Evaluation of Strategic Logistics of Rural Firms

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ABSTRACT

Logistics strategies and practices are essential elements for improving a company's competitiveness in domestic or global markets. Firms expanding into domestic and global markets from the Midwestern and Plains states need to employ efficient strategic logistics practices to compete. Identifying the competitive forces that affect a firm's supply chain management practices is essential for understanding each firm's competitive position and provides a basis by which a firm can develop an overall competitive position.

This study focused on identifying current logistics practices in North Dakota and Minnesota firms and determining their participation in strategic logistics concepts. Logistics practices in North Dakota rural firms were compared to the practices of leading-edge Minnesota firms. The project goals were to: 1) Analyze the supply chain management strategies of firms within North Dakota and Minnesota to determine if they employ a strategic logistics philosophy. And, 2) establish a case study(s) to determine the cost/benefits of employing the logistics strategies and determine a method of measuring the efficiency gains achieved by participating firms.

Firms selected for this study included retailers, manufacturers, and agricultural processors. Five companies from each state were selected. North Dakota firms consisted of those with revenues between $4 million and $50 million. Minnesota firms consisted of those with revenues between $600 million and $6 billion. A site visit was granted by one North Dakota company, which offered insight on how the company has increased operating efficiencies through lean principle workshops. A case study was then developed to discuss cost measurement and savings as the result of the company's implementation of lean principles. The insights gained through this study are valuable in understanding the strategic logistics activities in North Dakota and Minnesota firms.

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1. INTRODUCTION

Logistics strategies and practices are essential elements for improving a company's competitiveness in domestic or global markets. Firms expanding into domestic and global markets from the Midwestern and Plains states need to employ efficient strategic logistics practices to compete. Geiger and Dooley (1998) identified problems with North Dakota firms adopting strategic logistics practices. The study identified leading-edge firms using a supply chain management philosophy and North Dakota firms that have adopted some or none of a supply chain management strategy. One conclusion of the study found that leading-edge firms focus on strategic initiatives, while the North Dakota firms focus more on day-to-day operations. The conclusion of the Geiger and Dooley study recommended rural firms adopt a strategic logistics philosophy to position themselves as supply chain channel participants. This study will examine the logistics strategies of rural firms. The discussion will include logistical philosophies, trends, measurement, alliances, and technology.

1.1 Objective

This study focused on identifying current logistics practices in North Dakota and Minnesota firms and determining their participation in strategic logistics concepts. The project goals were to: 1) Analyze the supply chain management strategies of firms within North Dakota and Minnesota to determine if they employ a strategic logistics philosophy. And, 2) establish a case study(s) to determine the cost/benefits of employing the logistics strategies and determine a method of measuring the efficiency gains achieved by participating firms. The case study(s) may serve as a guide for other firms desiring to adapt a strategic logistics philosophy.

1.2 Justification

A firm's ability to manage or participate in the entire supply chain, from the source of raw materials to the end user, is an essential strategy in satisfying customer needs, improving competitiveness, reducing uncertainty, and generating profits. Identifying the competitive forces that affect the supply chain management practices in North Dakota firms is an important part of understanding each firms competitive position and provides a basis for which a firm can develop an overall competitive position.

1.3 Research Procedure

Information to evaluate strategic logistics practices of rural firms was gathered through electronic survey. A literature review of industry trends was conducted to further define research objectives and determine the status of rural firms' strategic logistics practices. Comparisons of logistics practices were made between leading edge firms and rural firms based on results from the survey and relevant literature. A case study was developed which identifies the competitive application of supply chain practices in rural firms.

1.4 Report Organization

The first part of the study is a review of literature related to industry trends, logistics functions, philosophy, and technologies. The next section presents case studies and discusses the survey instrument used to compare similarities and differences in logistics functions for North Dakota and Minnesota firms. An individual North Dakota company case study is also presented as well as a summary and conclusions. Appendix A includes inquiry letters to North Dakota and Minnesota firms and Appendix B includes the survey instrument used to develop the case studies.

2. LITERATURE REVIEW

In this section, discussion will consist of industry trends and terminology. Definitions of logistics management and supply chain management will be introduced to offer the reader a simple background. Lean manufacturing will be discussed providing the reader examples, benefits, and measurements for successful implementation, as well as disruption effects and counteraction methods for disruptions in the lean enterprise's supply chain. Differences between "fat" and "lean" manufacturing will be identified and described. This chapter will also include the Deming Wheel1 which identifies steps in continuous improvement process and a Business Continuity Planning (BCP) framework that can be used as a guide for strategic planning. Discussion of strategic alliances is also included in this section, which also identifies paradigm shifts that take place in successful strategic alliances. In addition, new technology devices that can enhance supply chain efficiencies will be discussed.

2.1 Logistics Management and Supply Chain Management Defined

Logistics is explicitly recognized as part of the supply chain process, which means logistics can affect how well an individual firm and its associated supply chain(s) can achieve goals and objectives (Murphy Jr. & Wood 2004). According to the Council of Logistics Management (CLM), "Logistics Management is that part of Supply Chain Management that plans, implements, and controls the efficient, effective forward and reverse flow and storage of goods, services and related information between the point of origin and the point of consumption in order to meet customers' requirements."2 CLM defines supply chain management as encompassing "The planning and management of all activities involved in sourcing and procurement, conversion, and all logistics management activities. Importantly, it also includes coordination and collaboration with channel partners, which can be suppliers, intermediaries, third-party service providers, and customers. In essence, supply chain management integrates supply and demand management within and across companies."1

2.2 Three Reasons to Establish a Supply Chain Management Philosophy

Geiger and Dooley (1998) identified three major reasons for establishing a supply chain management (SCM) philosophy: 1) to reduce inventory investment in the chain; 2) to increase customer service; and 3) to help build a competitive advantage for the channel (Cooper and Ellram, 1993). In expert interviews, Geiger and Dooley (1998) found the three major reasons identified by Cooper and Ellram (1993) for establishing supply chains were consistent with responses from companies interviewed. This established a baseline for evaluating and comparing the strategic logistics practices of leading edge and rural firms.

[1]Krajewski and Ritzman, Operations Management Strategy and Analysis Fifth Edition, 1999.

[2]www.clm1.org.

2.3 Lean Production

Lean production, sometimes referred to as "Kaizen,"3 is the identification and elimination of waste in production systems. Lean production can also be defined as a way to continuously challenge current operations and align value-creating actions in the best sequence while conducting activities more effectively and with greater consistency. All production systems contain some form of waste, and therefore, provide opportunity (through waste elimination) to eliminate it. Waste can be defined as those elements of the system (including elements of the final product) which do not bring value to the customer. One of the most common sources of waste in manufacturing is inventory retention and buildup. The posture of lean production philosophy is to eliminate parts and products in inventory that do not add value. Lack of quality is also a source of waste. Manufacturing parts and products that are defective and, therefore, need to be reworked, wastes both time and resources. Another common form of waste is the scrapping of parts in the manufacturing process (Karlsson and Ahlstrom, 1996).

For example, a manufacturer cuts a circle out of a square sheet of metal and wants only to use the circle in the final product. The manufacturer discards the remaining outer square piece of metal thus producing scrap. In addition, depending on the specification of the circle produced, the manufacturer may have to rework (example: smooth the sharp edges produced during the cutting process) the part to meet guideline specifications. If the original part did not meet specifications during the first operation, the part must be produced again. Thus, the manufacturing process continues producing scrap and rework until the specifications of the part meet the customer's demand for quality. Scrap and rework provide no value to the customer. Therefore, eliminating scrap and rework is the last determinate of the elimination of waste. The concept of lean manufacturing emphasizes the identification and elimination of waste while keeping minimal stocks of raw materials, work in progress, finished goods, and backlogs.

The following list produced by The Burton Group (2001) identifies several examples of waste:

- Overproduction,
- idle time, including people in downstream activities waiting on people in upstream activities, unnecessary movement of people or goods,
- irregular processes and process steps that are not actually needed,
- inventories of goods or documents awaiting processing,
- mistakes which require rectification,
- design of goods or services that do not meet the needs of the customer,
- failing to use the untapped potential of people, or wasting employees' time in unproductive and poorly run meetings.

Lean production processes work toward meeting customer demand and everyone in the organization is actively involved in the improvement process. People within the organization work in self-managed flexible teams to deliver quality products with an emphasis on defect prevention rather than inspection. The focus of lean production is processes rather than functions.

Lean production shifts focus from the organization and assets to the product and flowing product through stages of development in the company. The lean production process works to straighten the core processes by breaking down conventional boundaries between processes and people which in turn challenges the way the company operates. Lean production allows single items or small batches of work to keep flowing

[3]Translated to English as "improvement" or an approach to total quality management originating in Japan.

in synchronized fashion with delivery requirements. In addition, lean production techniques allow people to identify efficient processes and employ continuous process improvement. Thus, lean production is the initial starting point for continuous process improvement. Table 1 shows a side-by-side comparison of several plant variables and side-by-side differences between "fat" and "lean" manufacturing.

Although lean production could be viewed as the starting point for continuous process improvement, the lean concept is not limited to any one area of the organization. Lean concepts can also be implemented and transposed to other areas of the organization including purchasing, receiving, storage, maintenance, etc.

Table 1. Side by Side Comparison of Fat and Lean Manufacturing

Plant Attribute	Fat Manufacturing	Lean Manufacturing
Measurements	Standard cost variances; emphasis on labor efficiency and overhead absorption; static goals	Dynamic goals and data; emphasis on manufacturing process and quality measures; focus on continuous improvement
Scheduling	Available-to-promise orientation; tolerance of past dues; building finished good to level load; long runs and large lots	Scheduling to the environment; small lots close to the customer order
Forecasting	Done annually without benefit of a periodic SOP review; used for finished goods production only	Reviewed monthly in an SOP setting; used to drive buffer stocks; has probable forecast error capability
Demand balance	Run lines to capacity all the time; full utilization of the capacity; inflexible work force	Run lines to the demand rate; queue limits policy to ensure customer service; cross-trained workers
Plant layout / organization	Functional orientation; production of subassemblies in large quantities; linear layout; labor immobility	Organization in product cells; one-piece production of final cell product; U-shaped layout; worker in motion
Setup time	Long and inefficient setup practices accompanied by long run cycles and large lot sizes to amortize the setup	Rapid and well-planned setups permitting small lot production and short cycle times
Work standards	Imprecise and outdated work standards	Precise work standards based on current and realistic industrial engineering
Quality inspection	Inspection after the fact by dedicated inspectors; high reject rates	Self-inspection by the workers in the cell; no defective goods move to next operation; low reject rates
Material flow orientation	Push approach: make parts in advance of need based on the schedule for the manufacturing center	Pull approach: make parts only when signaled by extinguishing buffer stocks

Plant Attribute	Fat Manufacturing	Lean Manufacturing
Materials management	Price-only purchasing: supplier as non-participant; materials stored off line with delivery as part of the cycle time	Full value purchasing: supplier as partner; materials stored at the line
Maintenance	Breakdown maintenance or strict preventive maintenance according to the machine manufacturer's schedule	Total productive maintenance in which cell workers perform routine maintenance tasks and participate in maintenance decisions
Bottleneck management	Constraint center treated as a perennial problem with little focus	Constant focus on the constraint resource as an opportunity to increase throughput by breaking the bottleneck

(Source: Najarian, 2003)

2.4 Benefits of Lean Production

Table 2 lists benefits and improvement percentages claimed by companies using lean production techniques.

Table 2. Benefits of Lean Production

Benefits	Improvement Percentage
Reduced cycle times	60+
Improved space utilization	40+
Higher fill rates	Approaching 99
Greater throughput	25+
Reduced WIP and finished goods inventory	50+
Improved quality	50+
Reduced working capital	20+
Improved worker productivity	20+

(Source: Najarian, 2003)

2.5 Continuous Improvement

Continuous process improvement involves identifying benchmarks of what would be the most efficient processes and instilling a sense of employee ownership in the processes to meet or exceed the identified benchmarks. The continuous improvement philosophy is that virtually any aspect of the operation can be improved and people most closely associated with an operation are in the best position to identify changes that should be made (Krajewski and Ritzman, 1999).

According to Krajewski and Ritzman (1999), most firms actively involved in continuous improvement train their work teams to use the plan-do-check-act cycle for problem solving. This approach is known as the Deming Wheel for continuous process improvement.

The Deming Wheel (Figure 1) comprises the following steps for continuous improvement problem solving (Krajewski and Ritzman, 1999).

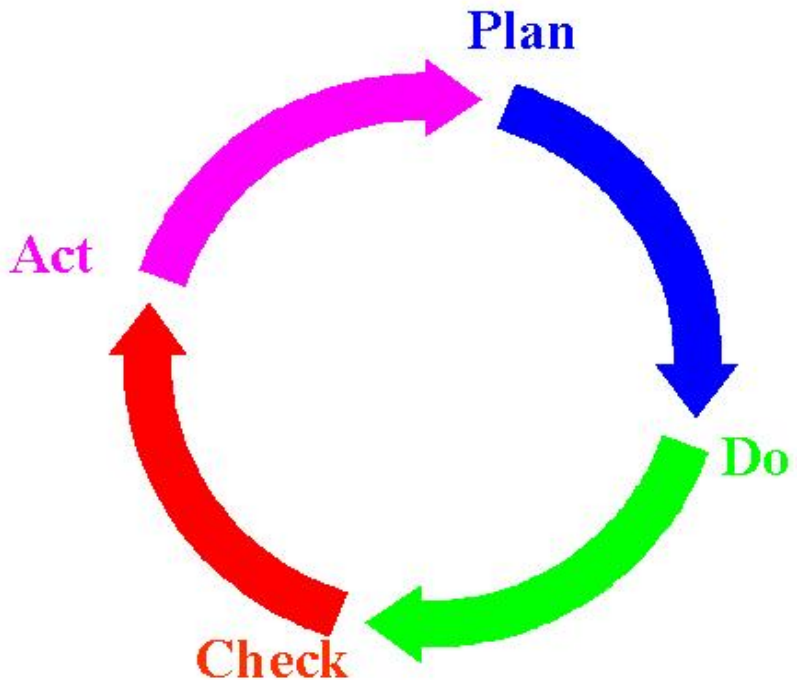
1. Plan - The team selects a process that needs improvement. The team then documents the selected process, usually by analyzing data and develops a plan with quantifiable measures for improvement.

2. Do - The team implements the plan and monitors progress. Data are continuously collected and used to measure the improvements in the process. Changes are documented and revisions are made as needed.

3. Check - The team analyzes the data collected in the “Do” stage and analyzes how the results correspond to the goals identified in the “Plan” stage.

4. Act - The team decides what actions are required to correct any problems. If results are successful, the team documents the revised process and implements the process as standard procedure for employees to use.

Figure 1. Deming Wheel



2.6 Measuring Success in Lean Production

The concept of lean production looks at ways to maximize production. However, concentration is shifted from efficient production of the individual machines to the overall production processes in the entire organization. Measurements of successful lean processes can be identified through benchmarking an organization's products, services, and processes against those of industry leaders.

Krajewski and Ritzman (1999), identify four basic steps of benchmarking:

1. Planning - Identify the product, service, or process to be benchmarked and the firm(s) to be used for comparison. In addition, planning involves determining the measure of performance for analysis and collecting data.

2. Analysis - Determine the gap between the firm's current performance and that of the benchmark firm(s) and identify the causes of significant gaps.

3. Integration - Establish goals and obtain the support of managers who must provide the resources for accomplishing the goals.

4. Action - Develop cross-functional teams of those most affected by the changes, develop action plans and team assignments, implement the plans, monitor progress, and recalibrate benchmarks as improvements are made.

Benchmarking focuses on setting quantitative goals for continuous improvement. Three types of benchmarking are: competitive, functional, and internal (Krajewski and Ritzman, 1999). Competitive benchmarking is based on comparisons with direct industry competitors. In addition, functional benchmarking compares areas such as administration, sales, customer service, and distribution. Through comparative analysis, companies set benchmarks for operational efficiency measurements. Internal benchmarking is often used by companies that have several business units or divisions. The business unit or division that operates proficiently is used as a benchmark for other business units or divisions. All forms of benchmarking are best applied in long-term programs of continuous improvement (Krajewski and Ritzman, 1999).

The Burton Group (2001) lists specific starting points for benchmarking and measurement which include:

- **Schedule adherence:** volume/variety flexibility
- **Schedule achievement:** On time in full
- **Quality:** internal/external
- **Productivity:** parts per person per hour
- **Process losses:** down time, rework, scrap
- **Work flow:** velocity, space used
- **Inventories:** raw materials, WIP, finished goods
- **Cycle time:** Actual/elapsed lead and cycle times
- **Safety:** Accidents/incidents; unplanned stoppages
- **Overall Equipment Effectiveness**

2.7 Supply Chain Management and Lean Manufacturing

As companies pursue lean manufacturing systems, the company's supply chain changes from a push type inventory and supply system to a pull system. Components are pulled through the manufacturing processes based on demand, rather than pushing them through the system on the basis of sales or assembly forecasts (Stundza, 2000). The pull system demands supplier proficiency in performance and trust as a partner of the firm. For example, Cessna Aircraft uses data-driven supplier-selection processes hoping to get suppliers to competitively control costs and help the company increase profit margin. The data-driven supplier selection process involves third-party review of data provided by suppliers which question the suppliers' approach and deployment of production. The supplier is ranked using a performance score. Suppliers scoring high are awarded work and low scores are phased out of Cessna's supply base (Stundza 2000). Numerous aerospace companies have been implementing continuous improvement programs to prepare their suppliers for higher levels of information integration. Stundza (2000) also discusses a Purchasing Magazine survey conducted in 2000, citing that aerospace/aviation company purchasing managers are implementing a full agenda of tactical supply chain management programs emphasizing:

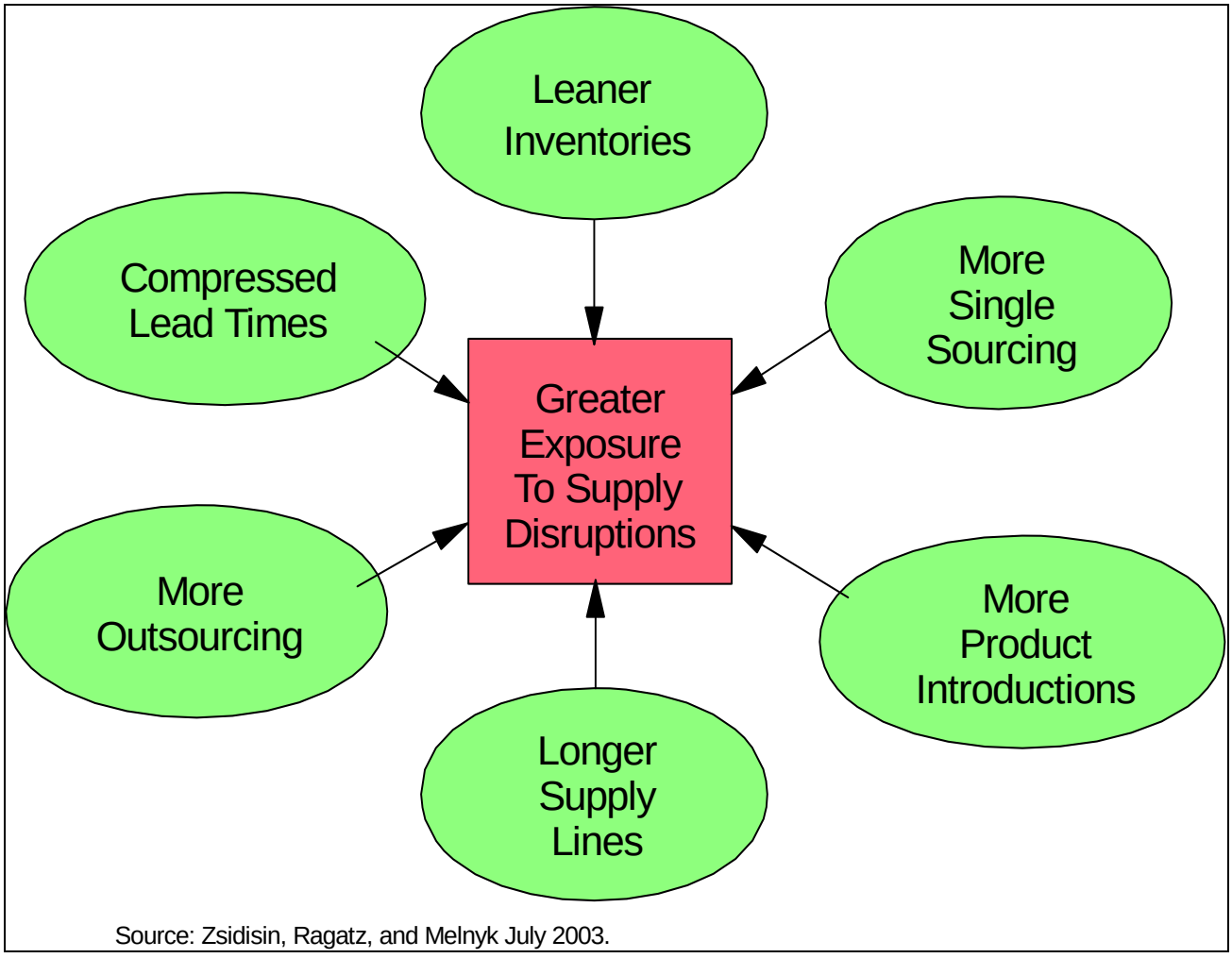
- supplier development programs that stress continuous improvement in all areas- quality, cost, delivery and after-sales support,
- strategic sourcing and supply base integration through long-term agreements that cover the life of the end product, and
- subcontract management techniques that push supplier development past the first tier to the second and third-tier suppliers.

Each manufacturing business is unique, and requires a distinct order and application of lean tools to address specific opportunities which exist with respect to the industry, company, and internal culture. Improving communication between all partners in the supply chain is an important step toward lean manufacturing. Even suppliers currently meeting a company's overall requirements should continuously look for ways to further improve operations.

2.8 Counteracting Disruptions in the Lean Enterprise

As a company becomes lean, its supply chain becomes increasingly "fragile" and less able to deal with disruptions (Figure 2).

Figure 2. Fragile Supply Chains

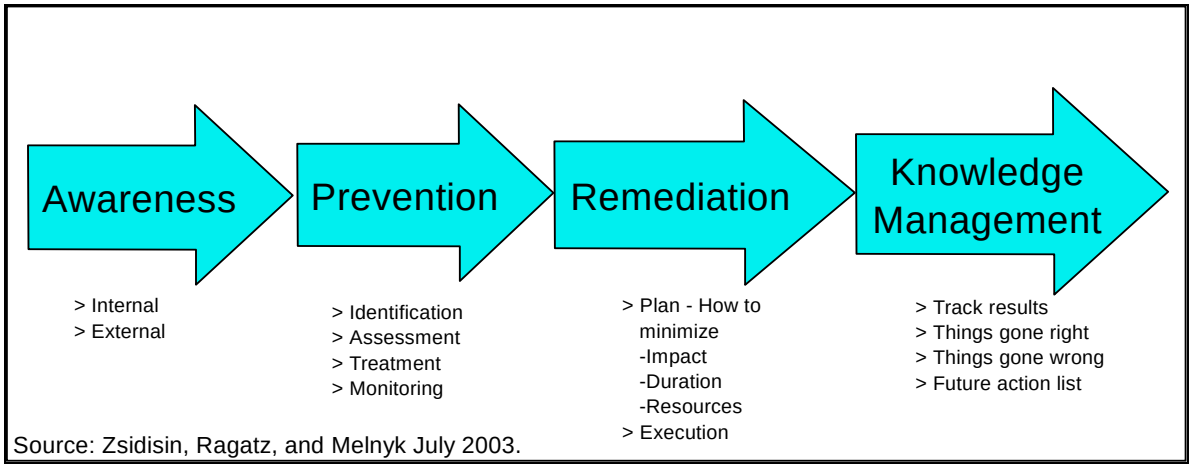


Source: Zsidisin, Ragatz, and Melnyk July 2003.

A number of unforeseeable events may take place that can cause supply disruptions, affecting the ability of the firm to meet customer commitments. Events such as tornados, floods, fires, electrical outages, terrorist attacks, and other unforeseen events can affect operations. One way to counter such disruptions is for the firm to identify the critical activities that must be carried out in order to effectively deal with such disruptions.

Business continuity planning (BCP) is one of the most recent set of formalized planning procedures that companies with lean practices can use as a guide to lessen the impact of disruptions. Barnes (2001) defines BCP as an integrated set of formalized procedures and resource information that firms can use to recover from an event that causes a disruption to business operations. The concept of BCP is not to be viewed as a separate or independent planning activity, but rather an integral part of the company's strategic sourcing process (Zsidisin et al., 2003). Through research conducted by Zsidisin et al. (2003), a framework model for effective supply chain BCP emerged. The supply chain business continuity planning framework model is shown in Figure 3 and consists of four processes: awareness, prevention, remediation, and knowledge management.

Figure 3. Supply Chain Business Continuity Planning Framework



Awareness includes both internal and external acknowledgment that the company is exposed to risk and needs to further develop appropriate processes to manage risk. The awareness element needs to be addressed in the supply chain so customers and suppliers can be included in the effort of managing risk.

Prevention reduces the impact of supply chain disruptions. Four key processes in the prevention element include (Zsidisin, Ragatz, and Melnyk, 2003):

1. **Risk Identification.** Identifying causes and sources of potential supply chain disruptions,

2. **Risk Assessment.** Evaluating the likelihood of an occurrence and the impact to the business,

3. **Risk Treatment.** Prioritizing the causes and sources of the potential supply chain disruption and develop strategies for reducing their impact, and

4. **Risk Monitoring.** Continuous monitoring of risks and developments in the supply chain that may increase or decrease risks.

The remediation element is the stage where a recovery course of action is developed for inevitable disruption. Although a company can take steps in the prevention stage to lessen the potential for disruptions, risks cannot be completely eliminated. Therefore, plans of action or contingency checklists should be developed to guide a company through the disruption, minimize the impact, shorten the duration of potential disruptions, and minimize the amount of resources required to overcome the disruption (Zsidisin, Ragatz, and Melnyk, 2003).

Knowledge management is the last element in the BCP framework. When disruptions occur in the supply chain, the business tracks the results of what went wrong and what went right, gaining knowledge for future strategic planning. Based on the experience, the business revises its overall BCP effort identifying deficiencies, and further strengthens existing plans. Zsidisin et. al (2000) identifies effective BCP as more than backing up critical data and systems: "It should be a structured and formal process that identifies, manages, and reduces all forms and types of supply chain risks." In addition, the study concludes, "BCP enables management to make effective and efficient supply chain management less of a game of chance."

2.9 Strategic Alliances

Strategic alliances are defined as "the pooling of specific resources and skills by the cooperating organizations in order to achieve common goals, as well as goals specific to the individual partners" (Varadarajan and Cunningham, 1995). For small and medium sized businesses, strategic alliances can be used to build innovative capability and technological competence. Through a strategic alliance, small or medium sized firms have a greater opportunity to overcome weaknesses such as a poor financial position or low levels of expertise in production, marketing, and management.

An integrated supply chain forces the acknowledgment that the supply chain will only be as strong as the weakest link or supply chain partner (Spekman, Kamauff, and Myhr 1998). However, many companies have tried to form strategic alliances without much success. Reasons strategic alliances fail often include lack of communication, credibility, shared goals, and common direction. Brouthers et al. (1995) suggest that failure occurs because "most companies adopt a 'seat of the pants' style in their approach to joint management, and learn lessons the hard way." Research conducted by Whipple and Frankel (2000) shows that only one in five companies in the United States has guidelines for maintaining alliances. In general, firms recognize the need to develop alliances, but once implemented, these same firms do not fully understand how to manage or maintain these relationships (Smith and Barclay 1997).

Changing the overall mind-set, culture, and behavior of the organization is often challenging because of the long-term focus needed to develop strong relationships. Yet, without these changes, a strategic alliance disbands and the direction of the relationship becomes conventionally structured and limited. Without the focal changes, senior management struggles with counterbalancing the long-term benefits of an alliance with the short-term focus on cost reduction (Spekman et al. 1998). Kurt Salmon Associates Inc. (1993) identified the largest barrier to alliance success as being organizational rather than technical or financial. In some cases, the alliance may produce anxiety from what appears to be a loss of control, logistics expertise and direct customer contact. According to Whipple and Frankel (2000), "Success results in a relatively even, but not equal, exchange of benefits and resources between partners. The key point is both partners agree on the characteristics and success factors that must be present for a mutually successful alliance to develop and be maintained." The strategic alliance continually evolves as an organization finds ways to reduce inventory, increase customer service, and build competitive advantage. Implementation allows the organization greater ability to focus on core competency thereby reducing the investment

required to manage logistics functions. Table 3 lists the paradigm shift from the traditional relationship to the partnering relationship.

Table 3. Paradigm Shifts in Relationships

Traditional	Partnering
Suspicion and mistrust; each party wary of the motives of the other	Mutual trust forms basis of strong working relationship
Each party geared to what is best only for themselves	Shared goals and objectives ensure common direction
Communications structured and guarded	Open communication avoids misdirection and bolsters effective working relationships
Single project contracting	Long-term commitment provides opportunity for continuous improvement
Objectivity limited due to fear of reprisal	Objective critique geared to candid performance testing
Mistakes lead to retribution	Create atmosphere where supplier is willing to come up with ideas and suggested changes
Limited organizational access; structured procedures; self preservation takes priority over optimization	Organizational access and sharing resources
Involvement limited to project personnel	Total company involvement all levels
Finger pointing and buck passing	Work as team to solve problems
Arm's length-at worst, adversarial relationship	Nurturing relationship

(Source: Ellram, Lisa M; Edis, Owen R.V. "A Case Study of Successful Partnering Implementation." International Journal of Purchasing and Materials Management, Fall 1996. Vol. 32 No. 4 pp. 28.)

2.10 E-Commerce

Large corporations working toward lower operating costs are searching for partners that can interact using online networks. Small and medium-sized businesses may increase their business with larger partners by using resources such as a computer and the Internet. However, many small and medium sized businesses have yet to adopt business to business (B2B) practices. According to a 2002 report by AMI Partners, (A global market research, forecasting and strategic consulting company), only 8 percent of U.S. businesses that employ fewer than 100 people and 19 percent of businesses that employ between 100 and 999 people use Web sites to conduct e-commerce with trading partners (Martin, 2003). Several factors affect small and medium-sized businesses' use of e-commerce including: misconceptions about the complexity of costs, wait-and-see attitudes, misunderstanding the practicalities and benefits, minimal knowledge of the process and other reasons depending on the company's goals and objectives.

Online marketplaces or e-marketplaces have increased the opportunities for small and medium-sized firms to conduct business and offer expanded opportunities for these firms to participate in a global supply chain. An e-marketplace is an online membership-based network for suppliers to display their goods and/or services. The e-marketplace provides an environment for buyers to look for what they need. The e-marketplace allows suppliers to demonstrate goods and buyers to procure a greater selection of supplies globally. Buyers have the opportunity to analyze bids and costs associated with procurement and select the goods that best meet their company's quality specifications and budget (Martin, 2003).

Although e-marketplaces charge fees, the potential advantages for small and medium-sized businesses to reach out to a greater market area may outweigh the cost of membership. For example, an annual membership for Exostar (An e-marketplace for the aerospace industry), is $395. The membership allows access to aerospace companies including: The Boeing Company, Lockheed Martin, BEA Systems, Raytheon, and Rolls Royce. The only investments needed by small companies looking to enter this market are the supplies that the aerospace buyer is looking for, an e-mail address, and Internet access. Other e-market places include ChemConnect (for trading chemicals and plastics), Onvia (for government procurement), Dairy.com (links dairy processors and customers), and Thomas Regional Directory (for industrial products: lighting, safety devices, electrical equipment, etc.). Many large companies have private trading exchanges in which they conduct business with qualified suppliers (Martin, 2003). Opportunities exist for small and medium-sized companies to become a part of these trading exchanges through an initial trial in the e-marketplace.

An obstacle facing small and medium-sized companies is the costs of electronic data interchange systems (EDI) which provides trading partners the ability to share sensitive data between each other efficiently and securely. Small and medium businesses have many EDI solutions to choose from, which offer the same capabilities as EDI systems in large companies at a reduced price. EDI software solutions can be obtained from companies such as Advanced Data Exchange (ADX), Global eXchange Services, and IBM Global Services. For example, ADX has an Internet EDI network that connects 250 large enterprises and thousands of small suppliers from a variety of industry sectors including retail, manufacturing, and wholesale distribution. ADX's rates are relatively inexpensive and start at $59 a month with transaction charges around 40 cents. Customers using this type of technology service, on average, pay approximately $100 a month (Martin, 2003).

2.11 Technology Advances

Within a few years and for many applications, the bar code will eventually be replaced by radio frequency identification (RFID) technology. RFID uses electronic tags and readers to remotely track goods and retrieve data. RFID tags typically are very small microchips and antennas attached to or embedded in a cardboard carton or layered on a printed label. There are two types of tags: active and passive. Active RFID tags have their own power source, while passive RFID tags do not have their own power source. Active tags are larger than passive tags and have a battery which enables longer range and larger memory capacity as well as the ability to store additional information sent by a transceiver. Passive tags are extremely small (0.4 mm x 0.4 mm with the thickness of a sheet of paper) and can be read when electrical current is induced through the tag's antenna by incoming radio frequency, providing the tag enough power to send a response. The radio frequency signal alerts the chip, which responds by transmitting its unique identification code (Wikipedia the free encyclopedia).

RFID is starting to gain notice as a widespread supply-chain solution. RFID can be used to automatically monitor and identify goods in the supply chain, such as pallets, containers, and individual items. When integrated with the information networks of manufacturers, suppliers, distributors, and retailers, RFID provides increased visibility and greater potential for efficiency gains throughout a supply chain.

A key benefit of RFID technology is automatic transmission of information to readers, reducing the need for human intervention in inventory tracking. Unlike bar-code readers, some RFID readers do not require a line of sight between tags and readers (Mello, 2003).

Mello (2003) states that RFID will revolutionize retail and warehousing operations. For example, warehouse workers scan about one or two boxes per second and a good checkout clerk in a grocery store can scan about two items per second while RFID readers can scan and track between 150 and 1,000 tags per second.

A major benefit of RFID is improving the visibility of a product as it moves through the supply chain (Mello, 2003). Many companies have fragmented visibility, contributing to stock outs, inefficient inventory management, vulnerability to theft, and other problems.

Once the tag readers capture the RFID data, they route it to software such as inventory-management and supply-chain event-management applications. Supply-chain participants, including manufacturers, retailers, logistics companies, and suppliers share the information over the network using a Web-based portal or a proprietary network. Because of the nascent nature of RFID standards, sharing information among an extended network of business partners is a complex task involving security, governance, and integration issues (Mello, 2003).

RFID improves inventory management efficiency by automatically verifying shipping and receiving and reducing time in "picking," the process of pulling products from inventory to fill customer orders. By knowing the exact locations of products throughout the supply chain, companies reduce inventory levels without jeopardizing customer service (Mello, 2003).

Companies that already implemented RFID solutions expect improvements in inventory management and supply-chain productivity. Procter & Gamble expects a 25 percent improvement in inventory and a 10 percent savings in overall supply-chain costs resulting from RFID-related efficiency gains (Mello, 2003).

3. NORTH DAKOTA AND MINNESOTA COMPANY CASE STUDIES

This research project used a survey to identify current logistics practices in North Dakota and Minnesota firms. The first step in obtaining results for the survey was to find willing participants. Potential candidates were contacted by telephone, asking their willingness to complete in this study. An inquiry letter (Appendix A) offering more information about the study was then emailed to individuals willing to participate. A link to a survey (Appendix B) website was also sent by e-mail. North Dakota and Minnesota firms selected for this study included retailers, manufacturers, and agricultural processors. Five companies from each state were selected as willing participants. North Dakota firms consisted of those with revenues between $4 million and $50 million. Minnesota firms consisted of those with revenues between $600 million and $6 billion. In all cases, companies were contacted requesting their approval before sending them a written copy survey or an internet survey. Each company was again contacted via email with the information needed to link to a Web survey. In one case, a company manager requested and preferred to complete a written copy of the logistics survey. The Web survey and the mail survey allowed selected companies to fill out the survey at their convenience. The purpose of the survey was to define the research solution by identifying and comparing logistics capabilities in North Dakota and Minnesota firms. The participant responses were summarized and compared with the previous study by Geiger and Dooley (1998).

3.1 Supply Chain Management and Operational Strategies

Company supply chain and operational strategies were obtained from responses to survey questions 1, 2, 3, 5, 10 and 15 (Appendix B). Questions 1, 2, 3 and 15 were designed as open-ended questions, giving the respondents the opportunity to list logistics and operational capabilities and strategies. Questions 5 and 10 were designed to capture the extent of the respondent's agreement or disagreement on a numerical scale.

Four out of five Minnesota companies responded to survey question 1 which asked: "Briefly describe your company's supply chain management and/or operational strategies." Minnesota companies listed the following strategies:

- Just-in-time with no warehousing,
- Pooled distribution,
- Use designated core carriers as well as regional distribution centers, and
- Maximize customer availability of products while minimizing costs from inventory and asset expenses.

Two North Dakota companies responded to question 1 and listed the following supply chain and operational strategies:

- Just-in-time,
- Use designated carriers,
- Make-to-order, and
- "First-in, first-out" production

From the responses to question 1, it could be concluded that Minnesota and North Dakota companies may have similar views for supply chain and/or operational strategies.

Question 2 asked companies the major reasons why they have established a supply chain management or logistics strategy. All five of the Minnesota companies responded to question 2 and listed the following reasons for participating in supply chain management and/or logistics strategies:

- Better end to end control of products,
- Increased cash flow while reducing operating expenses and other costs,
- Speed to market,
- Economic efficiency, and
- Critical and necessary for success

Two North Dakota companies responded to question 2 and listed the following reasons for participating in supply chain management and/or logistics strategies:

- Customer demand,
- Reduced costs,
- Increased service levels, and
- Ability to compete on a larger scale

The responses to question 2 indicate that Minnesota and North Dakota companies have similar reasoning for their supply chain management and/or logistics strategies.

Question 3 in the survey asked Minnesota and North Dakota companies if they require minimum logistics capabilities from suppliers, carriers and third party logistics providers. All five Minnesota companies responded to question 3 indicating that they do require minimum logistics capabilities (most importantly EDI and JIT) and listed the following requirements that current suppliers, carriers and third party logistics providers must have to conduct business:

- EDI
- Transportation management tools-Nistevo4
- Daily requirement monitoring tools or demand flow technology
- Just-in-time capabilities such as daily timing and shipment volume requirements
- Extranet capabilities

Only one of the North Dakota companies responded to question 3 indicating that they require EDI logistics capabilities for suppliers, carriers and third party logistics providers. Two North Dakota companies

[4] www.nistevo.com

indicated that they require JIT capabilities but do not have EDI technology implemented at the present time. Two North Dakota companies did not respond to question 3.

Question 15 asked companies to briefly describe the methods used to determine who the company's suppliers, carriers and third-party logistics providers will be. Four out of five companies surveyed in each state responded to the question. Responses describing the company's selection methods were nearly identical in each state. Each responding Minnesota and North Dakota company listed at least two or more of the following methods for supplier, carrier, and third-party logistics selection:

- Cost
- Metric achievement (present/past)
- Strategic location
- Service level attainment
- Level of compliance to requirements
- Customer demand

Table 4 shows the numerical agreement responses to question 5 in the survey. Question 5 was divided into four parts (Q5a - Q5d), and was designed to obtain the extent that companies agree or disagree on a scale of one to five (1=agree, 5=disagree) with each statement. An average response is also listed for each state.

Table 4. Company responses and averages for survey question 5a-5d

MINNESOTA	Q5a	Q5b	Q5c	Q5d
Company A	3	3	3	2
Company B	4	4	2	4
Company C	1	3	2	3
Company D	5	2	3	2
Company E	2	1	1	5
Average From Responding Company	3	2.6	2.2	3.2
NORTH DAKOTA	Q5a	Q5b	Q5c	Q5d
Company F	2	4	3	4
Company G	1	5	2	4
Company H	2	3	3	2
Company I	3	3	3	3
Company J	2	4	3	3
Average From Responding Company	2	3.8	2.8	3.2

Q5a- Decision-making is highly concentrated at top management levels
Q5b- Our company has a clearly defined supply chain management strategy
Q5c- A less formal organizational structure is used to more fully integrate operations
Q5d- Supply chain management planning is well coordinated

The average response rate indicated that decision making is highly concentrated at top management levels more in North Dakota companies than Minnesota companies (question 5a). The average response results from question 5b show Minnesota companies agreeing more that they have a more clearly defined supply chain management strategy. Question 5c average responses showed Minnesota companies agreeing slightly more than North Dakota companies that they use a less formal organizational structure to more fully integrate operations. And finally, question 5d shows that both Minnesota and North Dakota companies are neutral with slight disagreement (average 3.2 for each state), that supply chain management planning is well coordinated within the company.

Table 5 shows the numerical agreement responses to question 10 in the survey.

Table 5. Company responses and averages for survey question 10a-10i

MINNESOTA	Q10a	Q10b	Q10c	Q10d	Q10e	Q10f	Q10g	Q10h	Q10i
Company A	4	1	5	1	1	2	2	5	1
Company B	4	1	5	NA	5	3	NA	1	3
Company C	1	1	5	3	3	3	4	2	2
Company D	2	4	5	1	2	4	5	2	2
Company E	1	5	1	1	NA	5	NA	1	1
Average From Responding Company	2.4	2.4	4.2	1.5	2.75	3.4	3.7	2.2	1.8
NORTH DAKOTA	Q10a	Q10b	Q10c	Q10d	Q10e	Q10f	Q10g	Q10h	Q10i
Company F	2	2	3	2	2	3	2	2	2
Company G	3	3	4	3	3	3	NA	2	3
Company H	2	2	2	4	4	4	NA	1	2
Company I	3	3	3	4	4	4	5	5	5
Company J	3	4	2	3	4	3	5	3	3
Average From Responding Company	2.6	2.8	2.8	3.2	3.4	3.4	3.5	2.6	3

Q10a. My company's supply chain is complex (number of customers/sellers, geographical dispersion, delivery timing requirements, etc.)
Q10b. The demand for our goods and/services has remained stable over the past three years
Q10c. My company is currently facing change and uncertainty in it's supply chain measures
Q10d. In general, our customers adopt new technology soon after it becomes available
Q10e. In general, our suppliers adopt new technology soon after it becomes available
Q10f. In general, our transportation providers adopt new technology soon after it becomes available
Q10g. In general, our 3rd party logistics providers adopt new technology soon after it becomes available
Q10h. My company has maintained the same number of suppliers over the past three years
Q10i. The quality of products from our suppliers are stable and constant

Question 10 was divided into nine parts (Q10a - Q10i), and was designed to ascertain the extent that companies agree or disagree on a scale of one to five (1=agree, 5=disagree) with each statement. The average response ratings from question 10 were similar without significant variation in all but three of the questions. The largest average response agreement gap between Minnesota and North Dakota companies can be observed in Q10c, Q10d, and Q10i. Comparing average response ratings from Q10c, shows Minnesota companies scoring an average response of 1.5 whereas North Dakota companies scored an average response of 2.8. This indicates that Minnesota companies were more likely to agree that the company is currently facing change and uncertainty in supply chain measures compared to North Dakota companies. The average response rating from Q10d shows Minnesota companies agreeing to a greater extent than North Dakota companies that the company's customers tend to adopt new technology soon after it becomes available. For question Q10i, Minnesota companies scored an average response of 1.8, whereas North Dakota companies scored an average response of 3. From these average responses, one may conclude that Minnesota companies agree, to a greater extent, that quality of products from suppliers is stable and constant. North Dakota company average response of 3 indicates that North Dakota companies are neutral, neither agreeing or disagreeing to any extent that the quality of products from suppliers is stable and constant.

3.2 Technology Implementation

Geiger and Dooley (1998) identified that North Dakota firms trail "leading edge" companies with respect to information technology compatibility, EDI, and bar coding. Questions 6, 13, 14, 16, 17, 18, and 19 in the survey were designed to capture and compare information regarding company technology implementation. Question 6 asked Minnesota and North Dakota companies to indicate the approximate annual budget for operating and maintaining supply chain technology. Two out of five Minnesota companies responded to the question saying millions of dollars are spent with one company indicating an approximate dollar amount of $1.2 million. The other three companies in Minnesota did not provide an answer to question 6. North Dakota companies indicated much smaller expenditures in operating and maintaining supply chain technology. Two out of five North Dakota companies said they spend from $2,000-$4,000, one company said $80,000-$100,000; and the remaining two companies in North Dakota did not provide an answer to question 6.

Survey questions 13 and 14 were designed to obtain a response as to who or what entity encourages or drives the implementation of supply chain technology (customers, suppliers, transportation providers, 3rd party logistics providers, or N/A).

One Minnesota company indicated in question 13 that suppliers encouraged or drove the implementation of supply chain technology. The remaining four Minnesota companies selected N/A for question 13. In comparison, four out of five North Dakota companies said customers encouraged or drove the implementation of supply chain technology. One North Dakota company said 3rd party logistics providers encouraged or drove the implementation.

Responses to question 14 resulted in one Minnesota company conferring that they encouraged or drove the implementation of supply chain technology to customers and 3rd party logistics providers. Two Minnesota companies indicated that they encouraged or drove the change to suppliers, and three companies indicated that they encouraged or drove the change to transportation providers. In comparison, one North Dakota company indicated that they encouraged or drove the change to suppliers, while the remaining four companies selected N/A to question 14.

Question 16 asked companies to identify the types of supply chain technology systems that have been adopted and implemented and to what extent (Scale: 1-Not at all, 5- To a great extent) the technology systems have been implemented. Minnesota average indicated responses were above scale level three for five supply chain technology systems; transportation management systems (3.6), geo-coded tracking systems (3.2), bar coding technology (4.8), warehouse management systems (3.8), and demand forecasting management (4). Two North Dakota companies averaged a scale level of three on computer aided design systems, and bar coding technology. Minnesota company averages were higher than North Dakota's in all but one supply chain technology system: electronic commerce technologies (Table 6).

Table 6. Company responses and averages for survey question 16a-16m

MINNESOTA	Q16a	Q16b	Q16c	Q16d	Q16e	Q16f	Q16g	Q16h	Q16i	Q16j	Q16k	Q16l	Q16m
Company A	1	1	1	1	5	4	3	1	5	1	1	4	4
Company B	5	1	5	1	5	5	1	1	1	5	1	1	5
Company C	4	1	1	1	4	4	1	1	2	1	3	1	2
Company D	3	1	5	1	5	2	1	4	1	1	1	1	5
Company E	5	2	4	1	5	4	1	3	3	1	4	2	4
Average From Responding Company	3.6	1.2	3.2	1	4.8	3.8	1.4	2	2.4	1.8	2	1.8	4

NORTH DAKOTA	Q16a	Q16b	Q16c	Q16d	Q16e	Q16f	Q16g	Q16h	Q16i	Q16j	Q16k	Q16l	Q16m
Company F	1	1	1	1	4	1	1	1	1	1	5	1	1
Company G	1	1	1	1	1	1	1	1	1	1	1	1	1
Company H	1	1	3	1	2	1	2	2	2	4	3	1	4
Company I	1	1	5	1	5	1	1	1	1	1	1	1	1
Company J	1	1	5	1	3	1	1	2	1	1	1	1	1
Average From Responding Company	1	1	3	1	3	1	1.2	1.4	1.2	1.6	2.2	1	1.6

Q16a- Transportation Management Systems (TMS)
Q16b- Radio Frequency Identification Systems (RFID)
Q16c- Computer Aided Design System (CAD)
Q16d- Geo-coded Tracking Systems
Q16e- Bar coding technology
Q16f- Warehouse Management Systems (WMS)
Q16g- Manufacturing Execution System (MES)
Q16h- Product Data Management (PDM)
Q16i- Customer Relationship Management (CRM)
Q16j- Automated Quality Control System (AQC)
Q16k- Electronic Commerce Technologies
Q16l- Supply Chain Event Management (SCEM)
Q16m- Demand Forecasting Management (DFM)

As mentioned previously, Geiger and Dooley (1998) stated that North Dakota companies trail "leading edge" companies with respect to information technology compatibility, EDI, and bar coding. The results in Table 6 are consistent with the findings from the Geiger and Dooley (1998) study. However, in this study, Table 6 presents the extent of implementation with respect to information technology systems whereas the Geiger and Dooley (1998) study did not offer such comparison.

Question 17 asked companies what type of integrated information systems have been implemented by the company to link functional areas. Four out of five Minnesota companies stated that they use enterprise resource planning (ERP) systems to link functional areas. One company indicated using both ERP and supply chain planning (SCP), and one company uses other types of systems which were not specifically described. Two North Dakota companies responded to question 17 indicating that no integrated information systems are used to link functional areas.

Question 18 asked companies to indicate what they think will be implemented in the way of technology in the future. Two companies in Minnesota indicated radio frequency identification (RFID), one company stated new ERP systems, and one company stated it did not know at the present time. Two North Dakota companies responded to question 18 with one indicating bar coding and the other indicating RFID.

3.3 Logistics Capabilities

From the survey results, it was conclusive that Minnesota companies are more likely to require minimum logistics capabilities from suppliers, carriers and 3rd party logistics providers. All five Minnesota firms surveyed use some form of demand flow, electronic data interchange (EDI) technology, and Just-in-Time (JIT). Minnesota firms also indicated that they have set requirements that include daily timing, daily shipment volumes, and insurance for their suppliers, carriers and 3rd party providers. On the other hand, two North Dakota companies indicated that they required minimum logistics capabilities.

3.4 Lean Principles

Question 4 of the survey asked companies if they have adopted lean principles and if so, to describe the achievements and benefits gained through the implementation and use of the principles. Two of the surveyed North Dakota companies have employed "lean" principles in at least one area of the company, whereas four of the five Minnesota companies have employed "lean" principles in various divisions within company. One of the companies surveyed in Minnesota is just getting started with implementing "lean" and had not yet implemented the principles but plan to implement the principles soon. North Dakota companies that had implemented "lean" principles indicated they had limited implementation, where only a few select people within a specific area such as the manufacturing shop floor were educated on "lean" principles. Three North Dakota companies did not indicate whether they were just getting started or had not yet implemented the principles. Achievements and benefits gained were not indicated by either Minnesota or North Dakota companies. This may be because of confidentiality reasons.

3.5 Homeland Security Measures

Since Sept. 11, 2001, a vast amount of effort has been expended in protecting the safety and security of the country. As companies become increasingly global, stronger emphasis is placed on maintaining secure borders for transporting goods. Question 20 of the survey asked companies to indicate the extent that homeland security measures have affected their day-to-day logistics operations. Although intuitively aware of the need for safe and secure shipments, the companies from both states did not feel strongly that homeland security measures had affected day-to-day logistics operations. The survey question relating to homeland security measures was ranked as follows; 1-Not at all, 2-Very little, 3-Somewhat, 4-A significant amount, 5-To a great extent. None of the surveyed firms indicated 5-To a great extent. Three of the Minnesota firms indicated that they believe homeland security measures have "somewhat" affected the day-to-day logistics operations in the company while the remaining two Minnesota companies indicated "very little." Three North Dakota firms indicated that homeland security measures have "not at all" affected their day-to-day operations, one company indicated "very little," and one company indicated that their day-to-day logistics operations have been affected "a significant amount."

4. INDIVIDUAL COMPANY CASE STUDY

Glenmac Inc. was founded as a sales and marketing business in 1976 in Jamestown, ND. In 1983, Glenmac Inc. acquired the Harley company (a rock picking/rake machinery manufacturer) and began manufacturing a line of Harley rock rakes used for landscaping. Glenmac developed the rock rake machinery into what is now called the Power Box Rake which pulverizes, levels, and grades terrain. The Power Box Rake attaches to skid-steer loaders and tractors and is used in various applications including golf course and residential landscaping, and gravel road maintenance. Glenmac also manufactures the Harley Rock Picker which screens out oversize rock, leaving finer soil in place. The Harley Rock Picker is used for landscaping applications including golf course construction, gravel road maintenance, and agricultural field maintenance. In addition, modified rakes have been used to clear land mines in military operations. In January, 2002, Glenmac added a new line of products in the same type of industry with the acquisition of the Cherrington company located in Fairfax, MN. The Cherrington company manufacturers sand sifting equipment used for cleaning debris from beaches, horse tracks, athletic arenas, and golf courses. The sand sifting machine collects debris such as glass, seaweed, sludge and other types of unwanted items and deposits them into a holding box on the machine while depositing the screened sand back to the landscape. Glenmac sells products on six continents, employs almost 100 people, and has manufacturing facilities located in Minnesota and North Dakota.

As demand for Glenmac's products increased from the mid 1980s to the mid 1990s, plant capacity became an issue. In 1996, the company decided to construct a larger manufacturing facility in North Dakota to add capacity. The company continued to grow approximately 30 percent per year for the next four years. In 2000, due to a slowing economy, Glenmac faced the prospect of slowing some of its production. As budget constraints became tighter, chief executive officer (CEO) Mac McPherson, determined measures were needed to promote efficiency. On Nov. 8, 2000, the company briefly shut down one of its manufacturing facilities. The CEO used the shutdown opportunity to use existing resources in new roles to implement new strategies to improve efficiency. Glenmac sought assistance from the North Dakota Manufacturing Extension Partnership (NDMEP).5

During the slowest month in the manufacturing cycle, the company began sending manufacturing personnel through the lean principles workshops. The workshops included methods designed to minimize the resources required for production by eliminating non-value added activities, inventory requirements, and lead times. The workshops emphasized the use of preventive maintenance, flexible workforces, pull systems, and continuous improvement. The CEO of the company felt the key to a successful transition was involving all levels of manufacturing personnel. In addition, he believed that involving everyone on the shop floor would help create buy-in to the lean concept. Each employee first went through a "Lean 101" workshop in which members gained knowledge of lean manufacturing principles and how to apply the principles in their workplace. After completing "Lean 101," the employees attended training in value stream mapping. The value stream mapping training sessions helped the employees identify waste in their work setting and streamline processes to get rid of waste. Through knowledge gained from the training programs, employees developed ideas to make operations more efficient. Numerous ideas that seemed inconsequential by themselves, collectively added up to worthwhile company operations improvements. Employees identified almost 30 different "action items" that could be improved to allow the company to achieve greater efficiencies. Three of the 30 "action items" identified as inefficiencies in manufacturing

[5]A non-profit organization developed to help small and medium size businesses increase productivity. www.ndmep.com

production included: 1) transportation flow through the shop was not efficient, 2) assembly parts inventory levels were high and some operations were located too far away from parts inventory, and 3) equipment lacked necessary maintenance.

Because of a rebounding economy, the company's production increased once again. Using principles and strategies learned in the lean manufacturing training sessions, employees acted as change agents, developing solutions to inefficient operations. As the volume increased, employees looked closely at improving production flow. A line-flow strategy was implemented to reduce the frequency of set ups and allowed the company to operate with lower inventory levels. As part of the line-flow strategy, product transport racks were developed that allowed moving several parts at a time between operations allowing a one-worker multiple-machine-and-fabrication approach. The line-flow strategy advanced the manufacturing processes to a near just-in-time (JIT) operation with finely tuned flows of materials and little buffer inventory between workstations.

A preventative maintenance strategy was also implemented by employees at Glenmac. Because the JIT system operates with very little buffer inventory, unplanned machine downtime can be very disruptive. Therefore, employees developed a system of daily equipment maintenance. This system balances the cost of the preventive maintenance program against the risks and costs of machine failure. In addition, the preventive maintenance program promotes worker responsibility for routine maintenance on their own equipment and develops employee pride in keeping machines in top condition.

The resolutions to the three "action item" inefficiencies included: 1) Improving transportation flow and reducing traffic jams/bottlenecks in the shop by opening a passageway through the dividing wall between two operations, 2) Reducing assembly time by moving parts inventory with configured transport racks to the station were assembly takes place, and 3) Reducing equipment downtime and maintenance cost through daily maintenance by machine operators.

According to McPherson, "These changes were very simple. We just needed to step back for a moment and take a closer look at what was going on with our processes and come up with ideas to make things operate more efficiently. The training sessions helped our employees do just that. The key to becoming a good company is having the right people. Here at Glenmac our employees are the most valuable part of our success." According to Kim Lunde CPA, VP/Finance & Corporate Development, "The company could see the benefits of lean shortly after the principles and strategies had been put in place. However, it is hard to come up with detailed cost figures." According to Lunde, "The transition to adopting lean manufacturing principles and strategies was not costly. In-house costs were minimal, and overhead and inventory costs have decreased significantly." According to NDMEP, the initial results of implementing lean principles allowed the company to increase productivity and reduce floor time on the total assembly of a run. The estimated savings of the implementation is more than $50,000 annually. According to Lunde, the largest capital investment in the transition to lean manufacturing was the time used to move machinery and open a passageway by cutting out a door between the two sections of the shop. Moving machinery enabled better transportation flow by aligning processes and reducing the frequency of setups thereby decreasing production time and costs.

The right timing was also important for the company's transition to lean. The company was able to send its employees through training during the slowest time of the year which did not affect customer orders. In addition, lean principles learned in training sessions encouraged a sense of teamwork among employees enabling them to identify inefficiencies not only in their individual areas but supporting areas as well.

To measure gains in production efficiency, average monthly production hours by work center per manufactured product charts were developed. Data from the charts is the result of using a time-study method with performance-rating factors indicating how much above or below the shop's performance is on each production run. A bulletin board in the shop displays progress for the past production year which allows employees to compare the shop's performance from month-to-month and throughout the year. Statistics from July 2003 to June 2004 showed that average fabrication times for products have decreased by three hours. Employees have avoided adding a second shift because of production efficiencies gained by using lean strategies and statistical measurements. Glenmac also maintains high levels of quality with the implementation of lean strategies. Lean concepts allow self-inspection, increased labor utilization, and increased flexibility in product production in each cell. There is no defective parts movement between operations and reject rates are very low.

Lean manufacturing principles and strategies have been an important part of Glenmac's continued success. Over a four-year time period (2000-2004), the company has gone from a $3 million to a $10 million company. The company has also substantially reduced inventory levels with the implementation of lean strategies.

One of the primary concerns for the company is to keep lean strategies moving forward to achieve even greater efficiency. Glenmac employees continue to look for ways to improve processes and acknowledge there are still many improvements to be made. The company can see the benefits of lean, but keeping close measurement of the results remains difficult. According to MacPherson, "We recognized that there are better ways of doing things and we need to continue with lean principles to achieve greater efficiency. We can still do things better even after the changes we have made."

5. SUMMARY AND CONCLUSION

This study evaluated the strategic logistics practices in North Dakota rural firms and compared those practices with leading-edge Minnesota firms. Understanding logistics strategies and practices is essential to improving competitiveness in domestic and global markets. Firms expanding into domestic and global markets from the Midwestern and Plains states need to further employ strategic logistics practices to compete. This study focused on identifying current logistics practices in North Dakota and Minnesota firms and determining their participation in strategic logistics concepts. Extensive literature review was conducted and used as a guide for developing survey questions relevant to the study objectives. The literature review included: logistics management and supply chain management definitions, three reasons to establish supply chain management philosophy, lean production principles and benefits, continuous improvement, strategic alliances, E-commerce, and technology advances.

Surveys were used to obtain more information on what logistics practices and philosophies companies are currently developing and using. Participating companies were chosen based on size, economic distinction and similarity of industry. Companies were contacted in advance by telephone and e-mail for their help in completing either a Web-based or mailed survey. The results of research conducted by Griffis et. al. (2003) showed that Web surveys are comparable in quality to mail surveys and achieve quicker response as well as somewhat higher response rates. The author believed that contacting the companies in advance would also provide a better opportunity for an increased number of willing participants to respond. Baruch (1999) explains that response rates for academic studies have demonstrated a decline in recent years. In addition Griffis et. al. (2003) maintains that the decline in response rates is also "prevalent in logistics research, where achieving the traditional benchmark of 20 percent usable responses from a survey mailing seems less common today than ever before." Some companies, after being contacted, and upon initial review of the questions asked in the survey, believed the survey did not apply to their business. Others surveyed did not have the available time or resources to complete the survey and could not indicate specifically when they would have time. Therefore, the primary limitation of this study was the number of willing participants. Geiger and Dooley (1998) identified two similar difficulties with an expert interview survey method. "First, individuals may claim to be knowledgeable and seem eager to participate, but may not really possess the expertise." "Second, it may be difficult to locate and obtain help from experts outside the organization conducting the study."

A site visit was granted by one North Dakota company which offered insight as to how the company has increased operating efficiencies through lean principle workshops. A case study was then developed to discuss cost measurement and savings as the result of the company's implementation of lean principles.

The Geiger and Dooley (1998) study indicated that leading-edge companies focused on strategic activities, while North Dakota companies focus more on day-to-day operations. The case studies and survey data from this study indicated that some of the selected North Dakota firms are employing logistics concepts and focusing more on strategic activities such as lean production principles, continuous improvement, strategic alliances with transportation providers and suppliers, and technology such as EDI. Geiger and Dooley (1998) also identified that North Dakota firms trail leading-edge companies with respect to information technology compatibility, EDI, and bar coding. The survey information obtained in this study yielded similar results to those of Geiger and Dooley (1998). This study indicated that North Dakota companies presently trail Minnesota companies with respect to information technology compatibility, EDI, and bar coding with respect to both capital expenditure and level of implementation. However, it may also

be concluded that Minnesota firms initially have larger operating budgets for information technologies and, therefore, have advanced their capabilities based on capital expenditure.

The insights ascertained through this study are valuable in understanding the strategic logistics activities in North Dakota and Minnesota firms. Future research studies may consider a larger sample size to compare firms with more equivalent revenues to determine logistics and operational capabilities and strategies on a parallel basis.

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APPENDIX A

INQUIRY LETTERS TO MINNESOTA AND NORTH DAKOTA COMPANIES

NORTH DAKOTA INQUIRY LETTER

Dear Logistics/Transportation Manager,

The Upper Great Plains Transportation Institute at North Dakota State University would like to thank you for participating in our supply chain management survey. The research we are conducting evaluates the supply chains and strategic logistics practices in North Dakota firms. You are a part of a select group of individuals in North Dakota who we are approaching to assist us with this research project.

Essentially, we are looking at how firms strategically position themselves for operational effectiveness through their supply chain practices. Our research will involve identifying, from both firms and literature, what logistic trends manufacturers and processing firms confront today and how firms respond to these trends in terms of their specific business processes. In addition, we would like to stimulate a response from firms as to how homeland security measures have changed their logistical operations.

We appreciate your assistance in answering our survey and look forward to your response. Your insight and perceptions into future logistics trends and their impact on your firm, your suppliers or clients is an extremely valuable part of this project. This survey is voluntary and all individual company results will be held strictly confidential. If you have any questions or concerns, please feel free to contact us.

Sincerely,

Mark Lofgren
Associate Research Fellow
Upper Great Plains Transportation Institute
North Dakota State University
430 IACC Building
P.O. Box 5074
Fargo, ND 58105
(701) 231-6428
Fax: (701) 231-1945

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MINNESOTA INQUIRY LETTER

Dear Logistics/Transportation Manager,

The Upper Great Plains Transportation Institute at North Dakota State University would like to thank you for participating in our supply chain management survey. The research we are conducting evaluates the supply chains and strategic logistics practices in "world class" and "leading edge" firms. You are a part of a select group of individuals in the Upper Midwest who we are approaching to assist us with this research project.

Essentially, we are looking at how firms strategically position themselves for operational effectiveness through their supply chain practices. Our research will involve identifying, from both firms and literature, what logistic trends manufacturers and processing firms confront today and how firms respond to these trends in terms of their specific business processes. In addition, we would like to stimulate a response from firms as to how homeland security measures have changed their logistical operations.

We appreciate your assistance in answering our survey and look forward to your response. Your insight and perceptions into future logistics trends and their impact on your firm, your suppliers or clients is an extremely valuable part of this project. This survey is voluntary and all individual company results will be held strictly confidential. If you have any questions or concerns, please feel free to contact us.

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APPENDIX B

SURVEY QUESTIONS

Company name _____

Main business focus _____

SIC code (if available) _____

Your name
_____

Your title
_____

In order to stratify results, please provide the following information:

Please indicate the total number of employees in your company (include all locations):

_____

Please indicate the approximate annual revenues for your company (include all locations):

_____

Please place a check (√) by the geographic scope (markets, factories, etc.) of your company's operations? (Select one)
_____ Worldwide
_____ National
_____ Regional
_____ Only within the State

Briefly describe your company's supply chain management and/or operational strategies.

If your company participates in a supply chain management or logistics strategy, what do you believe is the major reason(s) for establishing this strategy?

Does your company require minimum logistics capabilities from suppliers, carriers, and third party logistics providers? (Things like JIT, EDI, etc.) If so, what are the requirements?

Much has been written about businesses adopting “Lean” principles and transforming a company into a “Lean Enterprise”. Has your company adopted “Lean” principles? If so, please describe what types of achievements or benefits your company has gained through the use of “Lean” principles and processes. (In brief, becoming “Lean” involves restructuring and continuous improvements to eliminate any processes that do not add value to the customer.) (If you could, please quantify with percentages or numbers.)

5. Please circle the corresponding number indicating the extent to which you agree with the following statements regarding your company.

	Agree----------Disagree 1----------5				
(a) Decision-making is highly concentrated at top management levels	1	2	3	4	5
(b) Our company has a clearly defined supply chain management strategy	1	2	3	4	5
(c) A less formal organizational structure is used to more fully integrate operations	1	2	3	4	5
(d) Supply chain management planning is well coordinated	1	2	3	4	5

6. Please indicate your company's approximate annual budget for operating and maintaining supply chain technology.

_____

7. Please indicate your company's total number of logistics and transportation employees.

_____

8. Please indicate how many information technology employees are dedicated to maintaining supply chain technology.

_____

9. Please circle the corresponding number which indicates the level of your company's performance compared to your industry competitor's performance in the following areas:

	Well below average		Average		Well above average
(a) Market share	1	2	3	4	5
(b) Average annual market share growth (over the past five years)	1	2	3	4	5
(c) Average annual sales growth (over the past five years)	1	2	3	4	5
(d) Overall customer service levels	1	2	3	4	5
(e) Overall product quality	1	2	3	4	5
(f) Overall competitive position	1	2	3	4	5

10. Please circle the corresponding number indicating the extent to which you agree with the following statements:

	Agree---------Disagree 1----------5					
(a) My company's supply chain is complex (number of customers/sellers, geographical dispersion, delivery timing requirements, etc.)	1	2	3	4	5	NA
(b) The demand for our goods and/services has remained stable over the past three years	1	2	3	4	5	NA
(c) My company is currently facing change and uncertainty in it's supply chain measures	1	2	3	4	5	NA
(d) In general, our customers adopt new technology soon after it becomes available	1	2	3	4	5	NA
(e) In general, our suppliers adopt new technology soon after it becomes available	1	2	3	4	5	NA
(f) In general, our transportation providers adopt new technology soon after it becomes available	1	2	3	4	5	NA
(g) In general, our 3rd Party Logistics Providers adopt new technology soon after it becomes available (If applicable)	1	2	3	4	5	NA
(h) My company has maintained the same number of suppliers over the past three years	1	2	3	4	5	NA
(j) The quality of products from our suppliers are stable and consistent	1	2	3	4	5	NA

11. List and briefly comment on internal and external factors that may have led your company to adopt and implement electronic commerce, supply chain technology or other initiatives.

_____

_____

_____

_____

_____

_____

_____

The following questions relate to supply chain relationships with the company's customers, suppliers, carriers, and third party logistics providers.

12. Please circle the corresponding number indicating the satisfaction level of the following activities:

	Satisfied---------Dissatisfied 1----------5					
(1) Cooperation between my company and our						
(a) Customers…….	1	2	3	4	5	NA
(b) Suppliers……...	1	2	3	4	5	NA
(c) Transportation Providers……..	1	2	3	4	5	NA
(d) 3rd Party Logistics Providers……	1	2	3	4	5	NA
(2) Information exchange between my company and our						
(a) Customers……	1	2	3	4	5	NA
(b) Suppliers……...	1	2	3	4	5	NA
(c) Transportation Providers……..	1	2	3	4	5	NA
(d) 3rd Party Providers……..	1	2	3	4	5	NA

Implementation of supply chain technology has been encouraged (they drove the change) by our: (Please circle all that apply)

(a) Customers
(b) Suppliers
(c) Transportation Providers
(d) 3rd Party Logistics Providers
(e) N/A

Implementation of supply chain technology has been encouraged (we drove the change) to our: (Please circle all that apply)

(a) Customers
(b) Suppliers
(c) Transportation Providers
(d) 3rd Party Logistics Providers
(e) N/A

What methods (examples: bid software, past performance indicators, specific contracts, etc.) does your company use to determine who its suppliers, carriers and third-party logistics providers will be? Briefly describe.

_____

_____

_____

The following questions relate to adoption of supply chain information technology.
Which of the following supply chain technology systems have been adopted and implemented by your company? Please circle the corresponding number indicating the extent of implementation.

	Not at all----------				----------To a great extent	
(a) Transportation Management Systems (TMS)	1	2	3	4	5	NA
(b) Radio Frequency Identification Systems (RFID)	1	2	3	4	5	NA
(c) Computer Aided Design System (CAD)	1	2	3	4	5	NA
(d) Geo-coded Tracking Systems	1	2	3	4	5	NA
(e) Bar coding technology	1	2	3	4	5	NA
(f) Warehouse Management Systems (WMS)	1	2	3	4	5	NA
(g) Manufacturing Execution System (MES)	1	2	3	4	5	NA
(h) Product Data Management (PDM)	1	2	3	4	5	NA
(i) Customer Relationship Management (CRM)	1	2	3	4	5	NA
(j) Automated Quality Control System (AQC)	1	2	3	4	5	NA
(k) Electronic Commerce Technologies	1	2	3	4	5	NA
(l) Supply Chain Event Management (SCEM)	1	2	3	4	5	NA
(m) Demand Forecasting Management	1	2	3	4	5	NA

What type of integrated information system has been implemented by your company to link functional areas?
a. Enterprise Resource Planning (ERP) (Examples: Baan, SAP, Oracle, PeopleSoft)
b. Supply Chain Planning System (SCP) (Examples: i2 Technologies, PSI Planner)
c. None
d. Other (please describe)_____

_____

Please describe what you think will be implemented in the way of technology in the near future. (Within the next 3 years)

Which of the benefits listed below has your company received from the adoption of supply chain information technology systems and to what extent?

	Not at all-------Significantly					
(a) Inventory reduction	1	2	3	4	5	NA
(b) Increase in inventory turns	1	2	3	4	5	NA
(c) Improved shipment accuracy	1	2	3	4	5	NA
(d) Lead time reduction	1	2	3	4	5	NA
(e) Improved customer service	1	2	3	4	5	NA
(f) Increased customer satisfaction	1	2	3	4	5	NA
(g) Service level cost decrease	1	2	3	4	5	NA
(h) Improved on-time delivery to the customer	1	2	3	4	5	NA
(i) Improved on-time delivery from suppliers	1	2	3	4	5	NA
(j) Information sharing with suppliers and customers has improved	1	2	3	4	5	NA
(k) Coordination of logistics activities with suppliers and customers has improved	1	2	3	4	5	NA
(l) Trust in suppliers and customers has increased	1	2	3	4	5	NA
(m) Greater commitment to supply chain relationships	1	2	3	4	5	NA

Please circle the applicable number below as it applies to the extent that homeland security measures have affected the day-to-day logistics operations in your company?

Not at all	Very little	Somewhat	A significant amount	To a great extent
1	2	3	4	5