing a large variety of products in low volumes with low repeatability in the production process, tend to use a push method such as Materials Requirements Planning (MRP). In this case production is started at the first workstation and pushed ahead to the next one. Inventory can accumulate at each workstation because workstations are responsible for producing many other orders and may be busy at any particular time. In environments where materials flows are complex and demands are highly variable, Materials Requirements Planning may be the system of choice. The materials flows are too complex for a JIT system, and pull techniques can't cope with the demand and lead time variability. However, choices between the push and pull system don't necessarily have to be the case. The best solution is determined by the nature of the production process and it is often a hybrid of the strengths of both approaches. (Krajewski & Ritzman, 1999)

2.1.4 Transportation

Lambert and Stock (1992) state that transportation is an important area of logistics because of its impact on customer service levels and the firm's costs structure. Transportation costs can account for as much as 10 to 20 percent of product prices. Effective management upon transportation can result in many firms achieving significant improvements in profitability. In addition, the manufacturer can improve customer service levels through scheduled routs, reduced product loss or product damage, and lowered transit times. (ibid) Krajewski and Ritzman (1999) stress that JIT systems need frequent shipments, short lead times, transportation that arrives on schedule, and delivered goods of high quality. Lambert and Stock (1992) also state that there are many strategic alternatives to choose from in the management of transportation. A manufacturer could own its private transportation entity, lease necessary resources, or co-operate with shippers. When such co-operation takes place, the shipper and manufacturer can become part of a partnership. (ibid)

2.1.5 Quality

JIT systems seek to eliminate scrap and rework in order to achieve a uniform flow of materials. Efficient JIT operations require conformance to product or service specifications and implementation of Total Quality Management. JIT systems control quality at the source, with workers acting as their own quality inspectors. However, a method like this places a great deal of responsibility upon the workers, which require knowledge and preparations. (Krajewski & Ritzman, 1999) High internal quality is a prerequisite, but companies that work with JIT must also work with the quality of its suppliers (Bergman & Klevsjö, 1994).

Total Quality Management has become very important. Total Quality Management is about leadership and employee participation to achieve a cultural change towards an organization, which is strongly customer focused and strongly committed to continuous improvement in all its processes. One goal is to assure a quality process, for turning out the most efficient product at minimum cost and within the most appropriate time, but to achieve it, we must not forget that Total Quality Management is a holistic approach. Most Total Quality Management implementation failures are due to trying to ignore the fact that all the elements or processes of an organization interact in ways, which make a system approach necessary. (Ramalhoto, 1999)

The enterprises that will have a strong chance of surviving an ever-increasing competitive environment will be the ones that have the flexibility to produce according to fluctuating demand. A huge waste of resources can be seen in the way a product is designed, made and sold. However, cost reduction is not synonymous with cost cutting. Cost reduction should come as a result of better cost-management. Today's customer wants improved quality at a reasonable price. The best way to serve these customers' needs and at the same time stay profitable is to practice JIT management, which supports the on-time delivery of quality products and services. To be successful in JIT the enterprise must focus quality improvement methods at the core of their activities, or were the real action takes place. This usually refers to the place where manufacturing activities are conducted in a factory as well as the place where employees have direct contact with customers in service sectors. (Ramalhoto, 1999)

Krajewski and Ritzman (1999) illustrate examples of such quality improvement methods. The antenna department at Texas Instruments had a defect rate that varied from zero to 50 percent on a daily basis, averaging about 20 percent. To compensate, production planners increased the lot sizes, which only increased inventory levels and did nothing to reduce the number of defective items. Engineers discovered through experimentation that gas temperature was a critical variable in producing defect-free items. They devised statistical control charts for the operators to use to monitor gas temperature and adjust it themselves. Process yields immediately improved and stabilized at 95 percent, eventually enabling management to implement a JIT system. (Krajewski & Ritzman, 1999)

However, management must realize the enormous responsibility this methods place on the workers and must prepare them properly, as one GM division quickly learned. When Buick City began using JIT in 1985, management authorized its workers to stop the production line by pulling a cord if quality problems arose at their stations. This eliminated production-line inspectors and cut the number of supervisors by half. Stopping the line, however, is a costly action that brings a problem to everyone's attention. The workers weren't prepared for that responsibility. Productivity and quality took a nosedive. The paint wasn't shiny enough, the seams weren't straight and the top of the dashboard had an unintended wave. Management, labor, and engineering formed a team to correct the problems. Work methods were changed, and the system was modified to include a yellow warning cord so that the workers could call for help without stopping the line. (Krajewski & Ritzman, 1999)

Suppliers should also be included into Total Quality Management. An example of this is the supplier participation in the design of new products so that inefficient component designs can be avoided before production begins. (Krajewski & Ritzman, 1999) Bergman and Klevsjö (1994) states that it is recognized that the supplier often is the product specialist and has the expertise to identify opportunities of improvement. Furthermore, leaders should ensure that the relationship is sound at all levels. A supplier's personnel could for instance be allowed to work at the partner for some time and then return to the supplier with a broader scope of how things work. (Bergman & Klevsjö, 1994)

2.1.6 Customer Service

Lambert and Stock (1992) state that the meaning of customer service varies form one company to the next. In broad terms, customer service can be considered the measure of how well the logistics system is performing in creating time and place utility for a product, including support after the sale. In most corporations customer service is looked upon in one of three ways:

1. As an *activity* that has to be managed, such as order processing, invoicing, or handling customer complaints.

2. As *performance measures*, such as the ability to ship 95 percent of the orders received complete within 48 hours.

3. Or, as an *element in the total corporate philosophy* rather than as an activity or a set of performance measures.

Lambert and Stock (1992, p. 112) also define customer service as "a process which takes place between buyer, seller, and third party. The process results in a value added to the product or service exchanged. This value added in the exchange process might be short term as in a single transaction or longer term as in a contractual relationship. The value added is also shared, in that each of the parties to the transaction or contracts are better off at the completion of the transaction than they were before the transaction took place. Thus, in a process view, customer service is a process for providing significant value-added benefits to the supply chain in a cost-effective way."

2.2 The Role of the Internet

This second major section provides various insights to the role of the Internet in a JIT context. These insights are divided into sub-sections beginning with, the Internet and supply chains, followed by the Internet and vendor relationships, inventory, transportation, and customer service.

2.2.1 The Internet and Supply Chains

The way firms are doing business today is changing at an increasing rate and one aspect that contributes to this change is the development of the Internet. This progress has created innumerable cost- and service- related opportunities for companies and their supply chains. (Lancioni, Smith & Oliva, 2000)

According to Oliver (1999) the increasing use of Internet-based solutions is helping many partners in a supply chain to lower costs and improve speed and efficiencies. Companies are creating solutions by allowing employees of partner companies that are in need of critical information access to their internal computer systems via the Internet. Today's publicly accessible and comparatively inexpensive Internet allows even small suppliers up and down the supply chain to quickly form partnerships. (ibid) Moreover, Lancioni, Smith and Oliva (2000) state that the Internet has enabled companies to more quickly incorporate EDI information programs with their customers. Before the development of the Internet, EDI took a long time to implement into the supply chain. This is because each channel member had to invest heavily in equipment, software, and training to make the system operational. This is similar to the situation with JIT delivery programs. As a consequence of the Internet, JIT and EDI systems only take half of the needed time to develop and to put into operation. Companies can also use the Internet to co-ordinate their JIT programs with vendors. This can minimize the difficulty in their production scheduling. (ibid)

2.2.2 The Internet and Vendor Relationships

Vendors are the specific people working at the sales unit of a company. The Internet has proven itself to be an important communication link with vendors. It can be utilized when making purchases from vendor catalogues. The purchasing function in the U.S. has been streamlined through the use of the Internet. General Electric, for example, has reduced its

purchasing staff by more then 50 percent, the order processing paperwork flows have been reduced, and order times has decreased. Many other companies have shown that the time between the order is placed and the time it is received by a customer, has been reduced by as much as one-half. The use of the Internet has also reduced the error rate involved in order processing, since errors now can be detected more easily and corrected more quickly. Furthermore, the accuracy of pricing is of high importance in order processing, and the Internet provides companies with the ability to check vendor prices on-line before an order is placed. Moreover, negotiations have also been streamlined through the use of the Internet. Face-to-face negotiations are not used as frequently since the negotiations can be conducted through the Internet. The Internet is also utilized to manage product-damage issues. This has lowered the costs of handling returned or damaged goods by improving the tracking of the items. (Lancioni, Smith & Oliva, 2000)

Another important factor in vendor relations is the ability of a company to rate the performance of its vendors based on the elements agreed to in their negotiated contracts. This include such factors as deliveries to company warehouses and depots, the on-time performance of the carriers used by the vendors, and vendor raw material inventory and general stock levels. The benefits of these evaluations improve the overall quality of vendor performance, lower purchasing and ordering costs, and improve the productivity of vendor operations. Hence, it is possible for companies to form partnerships based on information through Internet monitoring. (Lancioni, Smith & Oliva, 2000)

2.2.3 The Internet and Inventory

The most costly aspect of supply chains is the management of inventory. The Internet has affected inventory management most dramatically in the ability of companies to be dynamic in the management of inventory systems. This is shown in the ability of companies to notify customers of order-shipping delays and inventory emergencies. The information available to inventory managers is becoming more available because of the reporting systems that can be used through the Internet. This information includes finished-goods inventory levels at manufacturing and field level depots along with raw material levels at central and regional assembly locations. The Internet also provides both buyers and sellers with the ability to track out-of-stock inventory items in field depots. The overall benefit of the Internet to companies is to keep inventory levels low, reduce overall holding costs, and still provide high levels of customer service. (Lancioni, Smith & Oliva, 2000)

2.2.4 The Internet and Transportation

Another costly component in the supply chain is transportation. Research has shown that the monitoring of pickups at regional distribution centres by carriers is the most common application of the Internet in this area. This is particularly important for a company, since tracking shipments to regional depots provides the company with data on the reliability performance of the carriers it is using. This enables transportation managers to make sure that the motor carriers they use are meeting their promised arrival times. It also provides managers with the information needed to inform carriers of shipment delays as they occur, and to not

have to wait for days before the information becomes available for corrective measures to be taken. (Lancioni, Smith & Oliva, 2000)

2.2.5 The Internet and Customer Service

The Internet has provided companies with the ability to offer their customers another way to contact the company for service issues. The Internet has also given the customers a 24-hour access to the service department, enabling them to immediately notify the department of any service issues or problems that may arise. The overall effects are reduced response times and resolutions of customer service problems. The two-way communication capability can give a positive effect on customer relationships. Customers whose service issues are dealt with quickly and to their satisfaction are more likely to want to purchase again. This means that the Internet can be a tool for building strong product and service loyalty. (Lancioni, Smith & Oliva, 2000)

3 PROBLEM DISCUSSION, PURPOSE AND DELIMITATION

This third chapter holds a problem discussion, which leads to a purpose of this study. The purpose is finally delimitated.

3.1 Problem Discussion

In logistics, a company's success in achieving its outmost goal, to make long-run profits, stretches all through the multidimensional activities of the supply chain (Lambert & Stock, 1992; Lancioni, Smith & Oliva, 2000). According to Hutt and Speh (1995) potential waste is apparent at each stage of the production activities, from vendor to customer. Enterprises who succeed in allocating their scarce resources throughout these supply chain activities will have a better chance of surviving the ever-increasing competitive environment (Lambert & Stock, 1992; Ramalhoto, 1999). An efficient allocation results in increased revenues through improved customer service, which can be thought of as the output of the logistics system. On the other hand efficient allocation reduces costs and, therefore, also reduces the loss of working capital. (Oliver, 1999) However, cost reduction should not be viewed as something that is synonymous with cost cutting. Cost reduction should be the outcome of good management securing that actions taken don't affect the level of customer service. (Ramalhoto, 1999)

O'Grady (1990) declares that the management of JIT can offer solutions to a company's long-run profit objectives. JIT is according to Hutt and Speh (1995) a philosophy that attacks waste at every level. Kristensen, Dahlgaard, Juhl and Kanji (1999) stress that the most important kind of waste to eliminate with JIT is the imbalance between customer demand and production. If the wrong product or too many products are produced inventory is generated, which results in a waste of money. (ibid) Cost experts also point out that inventory throughout the supply chain system – from original raw materials suppliers, through various parts and assembly work-in-process steps, to producer and dealer finished goods – is the single largest category of cost (Oliver, 1999).

Krajewski and Ritzman (1999) state that a firms supply chain can be very complicated and include many suppliers. One way for a firm to gain control over its major suppliers is to buy controlling interest, which is called backward vertical integration. Another way is to engage into close partnerships with the suppliers. Since JIT systems operate with very low levels of inventory, close relationships of any kind with suppliers are necessary. Stock shipments or transportation must be frequent as often as several times per day, have short lead times, arrive on schedule, and be of high quality. It is therefore important to have good relations to a reduced number of local suppliers. Close co-operations can be a win-win situation for everyone since better communication enables more efficient planning of the materials flow. (ibid) Lambert and Stock (1992) state that there are many strategic alternatives to choose from in the management of transportation. Some firms may own their own transportation services, some lease these necessary resources and some engage in close partnerships. Oliver (1999) stresses that while many firms are working to tie their suppliers into the supply chain, equal effort should be focused on transportation.

Although a pull system is the true JIT system, it doesn't seem that the application of JIT requires a fully developed pull system. Krajewski and Ritzman (1999) states that the best solution is determined by the nature of the production process and this is often a hybrid of the strengths of both pull and push methods. Either way, the goal of JIT is to minimize materials inventories. (Hutt & Speh, 1995) Rather than building up a cushion of inventory, users of JIT systems maintain inventory with lot sizes that are as small as possible. Small lot sizes reduce cycle inventory, which is the inventory in excess of the safety stock held between orders. Reducing cycle inventory in turn reduces the time and space involved in manufacturing and holding inventory. Small lot sizes also reduce lead times, which is the time taken to refill stock. A decline in lead-time also has a number of positive implications. (Krajewski & Ritzman, 1999)

JIT systems control quality at the core of the production activities, where all the action takes place, with workers acting as their own quality inspectors. But suppliers should also be included in quality activities such as the design of new products so that inefficient component design can be avoided before the production stage. (Krajewski & Ritzman, 1999) According to Bergman and Klevsjö (1994) the supplier often is the product specialist who has the knowledge to identify opportunities of quality improvements. To secure quality at the core activities and at the suppliers level can enable cost reductions and provide increased levels of customer service (Ramalhoto, 1999).

The Internet can be used as a tool to create further opportunities to cost reductions and improved customer service (Lancioni, Smith & Oliva, 2000). Oliver (1999) states that inventory in a strategic sense are the physical manifestation of the lack of information between demand and supply. Hence, improving the information flow throughout the supply chain is of outmost importance. According to Lancioni, Smith and Oliva (2000) communication links that bring together the entire key databases are required. Oliver (1999) states that firms are creating solutions by allowing employees of partner firms that are in need of important information access to their internal computer systems via the Internet. According to Lancioni, Smith and Oliva (2000) the Internet can also enable firms to incorporate EDI and JIT programs with their channel members. Before the development of the Internet, such programs were expensive and time-consuming to incorporate, as each channel member had to invest heavily in equipment, software and training to make the system operational. As a consequence of the Internet, JIT and EDI systems only take half of the needed time to make operational. (ibid)

A research that was conducted by Lancioni, Smith and Oliva (2000) has shown that the Internet can affect activities along supply chains in various ways. The Internet has for instance proven itself to be an important communication link with suppliers, where it can ease and reduce costs of activities such as purchasing and order processing. The Internet has also affected the ability of firms to be dynamic in the management of inventory systems since the flow of information has become more available to inventory managers. In addition, the Internet has been used to monitor transportation, which has enabled transportation managers to ensure promised arrival times and also enabled managers to spread information about delays as they occur. Finally, the Internet has provided an improvement in the way customers and companies communicate. This includes 24-hour access to the service department, which has reduced response times and resolutions of customer service problems. (ibid)

As the Lancioni, Smith and Oliva (2000) research is a helpful theoretical support to this investigation it still provides a rather vague and a somewhat generalizing picture to the use of the Internet in a JIT related environment. The author of an article in Dagens Industri (Nordpointer, 2000) discuss the use of an Internet-based geographical information system in the forest industry, which gives an interesting view to this investigation. The basic principal of the system is that every tree that is cut down will be marked, which enables tracking of timber wherever it is along the supply chain. The author continues that this Internet-based method would not have been possible if it weren't for the development of mobile and wide-wired Internet. However, according to the author, the overall benefit of this Internet-based method is that sawmills can keep low inventory, provide improved quality and therefore solve efficiency- and profitability problems within many sawmills.

3.2 Purpose of this Study

The purpose of this study is to gain a better understanding of *how* the Internet can influence *how* sawmills work with JIT.

In order to reach my purpose I have formulated two research questions.

1. *How* do sawmills work with JIT?

2. *How* can the Internet be used when sawmills work with JIT?

3.3 Delimitation

The JIT philosophy is too vast for me to investigate since I would have to cover absolutely everything concerning the subject. JIT may in real life not necessarily be considered as a philosophy or a system and will, therefore, in this investigation focus upon close supplier ties, inventory, pull and push methods of materials flow, transportation, quality, and customer service.

When investigating how sawmills work with JIT, I have chosen to take on a perspective from within a sawmill. This means that I have taken the perspective of an inbound flow of materials towards production of the sawmill and an outbound flow of materials towards the customer.

4 METHODOLOGY

In this fourth chapter I will discuss and justify methodological issues connected to my research. The chapter begins with a discussion of the chosen research strategy followed by research method, sample selection, literature study, data collection, data analysis, and finally ends with issues of validity and reliability.

4.1 Research Strategy

A deductive research strategy is based upon the theories available about the area of investigation. This is to be followed by an attempt to describe and explain if the reality really is what the theories earlier stated. If the answers the researcher gets are different from the theory, the theory might need a modification. In contrast, the inductive strategy is not based on any theory at all. It is an approach of collecting data from which a general conclusion can be drawn. In a latter stage this could lead to a development of a theory. (Eriksson & Wiedersheim-Paul, 1999) I chose to conduct this thesis through a deductive research strategy. The available theories found is presented in chapter two, leading me to see if the empirical data could verify theory or show that it was incomplete. I also found this approach more appropriate since theory could lead me towards asking more relevant questions throughout the investigation.

The social sciences can be researched through two different, qualitative and quantitative, methodological strategies. The best strategy to use in a study depends on that specific study's research problem. Furthermore, the most profound difference between the two strategies is how we choose to use numbers and statistics. (Holme & Solvang, 1991) Quantitative data, or hard data often leads to more general results that often are presented in a statistical way (Eriksson & Wiedersheim-Paul, 1999). Qualitative data, or soft data is gathered for us to gain a deeper understanding of the problem so that it can be described and explained (Holme & Solvang, 1991). I chose the qualitative strategy when conducting my empirical study. The purpose of this thesis required a strategy that went in depth, describing and explaining the very complex problem at hand, instead of presenting more general quantitative data that could lead to generalizing results. Moreover, Lancioni, Smith and Oliva (2000) state that Internet applications in the area of JIT is a recent phenomenon where only few, if any studies have been done. This makes it increasingly important to take on a qualitative strategy that can allow an investigation in depth, which allows a deeper understanding of the problem.

4.2 Research Method

There are four major research methods that can be used when conducting a study: surveys, desk investigations, experiments and case studies. A survey is a research technique in which information is gathered from a sample of people through a questionnaire. Many cases are studied, but only a few variables. (Zikmund, 1994) Desk investigators use literature and earlier research to study a problem area and make different analysis from this existing material. A general problem when only using secondary data is that it has often been gathered for a completely different purpose than your own. (Wahlbin & Lekvall, 1993) Experiments

hold the greatest potential for establishing cause/effect relations. Experimentation allows investigation of changes in one variable, such as sales, while manipulating one or two other variables, perhaps price or advertising. (Zikmund, 1994) The investigator can manipulate behaviour directly, precisely and systematically and it can occur in a laboratory setting or in a field setting (Yin, 1994). The purpose of the case study method is to obtain information from one or a few situations that are similar to the researcher's problem situation. It is a technique that intensively investigates a problem. Therefore the advantage of a case study is that an entire organisation or entity can be investigated in depth with attention to detail. This highly focused attention enables the researcher to concentrate on identifying the relationships among functions, individuals or entities. (Zikmund, 1994) It is supported by Yin (1994) that research questions that are built upon *how* and *why* questions are of an explanatory character that often lead to case studies or experiments.

The proclaimed advantages of the case study convinced me in my choice of research method. I wanted to describe and explain the problem through an intense and detailed investigation of an environment similar to my problem. Such an investigation required information from a source applying the JIT philosophy through the Internet. When I could not find such a source I decided to conduct multiple case studies using two companies involved in very different areas of business.

4.2.1 Sample Selection

At the very beginning of my research I found an interesting article in Dagens Industri (Nordpointer, 2000) regarding the development of a new Internet-based geographical information system (GIS) that could solve problems related to quality and efficiency at sawmills within the forest industry. The article stressed the importance of using this Internet-based method to support the flows of materials along supply chains, decrease inventory, and reach higher levels of product quality. These JIT related issues and Internet application issues became the beginning of an idea that later formed into a problem area and a purpose. Therefore, it was only natural to conduct my two case studies in relation to the article and in relation to a sawmill.

I chose to conduct the first case study at Södra Timber AB, which holds a branch of six sawmills in the south of Sweden. Södra Timber AB was able to provide the information needed for me to understand how a company partially applies the JIT philosophy. This was done through a perspective of investigation within Alex Trä, one of their six sawmills. The second choice of case study object was Nordpointer Information Systems AB. This was the company from the article (Nordpointer, 2000) which developed Internet-based geographical information systems for application in the forest industry. Nordpointer Information Systems AB could provide valuable insights due to the expertise within their field of work. This expertise contained the related experience that came out of developing such a system for such an environment. However, it was the fact that their system was Internet-based that made the choice relevant to this study. My goal was not to describe technical details of the system itself, but to provide a better understanding of how the Internet *can* be used when sawmills work with JIT.

4.3 Literature Study

To support my deductive research strategy I went about collecting data from books concerning Logistics, JIT, Internet Marketing and Research Methodology. All of this literature support was searched for and found at the library of Luleå University of Technology, Sweden. I have also gathered scientific articles from the databases Academic-Search-Elite and ABI- Inform. When conducting my database search I used words such as Just in Time, JIT, Distribution, Inventory, Logistics, Internet, Web, and EDI. These search words were normally put together two by two in different combinations in order to find relevant articles.

Due to very scarce findings of literature support concerning Internet applications in a supply chain and JIT context, I have been restricted to the use of almost only one source in this area. The authors of this article (Lancioni, Smith & Oliva, 2000) stress that there have been few, if any, studies done on the use of the Internet in this area.

4.4 Data Collection

According to Eriksson and Wiedersheim-Paul (1999) there are two different kinds of data to collect when conducting a study. The first kind, secondary data, is the available data that someone already collected for a different purpose. The second kind, primary data, is the data that you collect for your own specific purpose. Since it is easier and cheaper to use existing secondary data, this should be used at first. If necessary this first step should be followed by collecting primary data. (ibid) I have only used primary data. It was my intention to use secondary data in the presentations of my two case study companies, but it was hard to come by. My empirical chapter is therefore based upon primary data alone.

Yin (1994) discusses six different sources of evidence: documentation, interviews, archival records, direct observation, participant observation and physical artifacts. One of the most important sources of case study information, he says, is the interview. Zikmund (1994) states that the interview enables a more controlled data gathering, which can allow more flexible questions. I chose to conduct interviews because the complexity of my investigation required such flexibility. Yin (1994) explains how interviews can take several forms:

1. *The open-ended interview*, in which you can ask key respondents for the facts of a matter as well as opinions about events.

2. *The focused interview*, in which a respondent is interviewed for a short period of time. In such cases the interview may still remain open-ended, but you are more likely to be following a certain set of questions from an interview-guide. For example, a major purpose of such an interview might be to corroborate certain facts that you already think have been established, but not to ask about other topics of a broader, open-ended nature.

3. *The formal survey*, which resembles a survey but is an interview technique containing more structured questions.

Yin (1994) also states that the advantage of the interview as a source of evidence is that it can focus directly upon the case study topic, which can provide a perception upon causal inferences. Downsides are that; poorly constructed questions may bias the outcome, the answers themselves may for different reasons be biased, inaccuracies may occur when interpreting the answers, and the respondent might give answers that the interviewer wants to hear. (ibid)

According to Zikmund (1994) telephone interviews are becoming increasingly popular. In comparison to the personal face-to-face interview it is less time consuming and relatively inexpensive as travel time and travel costs are eliminated. Wahlbin and Lekvall (1993) support this by saying that the telephone interview is cheaper, faster and still is almost as good as the personal interview. However, it is important to be aware of that the absence of face-to-face contact could be a liability. This is because a lack of body language and expression has a tendency to create confusion that could produce incomplete answers. (Zikmund, 1994)

I collected my primary data through two telephone interviews, one with each company, and these interviews tended to be focused by nature. I chose this source of evidence since I needed to collect data that could provide a close perception upon the case study topic. However, I did prefer to make personal face-to-face interviews since this would give me an opportunity to visit the companies, but due to issues of time and costs I had to choose otherwise.

To be able to obtain relevant data I had to make a subjective choice of whom within the two case study objects to interview. First I considered criteria of knowledge that the respondents ought to have due to their company key-positions. The final choices were based upon recommendations made by the companies themselves. At Södra Timber AB, I chose to interview Patrik Gustafson who at the time worked as a Raw Materials Manager at the Växjö Company Headquarters. He possessed valuable knowledge about the procedures along the supply chains and could therefore provide relevant information on any of the six (Alex Trä) sawmills at Södra Timber AB. At Nordpointer Information Systems AB, I chose to interview Bengt Sörvik who at the time was the Chief Executive Officer of the company. Sörvik could as the innovator of the specific geographical information system provide valuable knowledge regarding the objectives of such an Internet-based method. Sörvik also has background knowledge of the forest industry that comes out of related education and working experience. This makes Sörvik eligible to take on the perspective of within a sawmill.

In order to perform my telephone interviews under more controlled circumstances I booked appointments in advance with the chosen respondents, and I also designed interview-guides, one for each case study. (See Appendix 1 and 2) The interview questions were based on my literature review, which reflected upon the problem discussion, purpose and research questions. These interview questions were structured but still remained somewhat open-ended to allow a technique called probing. Probing is according to Zikmund (1994) necessary when the respondent must be motivated to enlarge on, clarify, or explain the answers. He also states that the technique is useful if the respondent begins to ramble or loose track of a question. However, I decided not to send the interview-guides to the respondents as this could create interview bias. Moreover, to provide myself with some support I used a speakerphone and a tape recorder. Both the telephone interviews were conducted on May 12, 2000 and they lasted for about an hour each.

4.5 Data Analysis

According to Yin (1994) every investigation should start with a general analytic strategy. He continues by saying that too many investigators start case studies without having the foggiest notion about how the evidence is to be analyzed. It is important to prioritize what to analyze and why, since case studies in lack of such plans easily become stalled at the analytic stage.

Yin (1994) also states that a preferred strategy is to follow the theoretical framework that led to the case study. The original objectives of my case studies were based on such a framework, which in turn reflected a purpose, a set of research questions, reviews of the literature, and new insights. For my analysis I have used a pattern-matching logic. With this logic in mind I could compare the empirically based pattern with the predicted theoretical pattern. This means that the empirical evidence of Södra Timber AB was compared with the whole literature review chapter in a within-case analysis. This was done to answer my first research question: *How do sawmills work with JIT?* Furthermore, the empirical evidence of Nordpointer Information Systems AB was then compared to the theoretical section of the Internet in a second within-case analysis. This was done to answer my second research question: *How can the Internet be used when sawmills work with JIT?* However, I have also conducted a third section of cross-case analysis that according to Yin (1994) has an explanation-building character. This is because I compared the results of the two within-case analyses to reach my purpose, which was *to gain a better understanding of how the Internet can influence how sawmills work with JIT.*

4.6 Validity and Reliability

An important area of concern is how theoretical conceptions such as models and ideas are transmitted to empirical observations. Two concepts in this context are validity and reliability.
Validity can be defined as the instrument of measurement's ability to measure what is intended to measure (Eriksson & Wiedersheim-Paul, 1999). This obvious purpose of measurement is not as simple as it sounds (Zikmund, 1994). However, I did take preventive actions in an effort to improve the validity of this investigation. First of all, I tried to find the right people to interview within the two companies. Then I formed the interview questions in such a way that they would reflect upon my theoretical framework. This led me towards asking the kind of questions that was relevant to the purpose of this study. Moreover, a focused telephone interview allowed me to take, to some extent, more open-ended actions. Probing was therefore used when I found it necessary to enlarge on, clarify, or explain the answers in a further matter. I was also faced with a significant problem as Nordpointer Information Systems AB, was going through the process of receiving a patent at the time of this investigation. This sensitive issue could highly affect the validity of my investigation and I decided to postpone the interview until the patent process was over.

The most significant problems within this investigation concerns validity. The JIT philosophy is of a very vast and complex nature and it is therefore likely that the competence, regarding these issues, is very spread within Södra Timber AB. While I had no doubts concerning my subjectively chosen respondent of Södra Timber AB and his overall knowledge, there might have been other people within the company that alone or together could provide different

and/or more enriching insights to various parts of my investigation. These resources could have been identified through a survey and used in several overlapping interviews. Such an attempt to improve the validity would unfortunately have been too time consuming and costly for me, and too bothersome for Södra Timber AB. Another validity problem of this study concerns the objectivity of Nordpointer Information Systems AB. The answers given to my interview questions may very well have been biased. This is because Nordpointer Information Systems AB might have had an interest in promoting the Internet-based product. Nordpointer Information Systems AB also preferred not to talk about the technical details of their product. My goal was not to investigate such issues but the company secrecy did however cause problems of objectivity in the description of the implementation of the Internet-based method. To deal with these validity problems I have kept these issues in mind, trying to be as careful and critical as possible in my analysis of the empirical evidence.

Eriksson and Wiedersheim-Paul (1999) state that validity is the most important concern upon an instrument of measurement and if the instrument does not measure what is intended, it is less important for the measure itself to be reliable. However, this second concept called reliability means that an instrument of measurement (e.g. an interview-guide) should give reliable and stabile answers. That is, should investigators have reached the same result using the same method? If someone were to repeat the attempt at another time with another sample selection, would this person get the same results? A method should therefore, in order to consist of high reliability, be independent from the investigator and, depending upon the chosen level of generalization, also be independent from the selected sample. (ibid)

To improve the reliability of this investigation I made an effort to decrease the probability of interview bias. First, I tried to design the interview questions in such a way the respondents would find easy to understand. I also felt that it was important not to ask leading questions, therefore, I had to be very careful in my probing for answers. I also decided not to send the interview-guides to the respondents as this could create interview bias. If the respondents were to see the interview questions in advance, perhaps they would draw leading conclusions from the questions, which followed a certain pattern along the supply chain. Finally, a speakerphone was used to allow me to tape the whole interview. This tape represented additional and more accurate notes to ease my interpretation of the empirical evidence.

5 EMPIRICAL DATA

This chapter includes the empirical data gathered from the two case studies. Each company is briefly presented before the actual interview data. See Appendix 1 and 2 for the interview-guides that were used throughout this study.

5.1 Case Study One – Södra Timber AB

The telephone interview was conducted with Patrik Gustafson who at the time worked as a Raw Materials Manager at the Södra Timber AB headquarters in Växjö. To be able to take on the convenient perspective that was needed throughout my interview, I asked my respondent to focus upon Alex Trä in Växjö, which is one of the six sawmills owned by Södra Timber AB.

5.1.1 Company Presentation

Gustafson states that Södra is a co-operative economical union holding four major divisions that are the base of the Södra activity:

1. *Södra Skog*, provides and sells timber
2. *Södra Cell AB*, is a world leader in the manufacturing of pulp
3. *Södra Skogsenergi AB*, is one of the largest bio-energy producers in Sweden
4. *Södra Timber AB*, produces and sell disintegrated and refined wooden products

Gustafson also states that Södra Timber AB with its head quarters in Växjö, owns six sawmills that are located in the south of Sweden. The productions at these sawmills involve 70 percent spruce and 30 percent pine mainly refined and sold internationally for construction purposes but also for furniture manufacturing and carpentry.

5.1.2 How does Alex Trä Work with JIT?

According to Gustafson, Södra is a co-operative economical union that is owned by 33.000 farmers. These farmers who own their own forest have invested money to build up the industrial structure enabling them to sell their wood. Therefore, Södra Timber AB purchases timber from its own owners for deliverance to Alex Trä. This is managed in the way where Södra Timber AB orders the timber from Södra Skog, which in turn do business with the owners of the forests. The number of forest owners that annually are involved in the deliveries of timber to Alex Trä varies from 300-400, and they are all very local with a maximum radius of 70 kilometers around Alex Trä. This enables Alex Trä to make transport optimizations. The actual raw material involve non-decorticated round-timber of spruce and pine, which are dimensioned from 16 to 40 centimeters in diameter.

Gustafson states that Alex Trä negotiates into an understanding with the suppliers of what is good and less good quality. This negotiation defines pricing upon the different quality levels

that may occur, and at Alex Trä's first station a measuring process will determine the quality and therefore what Alex Trä will have to pay for the delivered timber. This method makes efforts towards specific or higher quality at the suppliers' level, more or less self-regulated. Moreover, Alex Trä makes evaluations of the recent quality and then informs the supplier market of which kind of timber and of what quality these timbers need to be in future production. Gustafson also states that once the timber arrives to Alex Trä it has to be handled and refined through several production stations:

1. A *measurement* of the timber that defines how much Alex Trä will pay

2. *Sorting* of the timber in its various diameter dimensions

3. Now, a measured and sorted *raw materials inventory* exists

4. A production station that *decorticates* the timber

5. A *disintegration* where the timber is divided into parts. This is done through milling the edges of the log to make it square-shaped. This is followed by disintegration into planks and boards. A plank is the center material of the log that normally is disintegrated into larger dimensions, while a board often comes from the more knotty edge of the log.

6. From here, planks and boards go through a first *quality sorting*

7. A *drying procedure* of the planks and boards which takes several weeks

8. A second and more thorough *quality sorting* is made after the drying procedure since the wood can change shape

9. From here, the planks and boards can be *packaged* for customer shipment, or sent through further *refinements.* Alex Trä has a large production station where boards and planks, according to customer requests, can be planed, cut and cleaved etc.

Gustafson states that Alex Trä is working towards controlling and reducing inventory. This is first and outmost because large inventory ties very large values that can be used in many other areas. Secondly, wood is a fresh and living material where large inventory that results in long cycle inventory could cause quality problems at Alex Trä.

To reduce inventory Södra Timber AB co-operates with Södra Skog whose task is to purchase the raw materials and to control the flow. Södra Timber AB conducts a delivery plan for Södra Skog that is based on production forecasts at Alex Trä. This delivery plan defines what Alex Trä needs in order to sustain tight inventory that still enables the proceedings of normal production. However, Gustafson stresses that they avoid reducing inventory too much since there is a risk of disrupting the production process. Such a disturbance will most certainly cost much more than there is to gain from stressing the inventory levels. For example, sometimes it rains heavily for several days/weeks and the roads get useless for transportation or even closed down by the government. Therefore, Alex Trä's inventory level runs over one month, which is considered normal in this industry.

Gustafson also states that they try to cut lead-time through improving the connection between raw-materials-inventory and production. Every log in a lot of timber is different from one another and an attempt to define what product that comes from what log could reduce lead-times as well as cycle inventory since such information allows much lower inventory. Gustafson states that Alex Trä is working towards reaching such connections. If this information is unavailable Alex Trä need higher inventory levels that secures productions.

Södra has its own organization, Södra Shipping, which handles all the transportation. When raw materials are being ordered via Södra Skog, transportation is included and it is Södra Skog who connects and makes the flow tighter. About 15-20 trucks with timber arrive daily at Alex Trä to uphold the 14.000 cubic meter cycle inventory. Gustafson states that the delivery plan is the base for securing good lead-times. There are three parties involved in such activities: Södra Skog, Södra Shipping and the first station of measurement at Alex Trä, and all of these units work according to the same delivery plan so that they can adjust their activities in a uniform way. The delivery plan is also flexible and changes are notified through personal contacts via meetings, e-mail, or telephone. Finally, Alex Trä checks the daily transportation arrivals to make corrections the next day of any mistakes that might have occurred.

According to Gustafson, Alex Trä is a brilliant example of how a production system mixes the pull and push methods. The production of customer ordered center-planks would lead to the production of other products as well. Such specific pull orders can give up till three other products, and as Alex Trä need to be very customer oriented, they also need to use the raw materials in an optimal way which give a lot of push products.

Gustafson states that Södra Timber AB sells its products on provision to about 20-25 agents in partnership who act in the markets of the British islands, Holland, Germany, France, Saudi Arabia, Egypt, Japan and many other countries. These agents then sell the products to retailers who in turn sell to industrial firms, or to other intermediaries who sell directly to consumers. This long chain is according to Gustafson something Södra Timber AB wants to diminish since the profit marginal is too small. Today, the first and last members of the supply chain have the largest profit margins. However, Södra Shipping handles all the transportation from Alex Trä to customer. Södra Timber AB is working towards having as good personal contacts with the customers as possible. These close personal contacts and the overall performance in the logistics process are tools to achieve good customer service.

According to Gustafson, the management of information flows along the supply chain is handled in different ways depending upon what activity is to be handled. When purchasing raw materials the contact is usually made through telephone, e-mail or at meetings. If there is an agreement there is usually also a personal contact involved. To manage the harvest of purchased woods on root the communication is again managed through e-mail, telephone or meetings. To report the raw materials for transport, actually transport it, and administratively keep track of the transportation along the way, a 20-year-old computer system is used. This computer system was developed for this specific purpose and it is connecting relevant parts to perform this task. The hardware and software are, however, getting very old and Gustafson means that Södra need to replace this system. Finally, good customer service is upheld by having good personal contact with the customers and this is usually done through telephone but also through e-mail. In exception of occasional e-mails, Södra does not utilize the Internet.

5.2 Case Study Two – Nordpointer Information Systems AB

The telephone interview of this case study was made with Bengt Sörvik who at the time was the CEO (Chief Executive Officer) of the company. I explained to Sörvik that I was doing this research with the perspective of within a sawmill and, therefore, that I would ask questions in respect of such a perspective.

5.2.1 Company Presentation

Sörvik states that he has an educational background that involves forest logging and sawmill management. After completing his academic education he worked at a forester training school where he created educational programs for the forest industry. Later, he worked for *Nämnden för skoglig fjärranalys*, which was implemented by *Skogsstyrelsen* to investigate new tools of planning within the forest industry. These tools involved air-photos, GPS, and Geographical Information Systems. When the investigation was finished in 1995, Sörvik continued by opening his own business in the related area (Nordpointer Information Systems AB). He wanted to develop Geographical Information Systems, or so called digital maps in a further matter.

According to Sörvik the forest industry developed increasingly during the 70s and 80s and many companies started to utilize much better machinery in the forest logging process. Solutions to planning did, however, not follow this productive development. Sörvik states that accurate data is something that all the supply chain members of the forest industry need. Therefore, Nordpointer Information Systems AB's long-term business concept is to provide the forest industry with Geographical Information Systems, or information services, that the members of the supply chain can utilize according to their specific needs.

Lately, Nordpointer Information Systems AB with head quarters in Gävle, has gone through some structural changes. Sörvik states that he has sold company shares to alter the company towards the future. Today's board consists of a broad range of diversified competence among others Lennart Ahlgren - the former CEO of Assi Domän, and Jerry Lundquist – the founder of Enator. The board consists of a total of six people that at this moment are engaged in the company concept. The strengths of Nordpointer Information Systems AB are the ideas and patents that they have, and the fact that the board works intensively through the development of this Geographical Information System. Sörvik states that Nordpointer Information Systems AB will be in full production within a couple of years.

5.2.2 How Can the Internet be used when Sawmills Work with JIT?

According to Sörvik, the entire Geographical Information System will be built on an Internet platform that enables members within a supply chain of the forest industry to monitor data. In a brief description of this Internet-based method, it is basically managed through markings upon all logs that have gone through the first logging process in the forest. All logs can therefore be monitored on a digital map where they are at an exact moment, and all this

through the Internet. Therefore, this Internet-based method does not require many efforts of implementation among the members of the supply chain. They simply need the Internet.

According to Sörvik, the Internet-based method can aid the flow of raw materials from the forest to the sawmill. Sawmills will be enabled to more specifically know what kind of timber that can be received. This could involve the ordering of, not only generally sawed timber, but also other characteristics of the timber as it is being cut down in the forest. Sawmills might also need to get specific deliveries at a specific time. The knowledge of where the timber is at a specific point in time also enables the sending for transportation. Sörvik also states that the level of relationships, the number of suppliers, and the geographical distance within the supply chain does not matter to the utilization of this Internet-based method.

Sörvik states that the Internet-based method enables to secure quality. He also stresses that quality is a term that can be thought of in many different ways, and this case does not involve timber that is in any kind of bad condition. Timbers usually aren't in bad condition. This Internet-based method support sawmills in their connection between the timber and their production. When sawmills know what to produce and what timber they need for that production, the technology is there for them to support the planning of this event. Therefore, in this case quality means the right timber for the right product.

According to Sörvik, one of the purposes with the Internet-based method is to control and reduce inventory. With a profound knowledge of where the specific timber is at a specific point in time, sawmills can utilize this technology to plan their orders and, therefore, reduce inventory. Sawmills can reduce their cycle inventory since they can keep track of every log. The enabled information can therefore tell them where the logs went after arrival to the sawmill and what characteristics they have. For example, if a sawmill is to disintegrate and refine various parts of timber in the purpose of house-constructions, managers need to know what kind of timber and how much of the timber to use for windows, doors etc. This Internet-based method can monitor these issues, which enables planning towards reducing cycle inventory. This is equivalent to the reduction of lead-times. If the managers of a sawmill never have to doubt where the timber is at a specific point in time, they can perform more constructive planning towards reduced lead-times.

Sörvik also states that the Internet-based method can support the transportation of timber to sawmills. For example, imagine forest-logging machinery that are cutting down trees and scattering lots of timber in the area. They finish up in the evening and in the following morning there is about half a meter of snow covering the whole area. Transportation will have a hard time finding the timber, but this Internet-based method can enable them to exactly spot the scattered lots, brush them off and arrive to the sawmill as scheduled. The transportation itself could perhaps also be monitored, but this is an issue that Nordpointer Information Systems AB not has been taken under consideration yet.

Sörvik states that Nordpointer Information Systems AB, is not working towards developing this Internet-based method for utilization beyond the finished product at the sawmill. The purpose is to improve the logistics process, from logs to finished products so that suppliers, sawmills and their customers, gain from this method. The reduction of lead-times and cycle inventory enables sawmills not to tie capital. It also enables the sawmills to provide customers with the right product at the right time, which is considered good customer service. However,

the method could provide customer information in absurd proportions upon every product, but the real question is if there is any customer need for such information. A vague example of such customers could be English retailers that for environmental reasons want to have the ability to track purchased products. In this case the Internet-based method would enable patching of products with the necessary information.

6 ANALYSIS AND CONCLUSIONS

This sixth and last chapter presents three sections of data analysis. The first two sections hold within-case analysis for each case study and the third section carry a cross-case analysis from the results of the two prior sections. This is followed by the conclusions of this study.

6.1 Within-Case Analysis of Södra Timber AB

Södra is owned by 33.000 farmers, out of which 300-400 supply timber to Alex Trä. This commerce goes via Södra Skog and the conceptualizations of these events are a bit complicated. According to Krajewski and Ritzman (1999) there are two major approaches to gain control over suppliers; vertical integration and partnerships. However, the 33.000 farmers may own Södra shares but that doesn't make them vertically integrated. It is on the other hand very much an ongoing partnership where the supply chains were built to support each other. Södra Skog is the single actual supplier to Alex Trä. However, the 300-400 farmers that Södra Skog negotiates with are locally situated around Alex trä in order to make transport optimizations. According to Gustafson, 300-400 suppliers are considered low in the forest industry. This is all according to theory where Krajewski and Ritzman (1999) state that the work of JIT requires close relationships with a low number of local suppliers. They continue that this is important because stock shipment must be frequent, have short lead-times and arrive on schedule.

To secure the quality at the suppliers level, Södra Timber AB negotiates into an understanding with the suppliers of what good quality is. When the timber arrives, Alex Trä measures the characteristics and the quality to provide a base for payment. This method self-regulates the suppliers to perform well upon the type and quality of the timber that is being delivered to Alex Trä. However, frequent evaluations at Alex Trä results in the ability to inform suppliers of what kind of measures and quality that is needed throughout the upcoming deliveries. This is all according theory where Bergman and Klevsjö (1994) state that companies who work with JIT must include their suppliers regarding quality control. They continue that the supplier often is the product specialist who has the expertise to identify opportunities of improvement. Moreover, this theory does not adequately describe and specify Södra Timber's method to achieve this state, but Bergman and Klevsjö (1994) do however support the connection of quality between a producer and its suppliers. Alex Trä also controls its quality at the source of its production. This consists of two workstations along the production process where quality controls are performed. This somewhat matches the theory as Krajewski and Ritzman (1999) state that efficient JIT operations control quality at the source, with workers acting as their own quality inspectors along the production process. The workers at Alex Trä however only use two workstations for this purpose instead of controlling quality along the whole production process.

Södra Timber AB and Alex Trä are working towards controlling and reducing inventory. This is done through the assurance of a delivery plan that all relevant parties can take part of. According to Hutt and Speh (1995) one of the goals with JIT is to reduce inventory. The reasons of Alex Trä's reductive efforts are to release unnecessarily tied capital and to avoid quality reductions of the fresh raw materials. This match up well with theory as Oliver (1999)

states that reduced inventory contributes to reduced costs and therefore improved assets, and increased customer satisfaction. However, Alex Trä avoids reducing inventory too much since the production process is highly sensitive. This is because the production of a specific product at Alex Trä requires a specific log. Delivery processes could be disturbed by the weather and such disturbance could together with low inventory levels, disrupt the production process. Such disruption is evaluated to be far more costly than having higher levels of inventory and therefore Alex Trä's inventory level contains of 14.000 cubic meters that runs over one month. Alex Trä does however work towards cutting lead-times and reducing cycle inventory. This is according to theory as Krajewski and Ritzman (1999) state that JIT operations work towards the reduction of cycle inventory and lead-times. The authors continue that this should be done through bringing in small lot sizes of the different kinds of raw materials needed for production. Small lot sizes are something Alex Trä works towards and wishes to improve in their effort to connect a specific type of raw material with a specific type of product, and this is the issue that mainly makes the production process so highly sensitive.

Södra has its own division, Södra Shipping, which handles all the transportation and this division delivers about 15-20 trucks with timber to Alex Trä every day. The delivery plan of inward timber flows to Alex Trä, is the base of securing good lead-times and satisfying scheduling. Södra Skog, Södra Shipping, and Alex Trä co-operate in such a matter that the delivery plan will work accordingly. This is all according to theory as Oliver (1999) states that JIT operating companies should work towards tying distribution intermediates to gain control. Furthermore, Krajewski and Ritzman (1999) state that JIT operations need frequent shipments, short lead-times and transportation that arrive on schedule.

Krajewski and Ritzman (1999) state that there are two different pull and push methods to be utilized in a production system. They continue by saying that the pull method is the true method in JIT operations, but that the choice in between these methods don't necessarily have to be the case, as it can be a mix that often depends upon the nature of the production system. Alex Trä is a brilliant example of how a production system mixes the pull and push methods. The production of customer ordered center-planks would lead to the production of other products as well. The production of specific pull products can lead to the production of three other push products, and as Alex Trä need to be very customer oriented, they also need to use the raw materials in an optimal way which give a lot of push products.

Södra Timber AB is working towards having as good personal contacts as possible with Alex Trä's customers, or agents. These close personal contacts and the overall performance of the logistics process are tools to achieve good customer service. This view is according to Lambert and Stock (1992) a perspective where customer service is an element in the total corporate philosophy rather than as an activity or a set of performance measures.

The management of the information flow along Södra's supply chain is handled in different ways. Telephones, e-mails and meetings are the most common tools of communication throughout the different activities of the supply chain. To report timber for transportation and administratively keep track of the transportation along the way, a 20-year-old computer system is used. Although Alex Trä and its supply chain work with JIT they don't use developed JIT systems or JIT computer programs. This is however not in accordance to theory. Lubben (1988) states that JIT operations often are connected to a uniform system, such as the *Kanban*.

6.2 Within-Case Analysis of Nordpointer Information Systems AB

Nordpointer's Geographical Information System will be based upon an Internet platform that enables members within a supply chain of the forest industry to monitor data. Specifications of timber lots down to the single log will be actualized through the screen of an Internet-connected computer as long as you are an engaged member of the supply chain. This is in accordance to theory as Oliver (1999) states that the increasing use of internet-based solutions is helping many partners in a supply chain through allowing employees of partner companies that are in need of critical information to access their internal computer systems via the Internet. Since the Internet-based method is viewed on the Internet, further implementations within supply chain members are insignificant. The viewer simply needs a granted computer that can be connected to the Internet. Lancioni, Smith and Oliva (2000) state that the Internet has in many ways improved the implementations of EDI and JIT systems. Meanwhile, Sörvik states that this Internet-based method needs no significant implementations at all.

Nordpointer's Internet-based method can support the flow of timber towards the sawmill. Theory only support this in a very vague matter as Lancioini, Smith and Oliva (2000) state that the Internet can create cost- and service- related opportunities for companies and their supply chains. However, this support involves quality-related issues, inventory and transportation. Lancioni, Smith and Oliva (2000) state that the Internet can support inventory and transportation but they don't say anything about quality-related issues. The level of relationships, the number of suppliers, and the geographical distance within the supply chain do not matter to the utilization of this Internet-based method. This is because the Internet-based method doesn't need any significant implementations. This is not according to theory, as it states nothing of such kind.

The Internet-based method enables sawmills to ensure quality of the timber that comes in towards the sawmill. This is because it enables the sawmill to connect the timber to their production. When sawmills know what to produce and what timber they need for that production, the Internet-based method is there, for them to support the planning of the needed deliveries. Therefore, Sörvik states, quality means the right timber for the right product. This is not in accordance to theory. Lancioni, Smith and Oliva (2000) state that the Internet supports the purchasing function, order processing and much more, but nothing about the above.

One of the purposes of the Internet-based method is to control and reduce inventory. Quality means the right timber for the right product, and a profound knowledge of where specific timber is at specific time enable sawmills to utilize the Internet-based method to plan orders and therefore reduce inventory. Cycle inventory and lead times can therefore also be planned since it is possible to track and monitor the whereabouts and characteristics of every single log. Although Lancioni, Smith and Oliva (2000) state that the Internet has affected inventory management because of reporting systems that can be used over the Internet, this doesn't match what the Internet-based method enabled to do.

The Internet-based method can support the transportation of timber to sawmills. Since the technology allows exact monitoring of the timber, transports know exactly where the timber lots are even though it presumably is covered in half a meter of snow. However, the vehicles

themselves could be tracked and monitored but this is something the Internet-based method not is able to perform at the moment. This is not in accordance to theory as Lancioni, Smith and Oliva (2000) state that the Internet has enabled monitoring of the materials pickups at distribution centers to provide data on the reliability performance. Theory doesn't support materials identification that eases the pickups themselves.

The Internet-based is not developed for utilization beyond the finished product at the sawmill. The purpose is to improve the logistics process, from logs to finished products so that suppliers, sawmills and their customers can gain from this method. This will ultimately lead to the release of tied capital, which in turn enables sawmills to provide customers with the right product at the right time. This is good customer service. This is not in accordance to theory as Lancioni, Smith and Oliva (2000) state that the Internet improves customer service through better communications between companies and their customers. Theory doesn't support that the Internet can refine the logistics process to enable better customer service.

6.3 Cross-Case Analysis

Today, Södra Timber holds a 20-year-old computer system that is used to report timber for transportation and administratively keep track of the transportation. Nordpointer's Internet-based method is not a substitute, but it can, in many dynamic ways help Södra Timber AB in its supply chain activities. Specifications of the exact characteristics and whereabouts of timber lots down to the single log at an exact point in time will be actualized through the screen of an Internet-connected computer. Alex Trä's 300-400 partner suppliers that negotiate through Södra Skog are locally situated around Alex Trä in order to make transportation optimizations. This is important since stock shipments must be frequent, have short lead-times, and arrive on schedule. However, the utilization of the Internet-based method is never affected by the level of relationships that is held towards Alex Trä's suppliers, nor is it affected by the number of suppliers and their geographical position to Alex Trä. Moreover, the implementations of this Internet-based method are insignificant since Södra's and its members of the supply chain only need the Internet to utilize its benefits.

Södra Timber AB negotiates with its suppliers into an understanding of what good quality really is. This involve the timber condition as well as other characteristics and measurements. As the timber arrives, Alex Trä measures the characteristics and quality to provide grounds for payment. This method self-regulates the suppliers to perform well upon the wanted type and quality of the timber that is being delivered to Alex Trä. Frequent evaluations enables Södra Timber to inform the suppliers of what is wanted next, what changes are needed and so forth. The Internet-based method can change Alex Trä's quality methods significantly. It could enable Alex Trä to ensure the type and quality of the timber that comes in from the suppliers. When Alex Trä knows what products to produce and what required timber that are needed to produce these specific products, the internet-based method is available for them to utilize as a tool in their delivery planning. Alex Trä also controls the quality at the production stage. This is done through two workstations along the production process where workers control the quality of the materials. The Internet-based method is not able to aid these quality controls in any way since the nature of the production process affect the quality of the materials.

Alex Trä is working towards controlling and reducing inventory, but at the same time avoids reducing inventory too much since the production process is highly sensitive. This is because the production of a certain product requires a certain log with specific characteristics. Weather conditions or other unforeseen events could delay deliveries, and such delays could together with low inventory levels create a disturbance in productions. This is simply because the specific timber that is needed to produce the specific products would be absent, and such disruptions would be far more costly than keeping higher levels of inventory. This is why Alex Trä keep a constant inventory level of 14.000 cubic meters that runs over one month.

However, Alex Trä is trying to control and reduce inventory through the assurance of a delivery plan that is based upon a production forecast. This delivery plan defines what Alex Trä need to sustain tight inventory and still handle the proceedings of normal production. Moreover, Alex Trä is working to be better in the connection of timber with products. If they could perform this in an optimal way they would be able to bring in small lots of everything that is needed to maintain normal productivity. Small lots would in turn help Alex Trä in their efforts to reduce cycle inventory and cut lead-times. The Internet-based method can profoundly contribute to the achievement of Alex Trä's efforts in controlling and reducing inventory. If weather conditions close delivery roads or other unexpected events occur, the Internet-based method has no means to overcome this situation, but it could however support the connection between timber and the related products. As the Internet-based method provides information on what characteristics and where every single log is at a specific point in time, Alex Trä can use this information in their delivery and inventory planning. This would enable Alex Trä to hold low inventory levels without disturbances in the productivity.

The delivery plan of inbound timber flows to Alex Trä, is the base that enables the securing of satisfying scheduling and good lead-times. Södra Shipping, Södra Skog and Alex Trä co-operate to make the delivery plan work as planned. The Internet-based method can support the operations of transportation since the technology allows exact monitoring of the timber and even if the intended timber lots are covered in snow, transportation will be able to find the exact locations to bring home the timber lots.

Alex Trä exemplifies how a production system mixes the pull and push methods of materials flow. For example the production of customer ordered center-planks automatically lead the production of other products as timber contains of different subjects for different products. Pull products such as center-planks create several other products that have to be pushed towards the customer. The Internet-based method cannot aid throughout these events since the nature of the production process within most sawmills as well as within Alex Trä has to be handled in this way. Alex Trä need to be very customer oriented but they also need to use the timber in an optimal way to avoid inefficient scrap.

Södra Timber AB wants to achieve good customer service through refining the overall performance of the logistics process, and keeping close personal contacts with Alex Trä's customers. The Internet-based method would contribute to the achievement of refinement since it does help to refine various important issues within Alex Trä's logistics process. Quality improvements that lead to improved inventory management and transportation activities enable a release of capital. It also enables Alex Trä to provide customers with the right product at the right time.

6.4 Conclusions

This section presents the conclusions I have drawn from this study, which involves the findings of my two research questions and purpose. This is followed by the contributions I have made to theory and some suggestions of future research.

6.4.1 How do Sawmills Work with JIT?

I have come to conclusions that Södra Timber AB works with JIT in a number of ways. Although the company doesn't follow a proclaimed JIT philosophy, working with JIT production systems and JIT computer programs, their logistics process is characterized with various features of JIT. Alex Trä's suppliers are tied in partnership and positioned within a local radius of Alex Trä. Alex Trä also works towards securing the quality at the suppliers' level and at the production stage. More importantly, Alex Trä is working towards controlling and reducing inventory. This is actualized through the appliance of a delivery plan where managers are trying to make a connection of what timber is needed for deliverance in order to produce a certain product. If this connection is optimized, Alex Trä can keep low inventory and enable the reduction of cycle inventory and lead-times. Furthermore, Södra Timber AB controls its own transportation division that together with the delivery plan, enables frequent shipments, secure good lead-times and satisfying scheduling. Alex Trä also utilizes the pull method of materials flow and at the same time co-ordinate push products that comes as a result of the nature of the production process. All these JIT related means are solutions to refine the logistics process so that capital can be freed and good customer service is enabled.

6.4.2 How Can the Internet be used when Sawmills Work with JIT?

I have also come to conclusions that sawmills that work with JIT can use the Internet in various ways. An Internet-based Geographical Information System allows monitoring the exact characteristics and whereabouts of timber lots, down to the single log at an exact point of time. This can all be viewed upon a screen of an Internet-connected computer. This Internet-based method can be used regardless of the level of relationship, number of suppliers, and the geographical distance within the supply chain. The Internet-based method can improve the specifications of quality timber that flows towards sawmills and therefore enable the reduction of inventory. Furthermore, the operations of transportation can also be supported as timber lot locations can be identified with precision. However, the Internet-based method is not developed for utilization beyond the finished product at the sawmill. Its purpose is to improve the logistics process, release tied values, and provide better customer service.

6.4.3 How Can the Internet influence how Sawmills Work with JIT?

Finally, I have come to conclusions of how the Internet can influence how sawmills work with JIT. This involves the four major areas of quality, inventory, transportation and customer service. Today, Alex Trä works towards communicating with its suppliers to ensure that the delivered timber is of the required quality. The Internet-based method can provide another

solution to achieve this issue, since it enables monitoring of the specific timber characteristics. This can in turn also support Alex Trä's efforts to reduce inventory, since such monitoring allows detailed delivery planning. Alex Trä's production process is very sensitive and it is required to make connections between the timber and the products that come out of that timber. Optimization of such connections would allow Alex Trä to reduce the different timber lots and therefore also reduce cycle inventory and lead-times. Moreover, the Internet-based method can also support the operations of transportation since scattered timber lots can be identified regardless of weather conditions. Finally, the overall benefit is that the Internet-based method can support the refinement of Alex Trä's logistics process. Quality, inventory and transportation improvements enable a release of capital and provide customers with the right product at the right time. This is improved customer service.

6.4.4 Contribution to Theory and Suggestions towards Future Studies

Before the production of this study it was clear that the academic contribution towards Internet usage in a JIT related environment was rather vague. This study has contributed to the enforcement of the prior, the almost unavailable theory in such a context. More importantly, this study contributes with valuable information upon how the Internet can influence and improve issues of quality within the forest industry. The use of the Internet to support quality has, to my knowledge, not been investigated prior to this moment. Perhaps, the Internet could create numerous opportunities in the supply chains of other industries as well. Therefore, I suggest not only that further studies should be conducted to create a more generalizing picture of Internet usage in a JIT related environment. I specifically suggest that more studies should be conducted to enforce a generalizing view of how the Internet can improve issues of quality.

LIST OF REFERENCES

Bergman, B. & Klevsjö, B. (1994). *Quality*; *from Customer Needs to Customer Satisfaction*. Studentlitteratur: Lund.

Berthon, P., Lane, N., Pitt, L. & Watson, R., T. (1998). The World Wide Web as an Industrial Marketing Communication Tool; Models for the Identification and Assessment of Opportunities. *Journal of Marketing Management*, vol. *14*, 691-704.

Brierty, E., G., Eckles, R., W. & Reeder, R. (1998). *Business Marketing*. Prentice Hall.

Eriksson, L., T. & Wiedersheim-Paul, F. (1999). *Att utreda, forska & rapportera*. Liber Ekonomi.

Gustafson, Patrik. Raw Materials Manager at Södra Timber AB, May 12, 2000.

Holme, L., M. & Solvang, B., K. (1991). *Forskningsmetodik*; *om kvalitativa & kvantitativa metoder*. Lund: Studentlitteratur.

Hutt, M., D. & Speh, T., W. (1995). *Business Marketing Management*; *A Strategic View of Industrial & Organizational Markets.* Dryden Press.

Krajewski, L., J. & Ritzman, L., P. (1999). *Operations Management*; *Strategy & Analysis*. Addison-Wesley Publishing Company.

Kristensen, K., Dahlgaard, J., J., Juhl, H., J. & Kanji, G., K. (1999). Some Consequences of Just-in-Time; Results from a Comparison Between the Nordic Countries and East Asia. *Total Quality Management*, vol. *10*, 61-72.

Lambert, D., M. & Stock, J., R. (1992). *Strategic Logistics Management*. Irwin.

Lancioni, R., A., Smith, M., F. & Oliva, T., A. (2000). The Role of the Internet in Supply Chain Management. *Industrial Marketing Management*, vol. *29*, 45-56.

Lubben, R., T. (1988). *Just-in-Time Manufacturing*. McGraw Hill.

Lysons, K. (2000). *Purchasing & Supply Chain Management*. Prentice Hall.

Nordpointer sätter fart på svensk skogsindustri. (2000, 15 mars). *Dagens Industri*, p. 15.

O'Grady, P., J. (1990). *JIT*; *Just in time filosofin i praktiken*. Lund: Studentlitteratur.

Oliver, R., W. (1999). The end of Inventory. *The Journal of Business Strategy*, vol. *20*, 8-11.

Ramalhoto, M., F. (1999). The Research and Education Global Network in Stochastics for the Quality Movement. *Total Quality Management*, vol. *24*, 405-414.

Stear, E., B. (1997). What business are you in? *Online*, vol. *21*, 83-86.

Salehi-Sangari, E. (1997). *Assesment of Purchasing Decision Process of Electronic Data Interchange (EDI) - An Exploratory Study of Swedish Firms* (Research Report). Luleå University of Technology, Department of Business Administration and Social Sciences, Division of Industrial Marketing.

Sörvik, Bengt. Chief Executive Officer at Nordpointer Information Systems AB, May 12, 2000.

Wahlbin, C. & Lekvall, P. (1993). *Information för marknadsföringsbeslut*. IHM Förlag AB.

Womack, J., P., Jones, D., T. & Roos, D. (1990). *The Machine that Changed the World – the Story of Lean Production*. Rawson Associates.

Yin, R., K. (1994) *Case Study Research*; *Design and Methods*. Sage Publications.

Zikmund, W., G. (1994). *Exploring Marketing Research*. The Dryden Press.

APPENDIX

APPENDIX 1 INTERVIEW GUIDE – SÖDRA TIMBER AB

1. Company and Respondent information?

2. What kind of raw materials (RM) flow in towards your production station?

3. Where do your raw materials come from?
    - Suppliers in partnership?
    - Suppliers, no partnership?
    - Your own vertical integrated suppliers?
    - Why? Pros and Cons?

4. How many suppliers of raw materials do you have?
    - Why? Pros and Cons?

5. Where are your suppliers geographically?
    - Local?
    - Far away?
    - Why? Pros and Cons?

6. What is the nature of your production stage (WIP)?
    - Several workstations?
    - What kind of finished goods (FG)?

7. How do you secure high quality of materials and high quality of production to avoid inefficient scrap and rework?
    - At the production stage?
    - At the suppliers level?
    - Why? Pros and Cons?

8. Are you working towards controlling / reducing inventory?
    - Why?

9. How do you manage the flow of materials to control / reduce inventory?
    - Why? Pros and Cons?

10. How do you reduce cycle inventory: the inventory in excess of the safety stock carried between orders?
    - Why? Pros and Cons?

11. How do you reduce lead times: the time it takes to refill stock?
    - Why? Pros and Cons?

12. How do you manage the transportation from raw materials to production station?
    - Why? Pros and Cons?

13. How often do raw materials arrive to the production station?
    - Why? Pros and Cons?

14. How do you make sure that the raw material transports secure good lead times?
    - Why? Pros and Cons?

15. How do you make sure that the raw material transports arrive on schedule?
    - Why? Pros and Cons?

16. Pull or push method of finished goods (FG)?
    - Does the immediate customer demand activate the production activities from final assembler and back throughout the supply chain (Pull)?
    - Or, are products produced at an estimated rate of demand and pushed forward the supply chain to be available when customer buy (Push)?
    - Or, a mix?
    - Why? Pros and Cons?

17. Who are your customers?
    - Industrial customers?
    - Retailers?
    - Partnerships?
    - Vertical Integrated?
    - Why? Pros and Cons?

18. How many customers do you have?
    - Why? Pros and Cons?

19. Where are your customers?
    - Why? Pros and Cons?

20. How do you manage transportation from production station to customer?
    - Why? Pros and Cons?

21. How do you provide and maintain good customer service?
    - Why?

22. How do you manage the information flow from supplier to customer?
    - Extranet? Intranet? EDI? JIT-program? Other?
    - How does the system work?
    - Does the system float on the Internet?
    - Pros and Cons?

APPENDIX 2 INTERVIEW GUIDE – NORDPOINTER

1. Company and Respondent information?

2. Does your geographical information system float on the Internet?

3. Can this Internet-based solution aid the flow of raw materials from the supplier to a sawmill production station?
    - How?

4. What level of relationship between supply chain members is needed to support this Internet-based solution?
    - Why?

5. What does it take to technically integrate this Internet-based solution to the supply chain members?

6. Does the number of supplier matter to the use of this Internet-based solution?
    - Why?

7. Does the geographical distance between suppliers and sawmills matter to the use of this Internet-based solution?
    - Why?

8. Can this Internet-based solution be an aid to secure high quality of raw materials and high quality of production to avoid inefficient scrap and rework?
    - How?
    - At the suppliers level?
    - At the production stage?

9. Can this Internet-based solution contribute to the reduction of inventory?
    - How?

10. Can this Internet-based solution aid in the reduction of cycle inventory: the inventory in excess of the safety stock carried between orders?
    - How?

11. Can this Internet-based solution aid in the reduction of lead-times: the time for replenishment?
    - How?

12. Can this Internet-based solution aid the transportation of raw materials to production station?
    - How?

13. Can this Internet-based solution help track transportation between the supplier and sawmills to provide data on the performance?
    - How?

14. Can this Internet-based solution aid the flow of finished goods from Sawmills to their customers?
    - How?

15. Does the number of customers matter to the use of this Internet-based solution?
    - Why?

16. Does the geographical distance between sawmills and its customers matter to the use of this Internet-based solution?
    - Why?

17. Can this Internet-based solution help track transportation between the sawmills and its customers to provide data on the performance?
    - How?

18. Can this Internet-based solution help provide good customer service to sawmills customers?
    - How?