Analysis of Factors Impacting Supply Chain Management in the Wood Pallet Industry

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Abstract

This paper identified and validated relationships of theoretical factors affecting the wood pallet supply chain. The lack of information regarding how wood pallet manufacturers managed their operations, relationships, and uncertainties made it significant to explore the wood pallet supply chain through the application of a nationwide survey. For this purpose, 1,500 companies were mailed questionnaires with an adjusted response rate of 13.5%. Previous research and a literature review were used to develop a theoretical research framework that included the critical factors in the wood pallet supply chain. Once the data was collected, internal reliability and exploratory factor analysis tests were performed to ascertain and reduce the data. Then a multiple regression analysis was used to test for factor relationships. Results from the framework analysis indicated that higher levels of the value-added process will lead to greater levels of supply chain relationships. Increased levels of supply chain relationships will improve the supply chain management performance. The results of this study focus on supply chain management practices in the wood pallet industry, and as such, it provides an initial model that would help as basis for future research. Manufacturers should focus on the effective management of the value-added process (manufacturing) since it was demonstrated that it directly affects supply chain relationships, and as a consequence, it also affects supply chain management performance.

Keywords: Supply chain, wood pallets, logistics.

Introduction

Lambert and Cooper (2000) stated that a supply chain is not a chain of business-to-business relationships; rather, it is a complex network that includes a variety of businesses and relationships. Innovations in transportation and information technology; deregulation, and the fall of trade barriers enables actors in the supply chain to communicate more frequently, and participate more in the decision-making process that affects the entire value stream (Espinoza 2009, Stiess 2010). The concept and management of supply chains grew in importance for all kinds of organizations as operations become more complex and global. Efficient supply chain management (SCM) provides opportunities to protect a firm's competitive advantage and improve organizational performance (Li et al. 2005). Integrating a supply chain facilitates achieving improvements in flexibility, on-time delivery, and product quality, and as a result, business performance (Rosenzweig et al. 2003).

A variety of studies have been conducted on supply chains in diverse industry sectors. For instance, researchers found that supply chain coordination issues and incentive mechanisms for investing in information technology, such as radio frequency identification (RFID), can lead to improved efficiency and supply chain security (Lee et al. 2011). Another finding was the integration of "effective flexibility," which led to a strategic supply chain decision-making process (Das 2011). Relationships between environmental uncertainty, supply chain flexibility, and firm performance also were demonstrated in the findings from a survey of 85 manufacturing companies in Germany. Here, it was found that environmental uncertainty was a critical factor and to achieve superior firm performance, greater supply chain flexibility was required. Next, a theoretical model was developed and demonstrated by using the aforementioned three factors (Merschmann and Thonemann 2011). Supply chain management is applied by companies globally due to its demonstrated results, including time reduction, better financial performance, improvements in customer satisfaction, dependable suppliers and other benefits. Also, according to D'Amours, Ronnqvist, and Weintraub (2008) the forest products industry, including the wooden pallet sector, is implementing supply chain practices to improve their performance. However, more research is needed to better understand the factors affecting SCM in this industry (White and Hamner 2005).

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Wood pallets are utilized during the 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 United States (U.S.) wood products sector, representing an average of 5.8% of the total value of shipments, and 11.1% of the wood products sector employment from 2000 through 2008. Also, the value of product shipments (domestic production) has grown from about US$5 billion to US$7 billion during the 9-year period investigated. According to findings obtained from the trade statistics database (U.S. Census Bureau 2010), the top wood pallet importers were France, Canada, and China. Even though imports have remained nearly at a constant level in this time period, it is necessary to look for other potential sources of wood pallet raw materials, not only in the U.S., but also in other countries. The U.S. produces approximately 13% of the world's roundwood for all products, followed by India and China (9% each), and Brazil (approximately 7%). Information about the type of wood pallet material imports is limited in the literature. Also, it is important to add that competition for raw materials has increased. According to the Resource Information System Inc (RISI)'S Wood Biomass Markets report (2010), wood pallet manufacturers in the U.S. are currently competing for wood fiber due to the subsidy given to alternative energy markets by the Biomass Crop Assistance Program (BCAP), leading to greater demand for low-grade lumber.

Given the necessary factors for SCM implementation and raw material consumption, the objective of this research is to identify SCM success factors and their relationships in the wood pallet industry in order to develop and implement better SCM practices. The goal of SCM is to integrate entire processes along the supply chain to satisfy customer needs and in order to fully understand how these processes can be improved is necessary to understand the factors affecting those processes. To accomplish this objective, a theoretical framework was developed based on previous research and a literature review. The framework was tested through the application of a survey of wood pallet manufacturers and different statistical tests were conducted to validate the data and to test a set of proposed hypotheses.

Factors Affecting SCM in the Wood Pallet Industry

The objective of this research was to identify and understand the relationships among different factors affecting the wood pallet supply chain processes. To better understand SCM, research was centered on the three main processes of a supply chain: raw material supply, manufacturing, and customer service as defined by the Supply Chain Council's Supply Chain Operations Reference (SCOR) model (SCC 2010). A literature review was conducted to identify a theoretical SCM framework to be used as a departing point resulting in the selection of the framework published by Li (2002). This framework included as factors SCM practice, SCM performance, information technologies, SCM relationships, SCM driving forces, competitive advantage, and organizational performance. After reviewing Li's framework factors and comparing them with newer publications in SCM and wood products, the list of factors shown in Table 1 were determined. Following, a definition of each factor is presented:

a) Environmental Uncertainties. Refers to environmental issues in the product chain (Dwivedi and Butcher 2009) and it also is defined as a lack of information with respect

Table 1. Identification of research factors and sub-factors.

Factor	Sub-factors
Environmental Uncertainties (Dwivedi and Butcher 2009)	• Company environment (Wu 2006, Ambrose et al. 2010, Chen et al. 2004) • Government support (Quayle 2006) • Uncertainty aspects from overseas (Bized 2007, Wu 2006)
Information Technology (Simchi-Levi et al. 2003)	• Communication tools (Bowersox et al. 2007, O'Neill 2008, Tan et al. 1998) • Planning tools (Bowersox et al. 2007)
Supply Chain Relationship (Hines 2004)	• Relationship with suppliers (Hines 2004, Li et al. 2005) • Relationship with customers (Burgess 1998, Hoek 1999, Fraza 2000)
Value-Added Process (Manufacturing) (Bowersox et al. 2007)	• Flexibility (Bowersox et al. 2007) • Production system (Bowersox et al. 2007, Juran 1988, Quesada and Meneses 2010) • Quality (Dramm undated, Bowersox et al. 2007, Juran 1988)
Supply Chain Management Performance (Simchi-Levi et al. 2003)	• Logistic issues (Bowersox et al. 2007, McGinnis et al. 2010) • Supplier markets (Yushan and Cavusgil 2006, Eltantawy 2005) • Supplier performance (Steward et al. 2010) • Wood pallet materials (Lockamy and McCormack 2010, Canbolat et al. 2008)
Business Management (Ford and Mouzas 2010)	• Process strategy (Thomas et al. 2008, Sultan 2006) • Process performance (Pakdil 2010, Varadarajan 2010, Rust et al. 2004) • Product innovation (Verhees and Meulenberg 2004, Meeus and Oerlemans 2000, Organization for Economic Cooperation and Development 2005, Schramm 2008)
Customer Satisfaction (Bowersox et al. 2007)	• Customer service (Handfield and Nichols 1999, Lambert and Cooper 2000)

to the external environment. It could be obtained by integrating the perceived dynamism and complexity of the environmental variables (Yanes-Estévez et al. 2010).

b) Information Technology. Includes the internal and external systems to facilitate information transfer among the actors in the supply chain (Simchi-Levi et al. 2003).
c) Supply Chain Relationship. The level of trust, mutual benefits, and achievement of goals between trading partners (Hines 2004).
d) Value-Added Process (Manufacturing). Adding manufacturing or service steps to a commodity product in which the customer perceives as increasing its value (Bowersox et al. 2007).
e) Supply Chain Management Performance. Operational excellence to deliver leading customer experience (Simchi-Levi et al. 2003).
f) Business Management. It is "the process of managing networking between companies" (Ford and Mouzas 2010).
g) Customer Satisfaction. It is defined as expectancy disconfirmation (Bowersox et al. 2007).

A literature review and Li's framework were used to define sub-factors within each factor (Table 1) and to identify the interrelationships among the factors as shown in Figure 1. It was found from the literature that information technology (IT) and business management (BM) factors might be correlated with the value added process factor. Factors such as environmental uncertainties and value-added processes might be correlated with SCM relationships. Finally, SCM relationships might impact SCM performance and customer satisfaction factors.

In order to hypothesize the directions (positive or negative) of the interrelationships in Figure 1, an additional literature review was conducted. Results indicate that the factor value- added process (manufacturing) (VAPM) positively affected by factors business management (BM) and information technology (IT). Also, it was found that the supply chain relationship (SCR) factor is positively affected by the factors of environmental uncertainties (EU) and the VAPM. Lastly, the factors of customer satisfaction (CS) and supply chain management performance (SCMP) are both positively affected by the factor supply chain relationship (SCR). Table 2 includes the dependent and independent variables to be tested for each case and also the cited literature where the direction of the relationship was found.

Methodology

To collect the necessary data to evaluate the research framework in Figure 1, a questionnaire was developed using as input the proposed research framework, a telephone interview, the previous literature review, and expert opinions. The research instrument consisted of three sections: (1) general demographic information, (2) volumes, types, and species of imported and domestic wood pallets, and (3) supply chain management factors. Section 3 included the questions that are relevant for the research presented in this paper.

Figure 1. Proposed research framework.

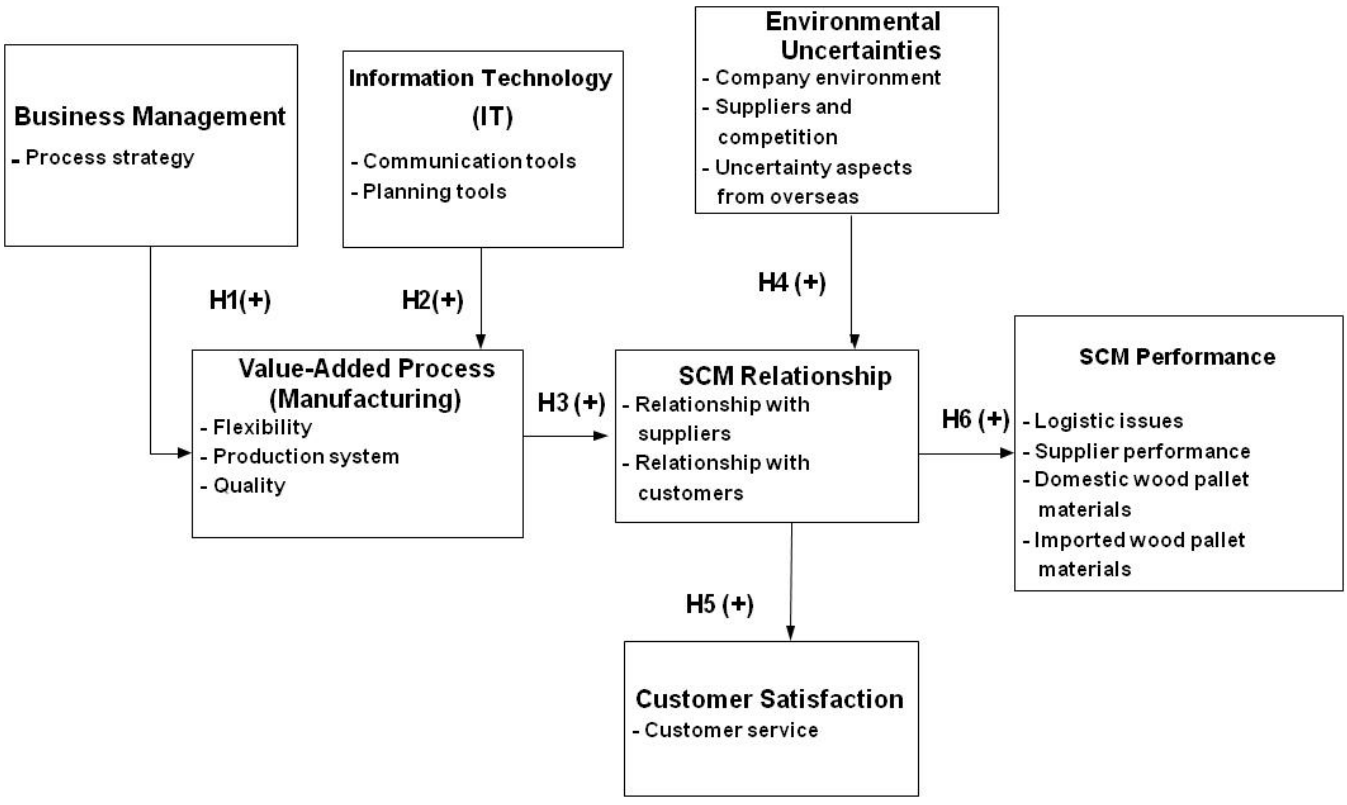

Table 2. List of hypothesis and specific literature that supports the framework.

Hypothesis	Independent Variable	Dependent Variable	Literature cited
H_1	Business Management (BM)	Value-Added Process (Manufacturing) (VAPM)	Terblanche (2006), Ford and Mouzas (2010), and Huber and Pallas (2006)
H_2	Information Technology (IT)	Value-Added Process (Manufacturing) (VAPM)	Simchi-Levi et al. (2003), and Patterson et al.(2003)
H_3	Value-Added Process (Manufacturing) (VAPM)	Supply Chain Relationship (SCR)	Jones and Womack (2002), Bowersox et al. 2007and Lambert and Cooper (2000)
H_4	Environmental Uncertainties (EU)	Supply Chain Relationship (SCR)	Dwivedi and Butcher (2009), Yanes-Estévez et al. (2010), Lee et al. 2009, and Sun et al. (2009)
H_5	Supply Chain Relationship (SCR)	Customer Satisfaction (CS)	Hines (2004), Bowersox et al. (2007), and Sheridan (1998)
H_6	Supply Chain Relationship (SCR)	Supply Chain Management Performance (SCMP)	Hines (2004), Bowersox et al. (2007), and Sheridan (1998)

A balanced-five point Likert scale was used to capture the perceptions of the surveyed companies on each of the formulated sub-factors. The scale was designed as an equally -spaced scale in order to be able to run parametric statistical analysis (Knapp 1990, Blaikie 2003). Each sub-factor was formed by a list of questions or items. The first version of the questionnaire was reviewed by academic and industry experts. Their feedback was used to improve the questions, eliminate redundancies and errors, and include some other questions or items that were considered appropriate to the objective of the research. A second version was pre-tested among some industry personnel to further improve the questionnaire. A pre-test is an indispensable part of the research process when carrying out research (Hunt et al. 1982, Churchill 1979, Dillman 2000) to find potential inconsistencies or errors, questions that need clarifications, and get experts' feedback to improve the research instrument. The questions used to capture the data for the SCM factor analysis are shown in the Appendix section.

In the fall of 2010, questionnaires were mailed to companies accompanied by a cover letter explaining the purpose of the survey and the potential benefits for the industry. The questionnaire contained a prepaid return postage code. Two questionnaires were mailed to 1,500 wood pallet manufacturers, with a four-week separation between each mailing (Cossio 2007, Dillman 2000). 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 was to compare 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.

Once the questionnaires were returned, Cronbach's alpha, Pearson correlations, principal components analysis, analysis of variance (ANOVA), and multiple-regression analysis were used for simplification and analysis of the data. Similar procedures were used by Lee (2009b), Li (2002), Li et al. (2005) and Quesada and Meneses (2010). According to Nunnaly and Durham (1975), Cronbach's alpha is frequently used as an estimation of the reliability of a multi-item measure. It also allows the measure of internal consistency, meaning the level at which items in the measurement are interrelated. It evaluates the reliability of the scale, and it could improve the scale reliability by eliminating one or more items. A Cronbach's alpha lower than 0.60 indicates poor reliability, values between 0.6 and 0.7 are acceptable (DeVellis 2003), and values equal to or higher than 0.70 indicate good scale reliability.

Exploratory factor analysis (EFA) is the mathematical model of relations of variables "to discover and to identify the latent common factor variables" (Mulaik 1987, and Suhr 2005) and as a reduction technique (Van-Aken 2007, Creighton et al. 1997). Stevens (2002) recommends the interpretation of absolute value of factor loadings greater than 0.4. This research was focused on using factor loadings greater than or equal to 0.45. Principal components analysis was used as the extraction method and an orthogonal rotation (Varimax) was employed to better distinguish the items within the factor loadings and among factors (Field and Miles 2010). In the same procedure, factor scores were calculated for further analysis. According to DiStefano, Zhu, and Mîndrilă (2009), factor scores can be calculated by using the method of sum scores by factor, this method allows researchers to obtain average scores which can be used in posterior analysis.

Once the factor scores are calculated, they will serve as input data for regression analysis. Regression analysis was used to validate the proposed model. Pearson (r) correlation analysis was carried out to explore the strength of the relationship between the factors. The scale for coefficients ranged from -1 to 1. The closer the coefficient is to one, the stronger the relationship between the variables (Younger 1979). After determining the magnitude and direction of the relationship,

regression analysis was used to describe and assess the relationship between the dependent variable and one or more independent variables (Chatterjee 2006). A general linear model was used for the multiple regression models, where the response Y is related to a set of qualitative independent variables The general linear model has the following structure (Ott 2001): $Y = B_0 + B_1X_1 + B_2X_2 + \ldots\ldots\ldots + B\kappa X\kappa + \xi$

Results

Response Rate

Out of the 1,500 questionnaires that were sent to wood pallet manufacturer firms in the U.S., 249 questionnaires were returned. Of those returned, 41 were questionnaires delivered to wrong addresses, 5 were out of business, and 1 was declined. Therefore, 202 questionnaires were considered in good shape for further analysis, a 13.5% response rate.

Results from the non-response bias assessment appear to show that larger companies were more likely to respond to this survey indicating that the conclusions from this study might only apply to medium-sized and large companies. A similar non-response bias test analysis was performed by Cumbo (2000).

Construct Analysis and Simplification

The subject's aggregate responses validated the three design sub-factors in the environmental uncertainty factor, which were named "company environment," "suppliers and competition," and "uncertainty aspects from overseas." Similar results were found by Lee et al. (2009) in the electronics sector and also by Paulraj and Chen (2007). However, two items were deleted for further analysis due to their low internal reliability scores (See Table 3). In the information technology factor, the two designed sub-factors ("communication tools" and "planning tools" with Eigenvalues 2.35 and 2.32, respectively) were retained. Eigenvalues (the variance of the factors in a standardized format, see Suhr 2005) are used to retain the latent factors if they are greater than 1. Similar results were obtained for the factor "supply chain relationships" where the two designed factors were retained for further analysis. This is similar to findings from Byoung-Chun, Yang-Kyu, and Sungbin (2011) who described that developing strategic relationships will lead to an improvement in the competitive advantage and organizational performance of the company.

Results also revealed the existence of the sub-factors "flexibility," "production system," and "quality," as part of the manufacturing value-added process factor. Their respective Eigenvalues were 3.4 (flexibility), 2.8 (production system), and 2.1 (quality). However, in the case of the supplier change management performance factor, one sub-factor had to be deleted (supplier market) for further analysis due to its low internal reliability score (0.226). Also, in this factor, the proposed factor "wood pallet materials" was divided into two variables ("domestic" and "imported wood pallet materials") as indicated by the respondents. Similar results were obtained in the factor "business management" where the sub-factors "process performance," "marketing strategy," and "innovations" had to be deleted due to their low internal reliability scores (0.437, 0.530 and 0.484, respectively). Finally, the analysis confirmed the "customer satisfaction" factor as it was proposed.

Table 2. List of hypothesis and specific literature that supports the framework.

Construct	Sub-factors		Final Cronbach Coefficient	Final factor loads	Initial # of items	Final # of items
Environmental Uncertainties	Company environment		0.613	2.218	7	5
	Government support		0.649	1.891	2	2
	Uncertainty aspects from overseas		0.628	1.513	3	2
Information Technology	Communication tools		0.759	2.358	4	4
	Planning tools		0.854	2.323	3	3
Supply Chain Relationships	Relationship with suppliers		0.838	3.600	8	7
	Relationship with customers		0.809	2.645	4	4
Value-Added Processes	Flexibility		0.768	3.449	4	5
	Production system		0.725	2.852	6	6
	Quality		0.698	2.105	4	3
Supply Chain Management Performance	Logistic issues		0.709	1.616	4	2
	Supplier markets		0.226	NA	4	0
	Suppliers performance		0.686	4.574	5	5
	Wood pallet materials	Imported wood pallet materials	0.808	3.422	13	5
		Domestic wood pallet materials		1.616		3
Business Management	Process strategy		0.702	1.541	2	2
	Process performance		0.437	NA	2	0
	Marketing strategy		0.530	NA	9	0
	Innovations		0.484	NA	2	0
Customer satisfaction	Customer service		0.870	3.657	6	6

Hypothesis Testing

To carry out the regression, each latent factor was considered and was constructed by one or more sub-factors, as previously demonstrated. Then, the average weight of each sub-factor score was used as the data input to test the significance of the regression coefficients (DiStefano et al., 2009). Moderate to higher values were found in the Pearson correlations between factors as shown in Table 4. In all cases, the direction of the correlation is positive, meaning that the increase of the independent variable will increase the dependent variable. The lowest correlation magnitude was found between the factor Supply Chain Relationship (SCR) and Supply Chain Management Performance (SCMP) with 0.392. Based on Stockwell (2008) guidelines for determining correlation between two variables, it will be considered as moderated any correlation values above 0.30 suggesting that further examination is needed.

Using the general linear model shown in Equation 1 above, multiple linear regression was used to test for hypotheses significance. For all hypothesis tests, a level of significance of 1% was used. In all cases, both the models and the parameter estimations were found to be significant or adequate as can be seen from Table 4.

Table 3. Hypothesis testing summary.

Hypothesis	Independent Variable	Dependent Variable	Pearson Correlation	Model adequacy	Parameter adequacy
H1	Business Management (BM)	Value-Added Process (Manufacturing) (VAPM)	0.432	VAPM = b_0 + b_1BM + b_2IT + ξ p<0.0001	BM p=0.0062
H2	Information Technology (IT)	Value-Added Process (Manufacturing) (VAPM)	0.556		IT p<0.0001
H3	Value-Added Process (Manufacturing) (VAPM)	Supply Chain Relationship (SCR)	0.524	SCR = b_0 + b_1VAPM + b_2EU + ξ p<0.0001	VAPM p<0.0001
H4	Environmental Uncertainties (EU)	Supply Chain Relationship (SCR)	0.468		p<0.0001
H5	Supply Chain Relationship (SCR)	Customer Satisfaction (CS)	0.607	CS = b_0 + b_1SCR + ξ p<0.0001	SCR p<0.0001
H6	Supply Chain Relationship (SCR)	Supply Chain Management Performance (SCMP)	0.392	SCMP = b_0 + b_1SCR + ξ p=0.0064	SCR p=0.0064

Discussion and Conclusions

This research was a first step to characterize the supply chain success factors in the wood pallet industry. The SCM framework was developed based on a predefined framework and adjusted with other available literature review on SCM. It was found that defining factors and sub-factors from the literature review was not an easy task because of the lack of clear definitions in the literature. However, using the SCM framework proposed by Li (2000) it was possible to identify an appropriate empirical SCM framework for wood pallet industries. The main SCM factors in the framework were defined from a literature review as "Business Management," "Information Technology," "Manufacturing Value-Added Process," "Customer Satisfaction," "Environmental Uncertainties," "Supply Chain Relationship," and "Supply Chain Management Performance." To test the framework, a survey of U.S. wood pallet manufacturers was conducted, with a sample size of 1,500 and a response rate of 13.5%. The proposed SCM framework was validated and tested through the use of statistic tools, such as Cronbach's alpha, and exploratory factor analysis (for factor structure and data reduction). Correlations among factors were also calculated, and those with high Pearson correlations (around 0.4 or higher) were subjected to hypothesis testing through the use of ANOVA to test for significance. The latter indicated that the proposed regression models were all adequate, as well as their estimators. The trends in these results compare to previous research found in the literature (Li 2002, Lee 2009). It is important to also clarify that results of this research apply only to medium and large companies given the results of the non-response bias test. It was found that environmental uncertainties directly affect supply chain relationships, and as a consequence, indirectly affect supply chain management performance. Results indicated that there are relatively strong associations between supply chain relationships and customer satisfaction (Pearson coefficient of 0.61). This also has been asserted in the literature by several authors. For example, Fynes et al. (2005) found an association between the quality of

supply chain relationships and customer satisfaction, chiefly through the improvement of conformance and design quality. Improved customer satisfaction through supply chain collaboration can originate from several sources. For example, customer satisfaction is more likely to occur if they 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 customer (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).

Results also indicated that information technology and the manufacturing value-added factors were positively correlated (Pearson coefficient of 0.56). Information technology can be a powerful tool when reducing inventory (non-value adding) and improving supply chain responsiveness (value-adding). Sanders and Premus (2005) proved that a positive relationship between information technology capability and collaboration and company performance exists, as measured by cost reduction and time performance improvement, to list a few items.

Finally, the manufacturing value-added process and supply chain relationships (Pearson coefficient of 0.52) were found to be correlated. Research supports that information sharing helps reduce wasteful activities, improved material flows, and reduced inventories (Stiess, 2010). Wikner et al. (1991) demonstrated that high-levels of information sharing result in reduced "demand variability," which is directly related to unnecessary inventory levels throughout the supply chain.

Implications for Business

This research can assist U.S. wood pallet manufacturers gain a better understanding of their supply chain management practices. The findings provide a theoretical framework for supply chain management in the wood pallet industry by measuring and studying seven key factors Manufacturers might achieve improvements in supply chain performance through the effective management of these critical factors identified. Industry support organizations can use the results from this research to design better technical assistance and educational programs for the wooden pallet-manufacturing sector.

Manufacturers should consider focusing on the effective management of value-added processes (i.e., manufacturing) since it was demonstrated that it directly affects supply chain relationships, and as a consequence, supply chain management performance. Wood pallet manufacturers should understand how critical it is to communicate, and to plan jointly with suppliers, thereby giving more consideration and credence to the supply chain relationships. Thus, through the understanding of the significance of this concept they are attaining a high level of customer satisfaction. Practitioners should conceptualize information flow in a coordinated manner, such as access to information and data interchange to improve customer and supplier relationship. This leads to the identification of information technology as a potential field for improvement. The methodology used in this research was demonstrated to be useful and can be utilized as a basis for future research in the study of supply chains.

Wood pallet manufacturers should understand that changes in customer demand occur quickly, and that the globalization of markets and changing technologies require companies to focus their efforts on improving competitiveness through attempting to meet customer satisfaction needs by adding more value to their products, processes and services. Also, producers should take into account the implementation of process strategies that will improve manufacturing performance and SCM performance.

Limitations of the Research

The non-response bias assessment indicated that very small companies were less likely to answer this survey. Therefore, the conclusions and recommendations may apply only to medium and large-sized companies. Also, this research did not include customers' perceptions, only the responses of wood pallet manufacturers.

As in all mail surveys, limitations apply to the results obtained from this study. Importantly, respondents' answers may not necessarily reflect the perspectives of other managers within the company or industry sector. Most of the results from this survey reflect company activity during 2009, when U.S. manufacturing output was at its lowest as a result of the recession that started in 2007, as measured by value of shipments. Therefore, the results of this research may reflect a considerable decline in economic activity for respondents' businesses and responses may have been influenced by the economy.

Future Research

By summarizing and considering the observations of the previous sections, recommendations for future research are presented.

- As importers from other countries (except Canada) demonstrated a certain level of participation in the market, it might be valuable to conduct research in those countries to identify opportunities to import or export more quantities and varieties of wood species.
- A research focus on the benefits gained from measuring the performance of SCM in a typical wood pallet value stream.
- This research focused on the experience and insights from the wood pallet manufacturers' perspectives, meaning that the scope was limited. A nationwide survey directed to customers and suppliers could be applied to gain a broader understanding of the supply chain, from both sides.

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Appendix: Designed Questions

Please, answer question **18** indicating the ***Origin of Your Raw Materials*** (Domestic and/or imported)

18. From the list below indicate country of origin if imported, and the percentage of each species in your total raw material input (e.g. Douglas-Fir from Canada, 50% of the raw material input) for the three most common wood species that you normally use for manufacturing pallets.

Species	Country of origin (if imported)	Share of total raw material input (board foot basis)	
Oak (red or white)			%
Maple			%
Southern Pine			%
Douglas-Fir			%
Hemlock-Fir			%
SPF (Spruce-Pine-Fir)			%
Yellow-Poplar			%
Red Alder			%
Radiata Pine			%
Eucalyptus			%
Mixed Hardwoods			%
Others (please specify)			
_____			%
_____			%
_____			%
Total		100	%

SUPPLY CHAIN MANAGEMENT FACTORS

19. Rate the following factors regarding BUSINESS MANAGEMENT. Please circle your answers.

BUSINESS MANAGEMENT											
1	2	3	4	5	N/A						
Strongly disagree	Disagree	Undecided	Agree	Strongly agree	Not applicable						
Our company forms leader groups from diverse areas for the planning and developing of the strategic business plan					1	2	3	4	5	N/A	
Our company develops strategic operation plans with suppliers					1	2	3	4	5	N/A	
Our company has reduced manufacturing processes cost in the last 3 years					1	2	3	4	5	N/A	
Inventory costs have been reduced in the last 3 years					1	2	3	4	5	N/A	
Our company offers competitive wood pallet prices					1	2	3	4	5	N/A	
Our company offers lower prices than our competitors					1	2	3	4	5	N/A	
Our company works with a differentiation strategy (produces unique products for different customers)					1	2	3	4	5	N/A	
Our company works with a segmentation strategy (categorizes its customers in groups with similar needs, and makes products to satisfy those needs)					1	2	3	4	5	N/A	
Our company produces only against firm customer orders or uses the "pull" production system					1	2	3	4	5	N/A	
Our company produces for stock replenishment					1	2	3	4	5	N/A	
Our company makes emphasis on the benefits of our product compared to our competitors'					1	2	3	4	5	N/A	
Our company offers wood pallets directly to the customer					1	2	3	4	5	N/A	
Our marketing team has a lot of experience					1	2	3	4	5	N/A	
Our company invests resources in new processes and products					1	2	3	4	5	N/A	
Our company usually hires some experts in the pallet field for improving processes and products					1	2	3	4	5	N/A	

Appendix: Designed Questions Contd.

20. Rate the following factors regarding CUSTOMER SATISFACTION. Please circle your answers.

CUSTOMER SATISFACTION											
1	2	3	4	5	N/A						
Strongly disagree	Disagree	Undecided	Agree	**Strongly agree**	Not applicable						
Our company keeps track of customer needs and asks their feedback on quality/service					1	2	3	4	5	N/A
Our company asks customers about their expectations					1	2	3	4	5	N/A
Our company makes it easier for the customers to look for assistance					1	2	3	4	5	N/A
Our company can deliver the required wood pallet quantities to the customers on time					1	2	3	4	5	N/A
Our customers are happy with the quality of the products that we offer					1	2	3	4	5	N/A
Our products are only focused on the customer's needs					1	2	3	4	5	N/A

21. Rate the following factors regarding SUPPLY CHAIN RELATIONSHIP. Please circle your answers.

SUPPLY CHAIN RELATIONSHIPS											
1	2	3	4	5	N/A						
Strongly disagree	Disagree	Undecided	Agree	**Strongly agree**	Not applicable						
Our company depends on a few reliable suppliers					1	2	3	4	5	N/A
Our suppliers give us high quality wood pallet materials					1	2	3	4	5	N/A
Our suppliers visit us frequently					1	2	3	4	5	N/A
Our company shares information with its suppliers					1	2	3	4	5	N/A
Our suppliers share information that can affect our company					1	2	3	4	5	N/A
The exchange of information between us and our suppliers is precise					1	2	3	4	5	N/A
The exchange of information between us and our suppliers is complete					1	2	3	4	5	N/A
The exchange of information between us and our suppliers is reliable					1	2	3	4	5	N/A
Our company evaluates the customer satisfaction frequently					1	2	3	4	5	N/A
Our company shares the mission, vision and objectives with its customers					1	2	3	4	5	N/A
Our company evaluates periodically the relationship with its customers					1	2	3	4	5	N/A
Our company recognizes the loyalty of actual customers frequently					1	2	3	4	5	N/A

22. Rate the following factors regarding VALUE ADDED PROCESSES (MANUFACTURING). Please circle your answers.

VALUE ADDED PROCESSES (MANUFACTURING)											
1	2	3	4	5	N/A						
Strongly disagree	Disagree	Undecided	Agree	**Strongly agree**	Not applicable						
Our company is able to manage big or small orders, according to the customer's requirements					1	2	3	4	5	N/A
Our company is able to answer quickly, to fast changes in the market, like the need of new products					1	2	3	4	5	N/A
Our company has cross-trained employees, who do several tasks					1	2	3	4	5	N/A
Our company uses state of the art technology in equipment and machinery					1	2	3	4	5	N/A
Our company is able to make fast changes in the production process to accelerate or desaccelerate the product production					1	2	3	4	5	N/A
Our company works to reduce production time					1	2	3	4	5	N/A
Our company works with indicators that measure the production process performance					1	2	3	4	5	N/A
Our company uses LEAN MANUFACTURING production principles					1	2	3	4	5	N/A
Our company uses SIX SIGMA strategy in the manufacturing process					1	2	3	4	5	N/A
Our company makes use of special software for designing pallets					1	2	3	4	5	N/A
Our company has a certification in quality system or it is in process of certification					1	2	3	4	5	N/A
Our company measures the quality of its products					1	2	3	4	5	N/A
Our company keeps track of customers feedback for the pre-sales and post-sale processes					1	2	3	4	5	N/A
Our employees (at all levels) are frequently trained and evaluated					1	2	3	4	5	N/A

Appendix: Designed Questions Contd.

23. Rate the following factors regarding INFORMATION TECHNOLOGY. Please circle your answers.

INFORMATION TECHNOLOGY											
1	2	3	4	5	N/A						
Strongly disagree	Disagree	Undecided	Agree	Strongly agree	Not applicable						
Our company has made investments in communication tools					1	2	3	4	5	N/A	
We use an internal computer network					1	2	3	4	5	N/A	
Our company has a website where customers can buy our products					1	2	3	4	5	N/A	
Our company requests wood pallet materials from suppliers through the internet					1	2	3	4	5	N/A	
Our company develops plans and strategies for information technology investments					1	2	3	4	5	N/A	
Our company is always training personnel in the use of information technologies					1	2	3	4	5	N/A	
Our company makes use of a software such as an Enterprise Resource Planning (ERP) for the company business					1	2	3	4	5	N/A	

24. Rate the following factors regarding the SUPPLY CHAIN MANAGEMENT PERFORMANCE. Please circle your answers.

SUPPLY CHAIN MANAGEMENT PERFORMANCE											
1	2	3	4	5	N/A						
Strongly disagree	Disagree	Undecided	Agree	Strongly agree	Not applicable						
When suppliers are transporting wood pallet materials, our company can check where they are exactly located					1	2	3	4	5	N/A	
Our company knows what orders are coming and when they are going to be delivered					1	2	3	4	5	N/A	
The competition for raw materials is strong in the wood pallet industry					1	2	3	4	5	N/A	
Our company prefers to work with domestic wood pallet materials rather than imported ones					1	2	3	4	5	N/A	
The cost of wood pallet materials from other countries is lower than domestic ones					1	2	3	4	5	N/A	
Our number of suppliers have increased in the last 3 years					1	2	3	4	5	N/A	
Our suppliers offer a reliable delivery					1	2	3	4	5	N/A	
Our suppliers deliver on time					1	2	3	4	5	N/A	
Our suppliers are consistent in their delivery operations					1	2	3	4	5	N/A	
Our suppliers are flexible when we request different qualities (grades) and quantities of wood pallet materials					1	2	3	4	5	N/A	
Our suppliers are able to respond quickly to our needs					1	2	3	4	5	N/A	
Our suppliers deliver materials which their properties vary greatly within the same batch					1	2	3	4	5	N/A	
Our suppliers are able to make fast changes in their production process to accelerate or desaccelerate the wood material supply					1	2	3	4	5	N/A	

25. Rate the following factors regarding ENVIRONMENTAL UNCERTAINTIES. Please circle your answers.

ENVIRONMENTAL UNCERTAINTIES											
1	2	3	4	5	N/A						
Strongly disagree	Disagree	Undecided	Agree	Strongly agree	Not applicable						
Our company works with more than 3 suppliers					1	2	3	4	5	N/A	
Our company trusts its suppliers					1	2	3	4	5	N/A	
Our company involves suppliers when planning strategic goals					1	2	3	4	5	N/A	
Our company is open to work with suppliers from other countries					1	2	3	4	5	N/A	
Competition in the wood pallet sector is strong					1	2	3	4	5	N/A	
There is a high level of communication and coordination with our suppliers					1	2	3	4	5	N/A	
Our company uses certified wood for manufacturing pallets					1	2	3	4	5	N/A	
Our company is informed by the government about important aspects that can affect our business					1	2	3	4	5	N/A	
Our company would like to work with suppliers who have availability of resources and consistency of supply					1	2	3	4	5	N/A	
Our company thinks that logistics and transportation is the number one criterion when selecting suppliers					1	2	3	4	5	N/A	
The delivery of imported wood pallet materials can easily go wrong					1	2	3	4	5	N/A	
Our company does not want to work with countries from overseas, because they tend to have a lot of social and political issues that would affect our production					1	2	3	4	5	N/A	