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Critical Factors Affecting Supply Chain Management: A Case Study in the US Pallet Industry

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1. Introduction

Supply chain management is applied by companies across the globe due to its demonstrated results such as delivery time reduction, improved financial performance, greater customer satisfaction, building trust among suppliers, and others. According to D'Amours, Ronnqvist, and Weintraub (2008), companies resort to supply chain practices to improve their performance. Thus, it is important to first understand how their supply chains work. Figure 1 shows a generalized supply chain in the forest products industry.

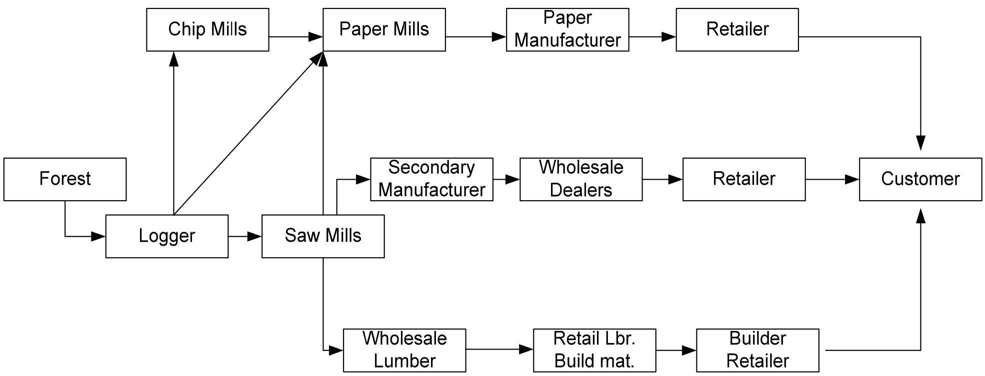

Fig. 1. Forest and wood products supply chain (Campbell and Kazan, 2008)

Figure 2 illustrates another example of the steps in a supply chain for wood pallet manufacturing industries. This process begins with logging operations, logs are then sent to the sawmill where cants and/or pallet parts are sent to the wood pallet manufacturer (pallet operations). Lastly, once wood pallets are manufactured, they are sent to a distributor or directly to the final customer.

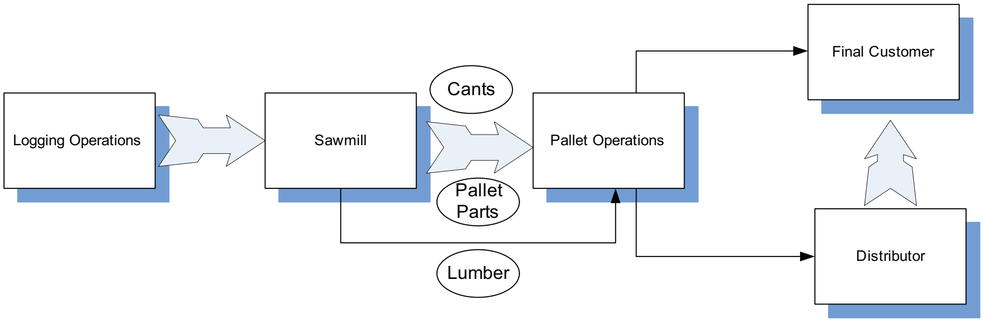

Fig. 2. Hypothesized wood pallet manufacturing process

2. Identification of Supply Chain Management factors

In order to understand how a supply chain works, it is important to identify the factors affecting supply chain management. The identification of these factors has been based on previous work by Li (2002), and Quesada and Meneses (2010). The following sections show generic supply chain management factors and sub-factors that might affect supply chain management activities.

2.1 Environmental uncertainty

Environmental uncertainty refers to the environmental issues in the product chain (Dwivedi and Butcher, 2009). Ettlie and Reza (1992) described this as the unexpected changes of customer, supplier, competitor, and technology. It was said by Yusuf (1995) that government support plays an important role for business success. Paulraj and Chen (2007a) mentioned that environmental uncertainty is an important factor in the realization of strategic supply management plans. The increase of outsourcing activities in the industry had augmented the awareness of the importance of strategic supply management, which leads to better relationship among organizations. Under this factor, three sub-factors were identified: environment, government support, and uncertainty aspects from overseas.

2.1.1 Company environment

This sub-factor is related to the company's relationship with suppliers and their level of trust and commitment. Company environment is also related to the company's expectations of quality, on time delivery, competition in the sector, and the level of rivalry among firms. In order to respond effectively to demand, companies realize that imports are a good option for obtaining flexibility in response, even though working with countries from overseas implies working with uncertainty (Wu, 2006). According to a study carried out by Ambrose et al. (2010), uncertainty negatively affects company performance. But this can be reduced if a strategic relationship with critical suppliers is established (Chen et al., 2004). Thus, companies need to implement new strategies that allow them to deal with environmental uncertainties in the supply chain (Wu, 2006) in order to perform in a proficient manner.

2.1.2 Government support

The level of support that the company receives from the government when importing raw materials or products from overseas or using domestic materials. It includes the use of norms, regulations, policies, and advice for the sector. The research conducted by Elzarka et al., (2011) describes how government can make a series of reforms to encourage exportats by increasing manufacturing sector's competitiveness in the international market through logistics competency. The increase of international trade for acquiring resources from other countries introduces complicated matters such as language barriers, transportation, transportation costs, exchange rates, tariffs, and administrative practices (Quayle, 2006).

2.1.3 Uncertainty aspects from overseas

When requiring the outsourcing of raw materials or products, it is important to acknowledge the existence of environmental factors such as political uncertainties in other countries that can increase risk for suppliers, provoke decisions of no investment, change business strategies, and in general influence business decisions. Social uncertainties such as religion, environment, language, cultural issues, limitations of communication (Bhattacharyya et al., 2010) and also the technology used in other countries might interfere with supply chain planning and function (Bized, 2007).

2.2 Information technology

Telecommunications and computer technology allow all the actors in the supply chain to communicate among each other. The use of information technology allows suppliers, manufacturers, distributors, retailers, and customers to reduce lead time, paperwork, and other unnecessary activities. It is also mentioned that managers will experience considerable advantages with its use such as the flow of information in a coordinated manner, access to information and data interchange, improved customer and supplier relationships, and inventory management not only at the national level but also internationally (Handfield and Nichols, 1999). Also the advantages will include supply contracts via internet, distribution of strategies, outsourcing and procurement (Simchi-Levi et al., 2003). All companies are looking for cost and lead time reductions with the purpose of improving the level of service but also to enhance inter-organizational relationships (Humphreys et al. 2001).

A study carried out by Tim (2007) states that through the use of communication tools, such as the web sites, industrial organizations can build value in their supply chain relationships. According to Turner (1993), another key for supply chain management success is the use of planning tools. He also mentions that without the use of information systems, companies cannot handle costs, offer superior customer service and lead in logistics performance. Turner (1993) indicates that firms cannot effectively manage cost, offer high customer service, and become leaders in supply chain management without the incorporation of top-of-the-line information technologies. Li (2001) identified 14 such information technology tools, among them electronic data interchange (EDI), enterprise resource planning (ERP), internet, and extranets. Li grouped these tools into three groups in terms of their primary purpose: communication tools, resource planning tools, and supply chain management tools. Given this classification, two subfactors are considered in this research: communication and planning tools.

2.2.1 Communication tools

Communication tools are used to facilitate data transfer and communication between the trading parts and this might include EDI, electronic fund transfer (EFT), intranet, internet, and extranet (Li 2002). Electronic Data Interchange (EDI) is used for procurement (purchase orders, order status, and order follow-up). EDI serves as electronic catalogs for customers who can get information, dimensions, and cost about a specific product. EFT provides trading partners with an effective way to transfer funds from one account to another through a value added network (VAN) or the internet. Intranets are corporate local area networks (LAN) or wide area networks (WAN) that communicate through the internet and are secured by firewalls. Usually this type of communication tool is used inside a corporation that features different locations. On the other hand, extranet allows business to communicate and share business with external collaborators with a certain degree of security and privacy. Another type of communication tool is the internet, a uniform interface that allows global communication with the use of browsers (Bowersox et al., 2007). According to O'Neill (2008) the advances in information technology have made communication tools easier for users, allowing its presence in components to extend in the supply chain. Another significant communication tool is the internet based information and communication technology (ICT), mentioned by Tan et al. (2009). This study suggested that the use of ICT is a strategic communication tool that improves the organization's competitiveness, allowing cost reduction and permitting the company's effectiveness.

2.2.2 Planning tools

Supply chain management planning tools are intended to integrate the resource planning activities in a firm or organization. Some of the most common planning tools are: material requirment planning (MRP), manufacturing resources planning (MRPII), and Enterprise Resource Planning (ERP). A MRP is a tool that allows an organization to schedule production activities to meet specific deadlines based on the bill of materials, inventory levels, and master production schedule. An improvement of MRP tools is MRPII which integrates manufacturing capabilities and capacities with the benefits of MRP. An ERP tool allows the organization to integrate all processing information tasks related to all processes in the value chain. This is usually a single system that might include order management, inventory fulfillment, production planning, financial planning, and customer service in a company. It is the backbone of the logistic systems for a variety of firms (Bowersox et al., 2007).

Some other IT tools exist that can be used to execute or manage the various activities and relationships in the entire supply chain (Kumar 2001). These may include: data warehouse (DW), vendor managed inventory (VMI), distribution requirement planning (DRP), and customer service management (CRM).

2.3 Supply chain relationships

Supply chain relationships play an important role in achieving the firm's goals. The coordination and integration of activities with suppliers and understanding of customer's needs results in greater benefits for companies. According to Fraza (2000), supply chain management is directly related to relationship management, which includes suppliers and customers. Strategic supplier partnerships and customer relationships are main components in the supply chain management practices (Li et al., 2005), leading to information sharing, which is one of the five pillars in achieving a solid supply chain relationship (Lalonde, 1998). Two sub-factors are considered in the model relationship with suppliers and customers.

2.3.1 Relationships with suppliers

Companies are inclined to work with different suppliers in different ways. It is important that the relationship with suppliers satisfies their company needs. Hines (2004) mentioned that in commodity products, it is common to find an adversarial relationship mainly based on price between buyer and supplier. This type of relationship with suppliers does not allow for cost reduction in the supply chain. It may be beneficial to network the supplier, to develop partnerships and alliances that will benefit both partners. This could be based on production, personal, and or symbolic networking, that will turn on strategic alliances (Hines, 2004), allowing the information sharing, risk sharing, obtaining mutual benefits and coordinating plans, permitting the improvement of the supply chain.

2.3.2 Relationships with customers

The global markets offer a variety of products of different quality and cost. As a result, companies are always competing and trying to reduce costs and improve quality. According to Burguess (1998) and Hoek (1999), customers look for more choices, better service, higher quality, and faster delivery. The relationship with customers has turned a strategic issue for today’s companies.

2.4 Value-added process (manufacturing)

Value-added products can be commodity processes or products that already exist; you only have to use smart modifications and apply them. According to Bishop (1990), value-added is defined as “*adding those manufacturing or service steps to a commodity product, which the customer perceives as increasing its value*”. Customers always want to pay the cost that they think is correct, and if they get something additional to the product, they got value-added. Two factors are significant when we talk about value-added: flexibility and quality. And, as stated by Benetto, Becker and Welfring (2009), production processes contribute to improved value-added.

For example, Dramm (undated) affirms that the forest products industry is mainly focused on acquiring the highest value throughout the manufacturing process at the lowest cost, improving efficiency, quality, and productivity. Thus, it is important to include the production system as a part of the value-added process.

2.4.1 Flexibility

The complex markets, fierce competition and fast changes in demand require that companies be ready to react promptly to customers’ needs. Flexibility can be understood as the ability to react and adapt quickly to changes in the market due to an increase or decrease of customers’ requirements, accelerating or decelerating the manufacturing processes when it is requested. Bowersox, Closs, and Cooper (2007) mention that a logistical competency of a firm can be measured by how well it is able to adapt to unpredictable situations.

2.4.2 Quality

Quality is not a bonus for the customer; it is expected. Quality is also important for the acceptance of a product. High costs, low productivity, and loss of market share are directly related to poor quality (Dramm, undated). Quality is meeting or exceeding the expectations of your customer (Bishop, 1990). This could be achieved, for example, by the use of quality metrics, which improves the production system (Juran, 1988). Achieving better efficiency, quality and productivity, and acquiring the highest value of a product at lower cost will improve the business performance of a company.

2.4.3 Production system

A study made in the automotive glass business showed how changing the industrial structure of the production system adds value to processes, which will help to expand their business future (Just-Auto, 2010). This value-added could be achieved by reducing activity time, cost processes, and identifying bottlenecks that will improve the production processes. As a result, it will give value-added to the products (Mehta, 2009).

2.5 Supply Chain Management performance (SCM)

SCM performance is defined as the operational excellence to deliver leading customer experience (Simchi-Levi et al., 2003). Beamon (1999) mentions some features present in effective performance measurement systems and these include the following: inclusiveness (measurement of all pertinent aspects), universality (allows for comparison under various operating conditions), measurability (data required are measurable), and consistency (measures consistent with organization goals). Also, the strategic goals include key elements such as the measurement of resources (generally cost), output (generally customer responsiveness) and flexibility. Stevens (1990) states that to build up an integrated supply chain requires the management of material flow from three perspectives: strategic, tactical, and operational. From these perspectives, the use of systems, facilities, and people must be seen as a whole and work in a coordinated manner. He also mentions that a company can measure the supply chain performance by inventory level, service level, throughput efficiency, supplier performance, and cost. Lear-Olimpi (1999) also stated that logistics play an important role in pursuing supply chain excellence which will lead to improved business performance (Lear-Olimpi, 1999). Another critical sub-factor of successful supply chain management is the analysis of the supplier market (Purchasing, 2007). An important point according to Canbolat, Gupta, Matera and Chelst (2008) is outsourcing, which is significant in the supply chain management for the opportunities and risks that it offers. Then, this factor comprises four sub-factors logistics, supplier markets, supplier performance, and materials sourcing.

2.5.1 Logistics

Logistics is defined by Bowersox, Closs, and Cooper as "*the responsibility to design and administer systems to control movement and geographical positioning of raw materials, work-in-*

process, and finished inventories at the lowest total cost" (Bowersox et al., 2007). The research of Autry, Zacharia and Lamb (2008) establishes that logistics must be focused on the coordination and collaboration of activities, logistics social responsibility, strategic distribution planning, and technology and information systems.

2.5.2 Supplier markets

According to Yushan and Cavusgil (2006), changes in the market create sensible companies regarding firm-supplier relationship. For manufacturers it is more important to build supplier's trust and to rely on suppliers, focusing on customer orientation, competitor orientation, and inter-functional coordination. The current competitive environment makes manufacturers aware of the need to reduce costs and to develop new products quickly. This is when supplier's expertise plays an important role. Superior supply chain management requires significant information with respect to supplier markets. Implementation of strategies in the supply chain will make the precious firm-supplier relationship difficult to copy by competition (Eltantawy, 2005).

2.5.3 Supplier performance

When looking for successful supplier performance, it is important to emphasize relationship quality. Researchers such as Walter, Kaufman, and Palmatier, propose relationship quality as a "multi-dimensional construct consisting of trust, satisfaction, and commitment." Steward, Wu, and Hartley (2010) consider factors such as product quality; responsiveness to requests for change; sales, service and/or technical support; total value received; and overall cost performance as a measurement of supply chain performance. They also found that "supplier performance is higher when the supply manager perceives trust and satisfaction on the part of the supplier's account executive."

2.5.4 Material sourcing

Companies in any manufacturing sector are always looking for low-cost raw material, domestic or imported. With the objective of improving their competitive advantage, some of them see importing as an appealing option. As there are some advantages when importing resources, such as lower labor cost and lower cost of resources, there are also some disadvantages that companies have to take into account when evaluating whether or not to work with offshore companies. Importing raw materials, components or products increases the dependence on suppliers (Lockamy and McCormack, 2010), and some risks are identified such as culture, language, foreign exchange rate, regulations, quality, political and economic stability, and transportation delays (Canbolat et al., 2008).

2.6 Business management

Business management consists of leading, planning, organizing, monitoring and controlling all the involved actors and activities in a company to achieve goals and objectives. It is described by Ford and Mouzas (2010) as "*the process of managing networking between companies*". Fast changes in customer demand, globalization of markets, and changing technology require companies to focus their efforts on improving competitiveness, trying to achieve customer's satisfaction through adding more value to their products (Hung, 2010).

Thus, improving business process performance is critical for business management (Linzalone, 2008). Also, process strategy is used to improve manufacturing performance, and as result business performance (Thomas et al., 2008).

Marketing strategy is viewed by managers as a tool for improvement of their financial returns (Peterson, 1989). And innovation should be seen as part of business management, allowing the implementation of new processes, products, and services to respond promptly to customers' requirements (Leavy, 2010).

2.6.1 Process strategy

Process strategies are utilized by companies to improve their manufacturing performance and as a result business performance (Thomas et al., 2008). Sultan (2006) states that process strategy management requires the identification of objectives, the creation of policies and assignation of resources for the plan's implementation.

2.6.2 Process performance

Companies are expected to provide superior quality at low cost. To achieve these goals, they have to look for tools and strategies that help them obtain high process performance. Rework rate, defect rate, and inventory turnover rate are measures of process performance (Pakdil, 2010).

2.6.3 Marketing strategy

Marketing strategy is defined "*as an organization's integrated pattern of decisions that specify its crucial choices concerning products, markets, marketing activities and marketing resources in the creation, communication and/or delivery of products that offer value to customers in exchanges with the organization and thereby enables the organization to achieve specific objectives*" (Varadarajan, 2010).

Managers are always confronting the problem of how to implement marketing strategies in the company. It might be better to increase advertising, to create and invest in loyalty programs, and to improve product or service quality by focusing on financial returns of marketing (Rust et al., 2004).

2.6.4 Innovation

Verhees and Meulenberg (2004) mention that innovation is the creation of a new product and the process of acceptation and implementation of the new product. There are three levels at which innovation can be studied: the sectorial, regional, and project level. According to Meeus and Oerlemans (2000) innovation allows companies to growth and survive in the complex markets. Also, according to the Organization for Economic Co-Operation and Development (2005) innovation is defined as "*the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organizational method in business practices, workplace organizations, or external relations.*" Another definition of innovation was done by Schramm (2008) as "*The design, invention, development, and/or implementation of new or altered products, services, processes, systems, organizational structures, or business models for the purpose of creating new value for customers and financial returns for the firm.*"

2.7 Customer satisfaction

The customer's perception is not always the same as the product manufacturer's perception. Customers may give more value to low cost, on time delivery, delivery date certainty, or receiving a customized product (Simchi-Levi et al., 2003). According to Kurata and Num (2010), manufacturers and retailers are always looking for practical after-sales policies that will permit them to enhance customer satisfaction levels. Furthermore, an analysis conducted by Ou, Liu, Hung and Yen (2010) showed that customer-firm-supplier relationship management improves operational performance and customer satisfaction. Based on this, a sub-factor customer service is identified.

2.7.1 Customer service

The goal of the companies is to give customers the best service in an efficient and effective manner (Handfield and Nichols, 1999), without forgetting about information such as product description, product availability, order status, shipping dates, and assisting them in all what they need (Lambert and Cooper, 2000). Quayle (2006) states that customer service is defined by demand forecasting, service levels, order processing, parts/service support, and aftermarket operations.

3. Validation of factors affecting Supply Chain Management

Once factors affecting supply chain management activities have been defined, it is necessary to test the relationships among those factors. For this test, the wood pallet industry sector was selected. Wood pallets are utilized during transportation of materials, from raw materials to finished products. Their importance has grown through the years; especially with globalization. Pallet and container manufacturing is a significant part of the wood products sector in the U.S., representing an average of 5.8% of the total value of shipments, and 11.1% of participation in the wood products sector employment, from 2000 through 2008. Also, the value of product shipments (domestic production) has grown from about $5 billion dollars to $7 billion over the investigated 9-year period. The top wood pallet importers were France, Canada, and China. Even though imports have stayed almost constant throughout those years, it is necessary to look for other potential sources of wood pallet materials not only in the U.S., but also in other countries. The United States produce approximately 13%, of roundwood followed by India and China with around 9% each, and Brazil with approximately 7% of the world's roundwood. Information about the type of wood pallet material imports is limited in the literature. Also it is important to add that competition for raw material has increased. According to the RISI'S Wood Biomass Markets (2010) wood pallet manufacturers are currently competing for wood fiber with alternative energy markets, who receivesubsidies from the Biomass Crop Assistance Program (BCAP).

3.1 Hypothesis development and testing procedures

The SCM model to be tested in the wood pallet industry sector is shown in Figure 3. The constructs, hypothesis, and items were designed using the previous review of factors affecting SCM. The literature reviewed supports the factors previously mentioned, and hypotheses need to be established in order to test their significance with regression analysis. In this case we are focusing on six hypotheses which would positively or negatively affect the three main factors: supply chain management performance, business management, and customer satisfaction. For better understanding, a detailed explanation of the relationship between factors is given here: environmental uncertainties, information technology, supply chain relationship, and value-added process are affecting supply chain management. Then, supply chain management directly affects business management, which as a consequence, affects customer satisfaction. Also the hypothesized arrows represent the relationship (positive or negative) between factors. In the following paragraphs a detail of the hypotheses is shown.

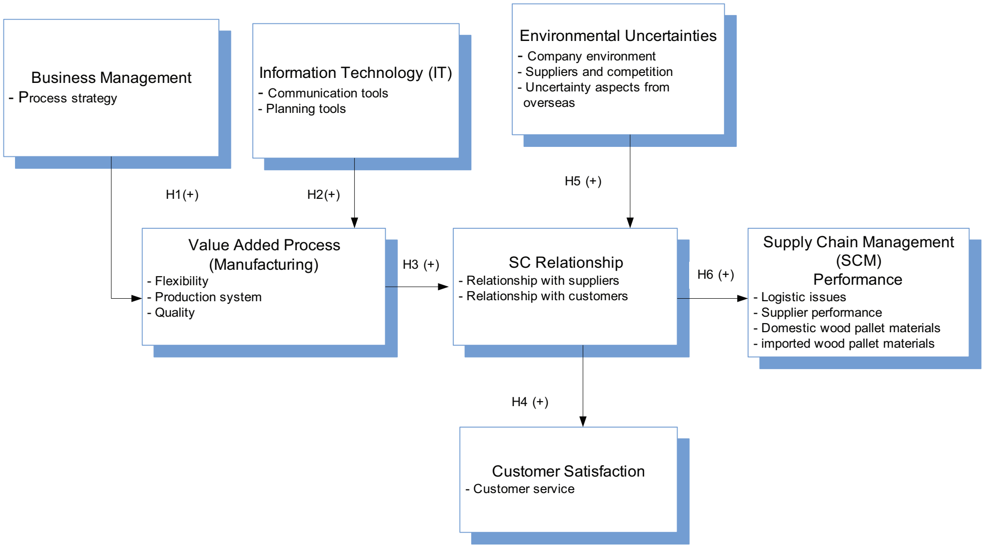

Fig. 3. Factors affecting supply chain management

Hypothesis 1 (H_1): Environmental uncertainties negatively affect supply chain management performance

The uncertainty of a business environment has many sources, including the wide variety of customer's needs. Environmental uncertainties are related to how hard it is to precisely foresee the future (Lee et al., 2009). According to Sung and Hsu (2009) supply chain performance can be influenced by environmental uncertainties, which can allow deciding about significant aggressive factors to take into account and weigh in for the formulation of a successful competitive strategy. This leads to the hypothesis:

H_1: Environmental uncertainties negatively affect Supply Chain Management Performance

Hypothesis 2 (H_2): Information Technology positively affects Supply Chain Management Performance

The use of information technology has turned companies need to utilize information technology to remain competitive. Its use in the supply chain allows transparency and more efficient collaboration. The global advancement of information technology allows companies to coordinate activities, to share information in real-time, and to put into practice electronic commerce and supply chain technology (Patterson et al., 2003). This leads to the hypothesis:

H_2: Information Technology positively affects Supply Chain Management Performance

Hypothesis 3 (H_3): Supply Chain Relationship positively affects Supply Chain Management Performance

According to Sheridan (1998), information technology is only one part of a successful supply chain management. The need to establish good supply chain relationships with internal and external members, from suppliers to customers, should be based on trust and information sharing. This leads to the hypothesis:

H_3: Supply Chain Relationship positively affects Supply Chain Management Performance

Hypothesis 4 (H_4): Value-Added Process (Manufacturing) positively affects Supply Chain Management Performance

Jones and Womack (2002) proposed the reduction of non-value-added activities at a supply chain level, because excessive inventories, transportation, and inefficient information flow are major drivers for supply chain inefficiencies. Thus, companies should reduce non-value adding processes; this will improve customer satisfaction, which is the ultimate goal of supply chain management (Lambert and Cooper, 2000). This leads to the hypothesis:

H_4: Value-Added Processes (Manufacturing) positively affect Supply Chain Management Performance

Hypothesis 5 (H_5): Supply Chain Management Performance positively affects Business Performance

There is ample support in the research for the link between supply chain management practices and business management performance (Berry et al., 1999; Mason-Jones and Towill, 1997; Towill, 1996b). Some benefits mentioned in the literature are reduced lead times, inventories and costs, and improved customer satisfaction. This leads to the hypothesis:

H_5: Supply Chain Management Performance positively affects Business Performance

Hypothesis 6 (H_6): Business Management positively affects Customer Satisfaction

Perceived quality and customer expectations are the inputs for achieving customer satisfaction. Customers focus on product value and product quality (Terblanche, 2006). According to Huber and Pallas (2006) the success formula is that all processes must be customer-oriented. Managers are always concerned about the customer's behavior, so they are always looking for strategies, methodologies, creating new products that will help the company to achieve customer satisfaction. This leads to the hypothesis:

H_6: Business Management positively affects Customer Satisfaction

To purify and test the internal reliability of the data obtained from the survey firms, Cronbach's alpha and factor analysis were used as suggested by Durham (1975), DeVellis (1991), Stevens (2002), and Field and Miles (2010). After data was purified and validated, factor scores were calculated using the method of sum by factor (DiStefano et al., 2009) to be used in multiple regression analysis. The regression model describes and assesses the relationship between a dependent variable and one or more independent variables

(Chatterjee, 2006). A general linear model is used for multiple regression models, where response Y is related to a set of qualitative independent variables. The general lineal model has the following structure (Ott, 2001):

$$Y = B_0 + B_1X_{11} + B_2X_2 + \ldots\ldots\ldots + B_\kappa X_{i\kappa} + \xi$$

Then, the main relationships between dependent and independent variables can be seen below:

- $VAPM = b_0 + b_1BM + b_2IT + \xi$
- $SCR = b_0 + b_1VAPM + b_2EU + \xi$
- $CS = b_0 + b_1SCR + \xi$
- $SCMP = b_0 + b_1SCR + \xi$

Where:

b_0 = Intersection, b_1, and b_2 = Regression coefficients, and ξ = Regression error
SCMP = Supply Chain Management Performance
BM = Business Management
CS = Customer Satisfaction
EU = Environmental Uncertainties
IT = Information Technology
SCR = Supply Chain Relationship
VAPM = Value-Added Process

3.2 Survey implementation

A pre-test is an indispensable part of the research process when carrying out a research (Hunt et al., 1982). According to Churchill (1979), the questionnaire development process has to include a pre-test. Therefore, this was conducted to evaluate the questionnaire developed in previous steps to find potential inconsistencies or errors, questions that need clarifications, and get expert's feedback to improve the research instrument, as suggested by Dillman (2000). A representative from a major trade publication, entrepreneurs, and professors reviewed the questionnaire and provided their feedback, which was used to improve the initial version of the questionnaire.

The questionnaires were sent to 1,500 companies in the US pallet industry to test the model. Once the questionnaires were returned, different inferential statistical methods were used to validate the model. Questionnaires were accompanied by a cover letter explaining the purpose of the survey and the potential benefits for the industry, and the questionnaire contained a prepaid return postage code. Two questionnaires were mailed to all companies, with a four week-separation between each mailing (Cossio, 2007; Dillman, 2000). Questionnaires were mailed during the fall of 2010. After the second mailing, a non-respondent bias assessment was conducted. The purpose of the non-response bias was to determine if there were significant differences between respondents and non-respondents. The methodology for the non-response bias compared early and late respondents; this practice is based on the assumption that there is a continuum in the likelihood to return a questionnaire from high for early respondents, to zero for non-respondents (Dalecki et al., 1993; Etter and Perneger, 1997b; Lahaut et al., 2003). Three company characteristics were selected for the non-response bias analysis: number of employees, revenue, and pallet production output.

All the responses were coded and entered into electronic spreadsheets. The statistical analysis was carried out using spreadsheet software for processing the data and presenting results, and statistical tests were carried out using SAS® and SPSS® statistical software. Excel was used to perform most of the charts elaborated during the research. Mann-Whitney test and Chi-square were used to analyze non-respondents bias, the former for interval data and the latter for categorical data.

3.3 Model testing results

Results show that there are relatively strong associations between the proposed factors as explained in the hypothesis. Table 1 shows the P values for the hypothesis test. For instance, supply chain relationships (SCR) have a positive effect on Customer Satisfaction (CS). This has been asserted in the literature by several authors. For example, Fynes et al (2005) found association between the quality of supply chain relationships and customer satisfaction, chiefly through the improvement of conformance and design quality. Improvement in customer satisfaction from supply chain collaboration can originate from several sources. For example, customer satisfaction is more likely if customers are more actively involved in the product development process or when defining order specifications (e.g., sawmills developing “custom grades” specific for pallets). Another way in which collaboration leads to customer satisfaction is when an industrial customers (e.g. pallet manufacturer) actively participates in improving the supplier’s (sawmill) internal processes (e.g., sharing improvement methodologies or even sharing costs of improvement programs).

Hypothesis	Description of Hypothesis	Model Equation	P value
H_1	Business Management (BM) positively affects Value-Added Process (VAPM)	$VAPM = b_0 + b_1BM + b_2IT + \xi$	<.0001
H_2	Information Technology (IT) positively affects Value-Added Process (Manufacturing) (VAPM)		
H_3	Value-Added Process (VAPM) positively affects Supply Chain Relationship (SCR)	$SCR = b_0 + b_1VAPM + b_2EU + \xi$	<.0001
H_5	Environmental Uncertainties (EU) positively affects Supply Chain Relationship (SCR)		
H_4	Supply Chain Relationship (SCR) positively affects Customer Satisfaction (CS)	$CS = b_0 + b_1SCR + \xi$	<.0001
H_6	Supply Chain Relationship (SCR) positively affects SCM Performance (SCMP)	$SCMP = b_0 + b_1SCR + \xi$	0.0064

Table 1. Results of model validation

Also, it was shown that Information technology (IT) has a positive effect on value-added process (VAPM). Information technology can be a powerful tool when reducing inventory (non-value adding) and improving supply chain responsiveness (value-adding). Sanders and Premus (2005) had proven the positive relationship between Information Technology capability and collaboration and company performance, as measured by, among other items, costs reduction and time performance improvement.

Value-added processes (VAPM) and supply chain relationships (SCR) are related as well (see Table 1) and line up with previous research results. Stiess (2010) for instance, supports that information sharing helps to reduce wasteful activities, specifically improving material flows and reducing inventories. Wikner et al (1991) demonstrated that high levels of information sharing result in reduced “demand amplification”, which is directly related to unnecessary inventory levels throughout the supply chain.

3.4 Practical implications

These results, although specific to a certain industry sector, can help manufacturers to have a better understanding of their supply chain management practices. Findings provide a theoretical framework for supply chain management by identifying and testing seven factors. Manufacturers could achieve improvements in supply chain performance through the effective management of critical items and factors identified in the research. Industry support organization can use the results from this research to better design technical assistance and educational programs for the wood pallet manufacturing sector.

Manufacturers should focus on the effective management of value-added process (manufacturing) since it was demonstrated that they directly affect the supply chain relationships, and as a consequence to supply chain management performance.

Manufacturers should be aware of how critical it is to communicate, and to plan jointly with suppliers. Increasing the importance of supply chain relationships and understanding the significance of this concept will increase customer satisfaction. Practitioners must realize that the flow of information in a coordinated manner, access to information and data interchangegreatly improve customer and supplier relationship. This identifies information technology as a potential area for improvement.

Manufacturers should also be aware that fast changes in customer demand, globalization of markets, and changing of technology require companies to focus their efforts on improving competitiveness by trying to achieve customer satisfaction through adding more value to their products. The implementation of process strategies will improve manufacturing performance and supply chain management performance.

4. Prioritizing success factors

The previous section identified and tested a model for supply chain management that includes seven factors. However, as the company moves forward to improve their supply chain management activities, it is important to identify which of the seven are the most critical factors that need to be improved in order to lead the firm to an overall success. In this section the authors developed a procedure to help practitioners to identify which of the previous seven factors have the highest priority.

4.1 Critical success factors

Daniel (1961) was perhaps the first one to mention critical success factors. In his paper on management of crisis in information systems Daniel pointed out that a company information system must be discriminating and selective. It should focus on "success factors". Daniel also says that in most industries there should be three to six critical success factors that determine success. Anthony, Dearden and Vancil (1972), in their work on the design of management control systems emphasized three musts for any such system:

"*The control system must be tailored to the specific industry in which the company operates and to the specific strategies that it has adopted; it must identify the critical success factors that should receive careful and continuous management attention if the company is to be successful; and it must highlight performance with respect to those key variables in reports to all levels of management.*"

Perhaps the most important contributions came from Rockart (1979) who argued that critical success factors are a key for development of information systems. Rockart's research was focused on developing a methodology for determining critical success factors. Rockart put together the ideas of Daniel, Anthony, Dearden and Vancil. Rockart suggests that every firm will have different critical success factors depending on firm's structure, competitive strategy, industry position and geographic location, environmental factors, and time factors. Rockart's (1979) original CSF methodology consisted of the following steps:

1. Three to six hour session to explain the method.
2. CSF method focuses on individual managers and on each manager's current information needs.
3. Interviews conducted in a minimum of two separate sessions.
   a. Session 1: Executive goals are recorded and CSF that underlie the goals are discussed. Interrelationships of the CSF and the goals are then talked about for further clarification and for determination of which CSF should be combined, eliminated or restated. At initial look at measures is also taken in this first interview.
   b. Session 2: Review results from session 1. Analyst will sharpen CSF and think about them.

Boynton and Zmud (1984) cited three main weakness of the CSF method. The first one has to do with the belief that the method is difficult to use. The second weakness is related to the bias introduced during the interview process. However; Munro (1983) showed that two independent analyses yielded similar results and no bias was found. The third weakness was pointed out by Davis (1979) who criticized the use of the CSF approach because it relied on managers' responses. Given these three main limitations, Boynton and Zmud stated that:

"It is not clear to what extent limitations such as these imperil the use of the CSF method. Research results and case experiences of applying CSF should eventually provide a better understanding of such issues."

Boynton and Zmud also suggest that there are two key strengths of the CSF method. First, the CSF method generates user acceptance at the senior management level, and second; the CSF facilitates a structured, top-down analysis or planning process.

Dickinson 1984 states in his research that CSF has been mainly studied for Management Information Systems (MIS). However, Munro and Wheeler (1980) suggest that CSF can be used to direct an organization's efforts in developing strategic plans besides applications in MIS. This implies that CSF can be used in a company to help achieve high performance.

Later,Kaplan and Norton (1992) accomplished what Munro and Wheeler suggested earlier - using the CSF methodology beyond the MIS scope. Kaplan and Norton described a procedure to define performance measures and CSF based on companies' strategic objectives called the balanced scoreboard procedure (BSP). BSP allows managers to look at business from four important perspectives: customers, internal, innovation and learning, and financial. As described by Kaplan and Norton (1993), the balanced scoreboard procedure consists of the following steps:

1. Preparation: Define the Scoreboard Business Unit for which a scoreboard is appropriate.
2. Interviews: First round. Senior managers receive background on the balanced scoreboard procedure, as well as documents that describe the company's vision, mission and strategy. Obtain input on tentative proposals for the scoreboard.
3. Developing the scoreboard: Top management team is brought in to develop the scoreboard. The following question is addressed: If I succeed in my vision and strategy, how will my performance differ for shareholders (customers), for internal business processes, for my ability to innovative, grow, and improve?
4. Review. Interviews with senior managers and top management to discuss further improvement of the scoreboard.
5. Implementation: Linking the scoreboard to the company databases and information systems, communicating the balanced scoreboard to the organization and facilitating the development of second-level metrics for decentralized units.

The main advantage of Kaplan and Norton BSP is that it integrates CSF with strategic objectives in a simple manner. For the BSP to be successful, the firm involved must have previously defined vision, mission and strategic objectives. Baetz and Bart (1996) defined a mission as a tool for formulating and implementing an organization's strategy. Lucas (1998) stated that a vision is necessary to trace a company's future. On the same subject, Leuthesser and Kohli (1997) mentioned that mission and vision statements are the ways in which a corporation reveals its philosophy and strategy, and Kaplan and Norton (2000) write how important it is to make sure the company strategy is understood by the entire organization in order to be successful.

Measuring whether the CSF achieved satisfactory levels of performance is an important part of this strategic process. Kaplan and Norton's (1992) BSP also provides a framework that translates company's strategic objectives into a coherent set of performance measures. Kanji (2002) also made contribution to the identification process of performance measures considering CSF. Kanji's methods show how the organization should measure performance considering both the internal processes and shareholder input. He used the Balanced Scoreboard Procedure from Kaplan and Norton as the base of his methodology. Moreover, his contribution consists of identifying specific variables when measuring performance and how those variables are related to each other.

As Kanji (2002) suggested, identification of the most important process is also a critical part when defining CSF and performance measures.

4.2 Methodology to prioritize factors in Supply Chain Management

Benchmarking in the manufacturing sector is always a difficult task to achieve for reasons such as confidentiality, time concerns, and targeted processes (what to benchmark). Most of the time the decision on what to benchmark comes directly from the top manager's point of view and that decision is arbitrarily made. There are no planning/research tools to help managers in making this decision by considering vision, mission, CSF, and key internal business processes. As was discussed in the previous section, there are methodologies that help determine CSF (Rockar 1979), to identify key performance measures (BSP of Kaplan and Norton 1992), and to prioritize what should be done first (AHP procedure and House of Quality). However, integration among those tools and procedures is necessary at this point when managers may not be certain which business process is the most critical one for the company, especially if a benchmarking exercise is on the firm horizon.

The objective of this section is to develop a methodology for determining key internal business processes firm critical success factors. This methodology should enable a company to:

1. Determine CSF and key performance measures by using Kaplan and Norton's BSP method based on vision, mission and strategic objectives statements.
2. Prioritize most important CSF according to rating scores such as cost savings, necessary improvement, and own discretion.
3. Relate CSF with internal business processes based on "strength of relationship" in order to define the most critical internal processes.
4. Compare possible differences in the perception of CSF and strategic objectives among different managing levels (higher-level managers vs. lower-level managers).

CSF to be determined should be based on each company's mission and vision as well as strategic statements. Kaplan and Norton (1996) discussed the importance of having a strategic management system to establish short and long-term goals. The balanced scoreboard procedure fits well for this purpose since mission and vision statements are translated into four dimensions that are broken down into measurable parameters in order to determine whether the firm is achieving its goals. With this in mind, the balanced scoreboard will be the starting point for prioritizing internal business processes.

Once top executives/managers have defined CSF and their key performance measures, an adaptation of the House of Quality (HOQ) (Hauser and Clausing 1988) matrix will be used (Figure 4) to prioritize CSF by importance, necessary improvement level, and cost leverage. Due to time restrictions, the urging situation of companies under study, and scope of the project; the prioritization matrix method (explained earlier) will be used to rank companies' CSF instead of the AHP procedure. In the same prioritization tool, top firm's representatives will also be asked to indicate how strong or weak is the relationship of their respective CSF to a predefined group of internal business processes (Figure 4). The mathematical description to prioritize CSF is described as follows:

$$\sum_{j=1}^{N} X_j(a_i + b_i + c_i)\text{, where i=1,2,3,..,CF} \qquad (1)$$

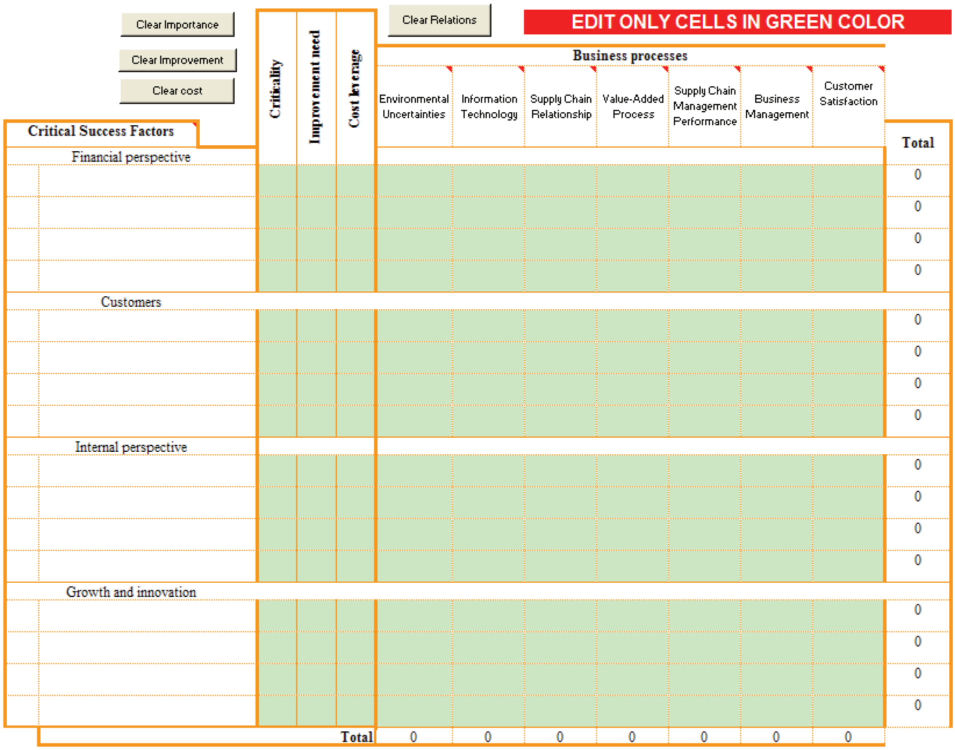

Fig. 4. Tool to prioritize SCM factors.

Definitions:

N: Number of business processes being evaluated.

X: Relationship of critical success factors with business process. Possible values are:

0 No relationship
1 Weak/possible relationship
3 Medium/moderate relationship
6 Strong relationship

a: Criticality of the critical success factor. Possible values are:

1 Low priority
3 Medium priority
6 High priority

b: If the critical success factors need improvement or not. Possible values are:

0 None needed
3 Needed

c: Cost leverage, meaning that if improvement is required then this would mean cost reduction. Possible values are:

0 No savings
1 Savings.

CF: Number of critical success factors to evaluate.

And the mathematical expression for prioritizing the internal business processes is:

$$\sum_{i=1}^{CF} X_i(a_i + b_i + c_i) \tag{2}$$

Definitions for Equation 2 are the same as for Equation 1.

This tool was applied to furniture industries in order to validate it. Companies were selected based on their ranking in the 300 Furniture Design and Manufacturing (FDM) ranking (Plantz 2003). Only furniture companies with plants or headquarters in Indiana were considered due to traveling, logistics and cost issues. Three companies agreed to participate in the study, two from the office furniture and one from the kitchen cabinet sector.

Prior to the initial face-to-face meeting, a project description was sent to the participating companies addressed to either the plant manager or the president/CEO. Next, a company visit was scheduled and divided into three sessions:

1. An executive meeting with the top executives or company president to explain the methodology to be followed (1-2 hours). The prioritization procedure was explained to the firm executives. Once the exercise was explained, an electronic version of the BSP and the prioritization tool was given to them.
2. A manufacturing plant tour guided by the respective process owners (2-3 hours).
3. A closing meeting to clarify the methodology and questions addressed during the plant tour (1/2-1 hour).

The application of the prioritizing tool was very useful to help managers to identify the critical success factors they should focus on. One weakness of this methodology is that it draws results based on perceptions that are not exactly representative of the real world. Munro (1983) commented on this apparent weakness of the CSF method and came to the conclusion that outcomes were very similar when comparing two case studies performed on the same population. It was evident that at the end, top-executives and managers were able to identify CSF, key performance measures, and most critical factors related to SCM.

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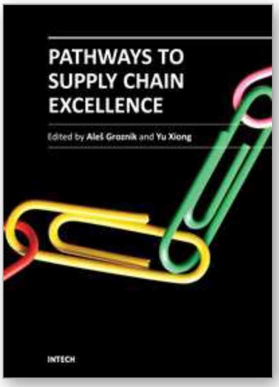

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Over the last decade, supply chain management has advanced from the warehouse and logistics to strategic management. Integrating theory and practices of supply chain management, this book incorporates hands-on literature on selected topics of Value Creation, Supply Chain Management Optimization and Mass-Customization. These topics represent key building blocks in management decisions and highlight the increasing importance of the supply chains supporting the global economy. The coverage focuses on how to build a competitive supply chain using viable management strategies, operational models, and information technology. It includes a core presentation on supply chain management, collaborative planning, advanced planning and budgeting system, risk management and new initiatives such as incorporating anthropometry into design of products.

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