A Quantitative Study of the U.S. Wood Pallet Industry Based on Supply Chain Management Practices

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ABSTRACT: Pallets play an important role in the movement of goods from place to place. They are not only used in warehouses or distribution centers, but also in all those activities that require an efficient and effective method of transportation. To better understand business practices and external factors that impacts supply chain management (SCM), a survey of 1,500 U.S. wood pallet manufacturers was conducted. Main results focus on the identification of critical aspects affecting purchasing decisions, supplier relationships, internal business practices, customer satisfaction levels, and external uncertainties.

INTRODUCTION

One of the major business developments of the last decade is the emergence of supply chain management [1], [2], and [3]. A supply chain is a system constituted by materials, suppliers, facilities, and customers, connected by the flow of materials and information [4]. Globalization, advances in transportation of goods, information technology, and increasing sophistication of customers are all drivers of supply chain management, as companies no longer compete as individual entities but as part of complex networks [4]. Successful companies realize the need to work in close relationship with their suppliers and customers, pursuing the same objective: customer satisfaction [5]. Research has demonstrated that collaboration between supply chain members provides a significant competitive advantage [3]. Typical benefits from supply chain management practices are shortened lead time, reduced costs, improved design, and overall im-

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proved customer satisfaction [5]. Researchers found that an efficient supply chain begins with customer and supplier collaboration and information sharing, and with the use of advanced technology such as Electronic Data Interchange (EDI), where the appropriate information can improve companies' operations.

The U.S. wood pallet industry faces several challenges to its competitiveness; among these, the competition for wood fiber with other users [6]; competition from substitute products such as plastic and steel pallets [7]; lobby from competitors to limit their use for food safety reasons [8]; downturn in the economy, which reduces the demand for goods transported on pallets; and the fragmented nature of the industry. The industry could benefit from adopting better supply chain management practices in their strategic planning and operations, both to ensure supply of raw materials and ensure better service to customers [4].

Goal and Objectives

The goal of this paper is to identify and understand current business practices affecting the US wood pallet industry. Specific objectives are:

- Understand the main demographics characteristics of the U.S. wood pallet industry.
- Identify what factors affect purchasing decision of raw materials.
- Compare perceptions of the U.S. wood pallet industry regarding customer service activities.
- Identify what business management practices are being used today in the U.S. wood pallet industry.
- Define the most important external uncertainties that U.S. wood pallet firms face today.

METHODOLOGY

Figure 1 shows the various steps that were conducted to collect, analyze, and present data. Data was collected through a large survey that was designed and validated using secondary sources, case study research, and expert's opinions. Secondary sources were used to find production volumes, types of pallets manufactured, species of raw materials, imports, and channels of distribution in the wood pallet industry.

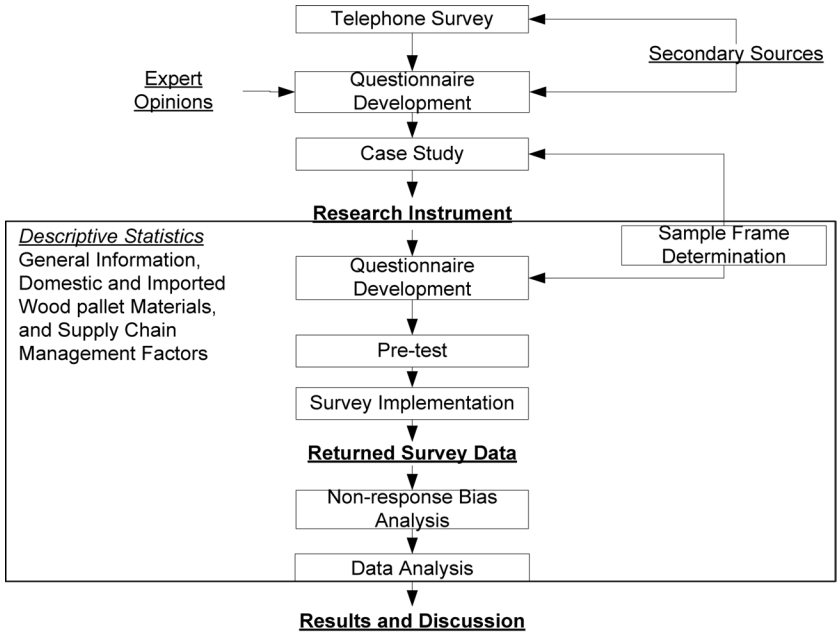

Figure 1. *Survey research methodology.*

This information was complemented with phone interviews and case study research conducted in three wood pallet industries following suggestions by Yin [9] in order to better understand factors affecting business processes in wood pallet industries.

A questionnaire was designed based on the previous inputs and it contained five main sections: (1) general information, (2) raw materials, (3) customer service, (4) business management, and (5) external uncertainties (Table 1). Questions included in the general profile and the wood pallet material sections are standard demographic questions included in similar surveys by Bush and Araman [10], Buehlmann *et al.* [11] and Hammett, Naka, and Parsons [12]. Questions included customer service, business management, and environmental uncertainties and were built considering results of interviews and case studies mentioned earlier and in addition to that, an extensive literature review was conducted as indicated (sources shown in Table 1). In a previous publication [13], the authors have validated the data using statistical techniques such as the alpha coefficient of internal reliability and exploratory factor analysis techniques.

A first draft was subject to review by experts in the academic world and industry. Their feedback was used to improve the questions, elim-

Table 1. List of Constructs and Their Items.

Section	Questions	
1. General profile	1. Type of business 2. Major products 3. Type of Customers 4. Number of employees	5. Average pallet production 6. Annual average gross sale
2. Wood Pallet Materials	1. Domestic wood pallet materials factors 2. Purchasing raw materials factors 3. Monthly raw material input 4. Average supplier's order lead time 5. Major customers 6. Wood pallet materials from overseas	7. Environmentally certified wood pallets 8. Barrier imports factors 9. Imported wood pallet materials factors 10. Comparison of domestic and overseas suppliers 11. Wood species and origin
3. Customer service [14], and [4]	1. Our company keeps track of customer needs and asks their feedback on quality/service 2. Our company asks customers about their expectations 3. Our company makes it easier for the customers to look for assistance 4. Our company can deliver the required wood pallet quantities to the customers on time 5. Our customers are happy with the quality of the products that we offer (CS5) 6. Our products are only focused on the customer's needs	
4. Business Management [15], [16], [17], [18], [19, [20], [21], [22] and [23]	1. Our company forms leader groups from diverse areas for the planning and developing of the strategic business plan 2. Our company develops strategic operation plans with suppliers 3. Our company has reduced manufacturing processes cost in the last 3 years 4. Inventory costs have been reduced in the last 3 years 5. Our company offers competitive wood pallet prices 6. Our company offers lower prices than our competitors	

(continued)

Table 1 (continued). List of Constructs and Their Items.

Section	Questions
4. Business Management [15], [16], [17], [18], [19, [20], [21], [22] and [23] (continued)	7. Our company works with a differentiation strategy (produces unique products for different customers) 8. Our company works with a segmentation strategy (categorizes its customers in groups with similar needs, and makes products to satisfy those needs) 9. Our company produces only against firm customer orders or uses the "pull" production system 10. Our company produces for stock replenishment 11. Our company places emphasis on the benefits of our product compared to our competitors' 12. Our company offers wood pallets directly to the customer 13. Our marketing team has a lot of experience 14. Our company invests resources in new processes and products 15. Our company usually hires some experts in the pallet field for improving processes and products
5. Environmental Uncertainties [24], [25], [26], [27], and [28]	1. Our company works with more than 3 suppliers 2. Our company trusts its suppliers 3. Our company involves suppliers when planning strategic goals 4. Our company is open to work with suppliers from other countries 5. Competition in the wood pallet sector is strong 6. There is a high level of communication and coordination with our suppliers 7. Our company uses certified wood for manufacturing pallets 8. Our company is informed by the government about important aspects that can affect our business 9. Our company would like to work with suppliers who have availability of resources and consistency of supply 10. Our company thinks that logistics and transportation is the number one criterion when selecting suppliers 11. The delivery of imported wood pallet materials can easily go wrong 12. 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

inate redundancies and errors, and include some items that were considered appropriate to the objectives of the research. A second version was pre-tested, and results from this pre-test were used to further improve the questionnaire. Before mailing out the questionnaires, a pre-test was conducted. A pre-test is an indispensable part of the research process when carrying out research [29], [30] to find potential inconsistencies or errors, questions that need clarifications, and get expert's feedback to improve the research instrument. To conduct the pre-test, a representative from a major trade publication, entrepreneurs, and professors were appointed to review the questionnaire and provide feedback. Once the questionnaires were improved based on the results of the pre-test, the mailing was conducted. Along with the questionnaire, a cover letter (explaining the purpose of the survey and the potential benefits for the industry), and a prepaid return postage code were mailed as well. Two questionnaires were mailed to 1,500 wood pallet manufacturers during fall 2010 with a four week-separation between each mailing [31], [32].

Data collected is presented and analyzed using nonparametric techniques and statistics. The sample was stratified by industry size following a similar procedure indicated by Mangun and Phelps [33]and all analysis was performed using the statistical software SAS. Table 1 shows only the sections of the questionnaire that are analyzed and reported in this article.

The survey management was conducted using procedures recommended in Dillman's Tailored Design Method [32] as shown in Figure 2. According to the U.S. Census Bureau, there were about 2,600 companies in the U.S. that produce wood pallets and containers in 2006 [34]. However, due to budget limitations, the sample frame was reduced to 1,500 representing approximately 57% of the total wood pallet and container companies in the U.S. To access the sample size, a list of companies was provided by a trade journal publication that specializes in the pallet industry and the mailing process was performed through a third party firm. Rea and Parker [35] recommended that the minimum of 94 respondents is necessary for a population of 3,000 (95% confidence level).

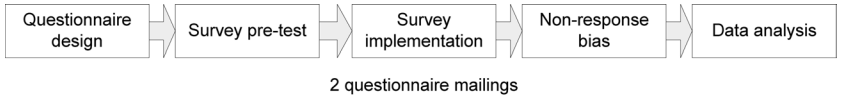

Figure 2. *Survey process.*

RESULTS AND DISCUSSION

The survey response rate was 14% (Table 2). A total of 249 questionnaires were returned but only 202 were in good shape for further analysis. Given that two mailings were made, a non-response bias analysis was carried out to evaluate if respondents tend to have different characteristics than non-respondents. To accomplish this, company characteristics of early respondents were compared to those who returned the questionnaire later [36]. Results from the non-response bias assessment appear to show that medium and large companies were more likely to respond to this survey. However, the data is grouped and analyzed by industry size in order to make the results applicable to all type of industries in this sector.

General Profile of the Industry

Results from the questionnaire indicated that firms are involved in multiple business activities. A 93% out of the 202 firms who responded to the questionnaire were manufacturers of new wood pallets, followed by 45%, which corresponded to a pallet recycler or repairer (see Table 3). Pallet broker, lumber broker and pallet material importer accounted for 8%, 5%, and 3% of respondents respectively. "Other" type of business accounted for 11%, this group included activities such as dunnage, mulch, pallet parts, wood crates, specialty boxes, survey stakes, cut stocks, grade lumber or run their own sawmill.

When companies were asked to report their more important products for year 2009, new wood pallet production was pointed out as their lead activity, followed by recycled/repaired wood pallets in small and large industries (Table 4). The third most important activity for small and large industries is lumber production. Recycle/repaired wood pallet

Table 2. Response Rate.

Description	Quantity
Initial mailing	1,500
Returned questionnaires, and useful for data analysis	202
Returned questionnaires, but were out of business	5
Returned questionnaires, but declined to fill out	1
Undeliverable	41
Non-respondents	1,251
Adjusted response rate	14%

Table 3. Industry Type of Respondents.

	Frequency by Type of Business			
Type of Industry	**0 < Employees < 20 (total of 109)**	**20 ≤ Employees < 100 (total of 78)**	**100 < Employees (total of 15)**	**%**
Manufacturer of new pallets	102	71	15	93%
Pallet material importer	4	1	0	2%
Pallet recycler or repairer	36	46	9	45%
Lumber broker	4	5	0	4%
Pallet broker	6	9	2	8%
Other type	13	8	2	11%

production is the lead activity for medium size firms. Similar results were obtained in the research conducted by Bush and Araman ([10] and [37]) where 57% of companies reported new wood pallet production as their primary activity.

In terms of wood pallet production (Table 5), results indicate that small, medium, and large industries produced 135,276, 982,707, and 4,134,888 units respectively during 2009. Bush and Araman [10] indicated in their 2008 report that production per firm was 512,533 units for 2006 (as an aggregate for all industries).

Annual average gross sale for 2009 indicates that 43% of respondents reported having gross sales from 1 to 5 million dollars, followed by 35% indicating less than 1 million dollars in revenue, and 12% between 5 to 10 million dollars. Eight percent reported to have annual revenue between 10 to 20 million dollars, and 3% reported more than 20 million dollars in the same category. Surveyed firms were also asked

Table 4. Most Important Products by Companies.

	Most Important Products (7 most important, 1 less important)		
Type of Industry	**0 < Employees < 20**	**20 ≤ Employees < 100**	**100 < Employees**
New wood pallets	7	7	7
Wood pallet parts	4	6	1
Recycle/repaired wood pallets	6	5	6
Lumber	5	3	5
Railroad ties	3	2	2
Wood containers	2	4	3
Others	1	1	4

Table 5. Pallet Production in Units.

	Frequency by Type of Business			Kruskall-Wallis test
Type of Material	0 < Employees < 20	20 ≤ Employees < 100	100 < Employees	p-value
Pallet production in units (sample size)	135,276 (90)	982,707 (69)	4,134,888 (11)	< 0.0001

to report back their sales by type of customers (Table 6). On average, small, medium, and large firms reported that 84%, 75%, and 79% of their sales come from manufacturers in that order. Second most important customer for small wood pallet firms are retailers and pallet brokers with 49% of sales in both cases. For medium size and large wood pallet firms, the second most important customer is distributors. A nonparametric test was conducted to compare the mean percentage of each group with a 0.05 significance level. The mean percentages were statistically significant for retailers, pallet brokers, and for manufacturers as indicated in Table 6.

Wood Pallet Materials

Data about species used was also collected in order to learn about the wood pallet market (see Table 7). Approximately 50% of respondents answered this question (no comparison between groups is presented here). Mixed hardwoods had the highest percentage in the mix (27.3%), followed by oak and southern pine, with around 16% each; spruce-pine-fir followed with 12.7%, yellow poplar with 8.1%, maple with 4.7%, and Douglas fir with 4.3%. "Other" species (4%) included aspen, larch, ponderosa pine, black ash, lodgepole pine, cottonwood and cedar. This

Table 6. Type of Customers.

	Distributor	Retailer	Pallet Broker	Government (GSA, DOD)	Manufacturer	Other
Industry Size	Mean (as % of total sales)					
0 < Employees < 20	30%	49%	49%	26%	84%	24%
20 ≤ Employees < 99	23%	14%	18%	11%	75%	12%
100 < Employees	16%	7%	9%	4%	79%	10%
Kruskall-Wallis test (p value)	0.83	0.03	< 0.0001	0.77	0.004	0.63

Table 7. Species and Source of Wood Pallet Materials.

		Source (percent of respondents)		
Species	**% in mix**	**Domestic**	**Canada**	**Other Countries**
Mixed Hardwoods	27.3%	87%	13%	
Oak (red or white)	15.8%	92%	8%	
Southern Pine	15.5%	100%		
SPF (Spruce-Pine-Fir)	12.7%	27%	73%	
Yellow-Poplar	8.1%	92%	8%	
Maple	4.7%	79%	21%	
Douglas-Fir	4.3%	60%	40%	
Others	4.0%	55%	45%	
Hemlock-Fir	3.3%	82%	18%	
Red Alder	1.2%	86%	14%	
Eucalyptus	0.4%			100%
Radiata Pine	0.2%			100%

hardwood/softwood split compares quite well to 63.6 percent (by volume) hardwood and 36.4 percent softwood material in 2006 reported by Araman, Bush, and Hager [38]. It was also found that some companies import SPF from Canada as well as eucalyptus and radiata pine from South American countries like Chile, Brazil, and Uruguay. The amount of pallet wood imported from Canada is very impressive.

When industries were asked about the percentage of new or recycled materials for the production of recycled pallets, results show that small and large industries use more new materials than recycled ones (see Table 8). The opposite trend was found in medium size industries where it was indicated that a majority of recycled material is preferred over new materials. According to Bush and Araman [10] and Brindley [39], the production of recycled wood pallets has shown an increase due to their advantages in cost, and technical characteristics compared to new wood pallets.

Supply of pallet materials is an important issue for wood pallet man-

Table 8. Type of Materials Used for Production of Recycled Pallets.

	Percentage (sample size)			Kruskall-Wallis Test p-value
Type of Material	**0 < Size < 20**	**20 ≤ Size < 100**	**100 < Size**	**p-value**
New wood materials	68.1% (37)	47.3% (46)	57.6% (11)	0.04
Recycled materials	54.5% (40)	62.5% (50)	46.6% (10)	0.42

Table 9. Perceptions Regarding Local Supply of Wood Pallet Materials.

Perceptions Regarding Local Wood Pallet Materials Supply	Mode (sample size)			Kruskall-Wallis Test p-value
	0 < Employees < 20	20 ≤ Employees < 100	100 < Employees	
Domestic wood pallet materials supply is not consistent	Agree (96)	Agree (78)	Agree (14)	0.91
Domestic wood pallet materials supply is not delivered on time	Disagree (96)	Disagree (77)	Disagree (13)	0.16
Transportation is a problem when acquiring wood pallet materials	Disagree (95)	Disagree (77)	Disagree (13)	0.89
Suppliers cannot give us information about where wood pallet materials are located when transported	Disagree (87)	Disagree (74)	Disagree (14)	0.53
Domestic wood pallet materials are of high quality	Agree (97)	Undecided (78)	Agree (14)	0.41

ufacturers. Respondents were asked to rate in a Likert scale (1 = Strongly Disagree, 2 = Disagree, 3 = Undecided, 4 = Agree, and 5 = Strongly Agree) their perceptions in factors related to the supply of local materials for pallet manufacturing (Table 9). All groups seem to agree that supply of pallet materials is not consistent. However, all groups agree that local suppliers deliver on time, provide good means of transportation and material traceability features. In general, respondents believe that the quality of the materials provided by suppliers is of high quality. Comparisons across groups were not statistically significant (using a nonparametric test with a 0.05 significant level), meaning that answers by group can be treated as the same.

It is also critical to understand what factors affect purchasing decisions of pallet raw materials. A total of 16 questions in this regards were asked to the survey participants in a Likert format scale as shown in Table 10. In some of the cases responses were statistically significant across groups (by industry sizes) after conducting an independent sample test comparison using the nonparametric Kruskall-Wallis test (significant level of 0.05). A comparison across items was not conducted in order to statistically compare each item against others. However, the mode will be used to rank the level of importance across the items.

Cost, quality, reliable supplier, delivery on time, and availability of materials received the highest scores among all the factors (comparing the modes with no statistical test across items). The wood pallet industry is very sensitive to these factors, specially to cost, quality, and material availability given the impact on manufacturing costs and to the end product quality. Supplier reliability has become an important issue while reliable transportation and delivery on time are also critical issues that impact not just the manufacturing cost but also customer satisfaction issues. In this specific case, industries were also asked to report on their supplier's delivery time. Small companies indicated that on average it takes 7.26 days, 7.44 days for medium size firms, and 7.57 days for large firms as the time it takes their suppliers to receive an order. The nonparametric test indicates no difference between the mean responses of each group (using a 0.05 significance level and group sizes of 89, 73 and 13 for small, medium, and large industries respectively).

In second place (comparing by the mode, not statistically test) factors were ranked machinability, mechanical properties, durability, strength, stiffness, density, logistics and transportation, workmanship, and species. These factors are mostly technical aspects related to the physical properties of the raw material which is different from the pre-

Table 10. Rating of Factors Affecting the Materials Purchasing Decision Process.

Factors Affecting Purchasing Decisions of Raw Materials	Mode* (group size)			Kruskall-Wallis test
	0 < Employees < 20	20 ≤ Employees < 100	100 < Employees	p-value
Machinability	Agree (87)	Agree (69)	Agree (13)	0.35
Mechanical properties	Agree (77)	Agree (62)	Undecided (12)	0.42
Durability	Agree (94)	Agree (74)	Agree (14)	0.43
Strength	Agree (97)	Agree (74)	Agree (14)	0.17
Stiffness	Agree (90)	Agree (72)	Agree (14)	0.88
Density (specific gravity)	Agree (89)	Agree (71)	Agree (14)	0.07
Environmental certified	Undecided (87)	Undecided (71)	Strongly disagree (13)	0.07
Cost	Strongly agree (103)	Strongly agree (77)	Strongly agree (14)	0.23
Availability	Strongly agree (101)	Strongly agree (76)	Strongly agree (14)	0.43
Quality	Strongly agree (102)	Strongly agree (76)	Strongly agree (14)	0.93
Reliable Supplier	Strongly agree (102)	Strongly agree (76)	Strongly agree (14)	0.88
Delivery on time	Strongly agree (100)	Agree (75)	Agree (14)	0.31
Logistics and transportation	Agree (93)	Agree (75)	Agree (14)	0.55
Workmanship	Agree (95)	Agree (74)	Agree (13)	0.21
Species	Agree (93)	Agree (73)	Agree (13)	0.49

*Measured using a five point interval Likert scale where 1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, and 5 = Strongly Agree.

vious factors that more closely related to business aspects. It would be interesting to conduct an item reduction procedure, such as principal component analysis (PCA), to be able to compare business and technical factors affecting purchasing decisions. However; this potential test falls outside of our objectives.

The results of the industry perception on the importance of environmental certified raw materials when making purchasing decisions is very interesting given the attention that sustainability and environmental issues are receiving today. Small and medium size firms seem to be undecided on this item but large size industry responded that environmental certified products is not a factor affecting purchasing deci-

sions. Survey participants were specifically asked if they believe their customer will pay more for environmentally certified products (a nominal question, Yes or No) and the aggregate answer was 86% No and 14% Yes. Respondents indicated that the main reasons given by their customers for not purchasing these types of products are price (70.7%) and low demand (10.5%). In contrast, the most important driver for demanding environmentally certified products is when certified products is a requirement. It is not a requirement and this will (or may) not change until pallet customers demand environmentally certified pallet materials.

Although the majority of respondents purchased raw material from domestic suppliers, surveyed firms who imported raw materials (cants, lumber or pallet parts) were asked to rate barriers to the import process as shown in Table 11. Price, tariffs, paperwork, government policies,

Table 11. Rating Barriers Affecting the Imports of Cants, Lumber, and Wood Pallet Parts.

Factors Affecting Purchasing Decisions of Raw Materials	Mode* (group size)			Kruskall-Wallis test
	0 < Employees < 20	20 ≤ Employees < 100	100 < Employees	p-value
Price	Agree (41)	Strongly agree (56)	Strongly agree (10)	0.04
Tariffs	Agree (40)	Undecided (52)	Strongly disagree (9)	0.01
Paperwork	Agree (39)	Undecided (53)	Disagree (10)	0.05
Quality	Undecided (41)	Agree (56)	Disagree (9)	0.18
Language	Undecided (40)	Undecided (53)	Disagree (9)	0.13
Delivery on time	Agree (42)	Agree (56)	Agree (9)	0.21
Logistics and transportation	Agree (41)	Agree (53)	Agree (10)	0.83
Production capacity	Undecided (39)	Undecided (54)	Undecided (9)	0.73
Government policies	Agree (40)	Undecided (54)	Undecided (9)	0.005
International treaties	Undecided (38)	Undecided (53)	Strongly disagree (9)	0.005
Past experiences	Undecided (31)	Undecided (51)	Disagree (9)	0.75
Phytosanitary requirements	Undecided (38)	Undecided (53)	Undecided (9)	0.04
Payment methods	Undecided (40)	Undecided (54)	Agree (9)	0.37

*Measured using a five point interval Likert scale where 1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, and 5 = Strongly Agree.

and international treaties seem to be different for each group. Large and medium size firms believe that price is a strong barrier. Medium and large size firms perceive tariffs as a barrier while medium size firms are undecided in this item. It is interesting to see that large industries did not perceive paperwork as a barrier as is the case of small firms. This leads one to believe that large firms have more experience with international suppliers than small and medium large firms. Other factors such as government policies, international treaties, and phytosanitary requirements were also statistically significant. While small companies believe that government policies have an impact on the import of raw materials, large and medium companies are not clear about this item. However, large firms clearly indicate that international treaties are not a barrier and it might be perceived as an opportunity to source materials from overseas with competitive conditions. Surveyed firms were also asked to compare (Kruskall Wallis test with a 0.05 significance level) local and international suppliers in a few categories but in any of the four categories (technical performance, better customer service, meeting technical specifications, and easier to do business with) there were no statistical significances. In summary, none of the groups (small, medium and large) perceived international suppliers as better than local suppliers in the four categories mentioned above.

Business Management

Wood pallet companies were asked about their perception on a series of items (see Table 1, Section 3, 4 and 5) categorized as customer satisfaction, business management, and external factors. A balanced-five-point Likert scale was designed to capture the companies' perception. Given that Likert scales are in nature ordinal, nonparametric techniques are used to analyze and present the data [40]. As a measure of central tendency, the mode is used and for each item the frequency for each score is calculated as well. Data is segmented by industry size following a similar procedure by Mangun and Phelps [33]. The Kruskal Wallis statistic (a nonparametric test) is used to test for item differences by company size and the mean scores of the Wilcoxon Scores test (not shown) are used to break the ties when differences are detected (see Table 12).

Survey firms were asked their perception on 15 items related to general business management aspects including strategy, operating planning, marketing, investments, and inventory management. In terms of

Table 12. Perceptions on Business Management Issues.

Business Management Issues	Mode* (group size)			Kruskall-Wallis test
	0 < Employees < 20	20 ≤ Employees < 100	100 < Employees	p-value
1. Our company forms leader groups from diverse areas for the planning and developing of the strategic business plan	Disagree (64)	Neutral (64)	Agree (13)	0.09
2. Our company develops strategic operation plans with suppliers	Agree (78)	Agree (68)	Agree (13)	0.02
3. Our company has reduced manufacturing processes cost in the last 3 years	Agree (91)	Agree (73)	Agree (15)	0.007
4. Inventory costs have been reduced in the last 3 years	Agree (91)	Agree (75)	Agree (15)	0.05
5. Our company offers competitive wood pallet prices	Agree (97)	Agree (74)	Agree (15)	0.70
6. Our company offers lower prices than our competitors	Neutral (95)	Neutral (76)	Agree (14)	0.03
7. Our company works with a differentiation strategy (produces unique products for different customers)	Agree (90)	Strongly Agree (73)	Agree (15)	0.16
8. Our company works with a segmentation strategy (categorizes its customers in groups with similar needs, and makes products to satisfy those needs)	Agree (79)	Neutral (68)	Agree (14)	0.93
9. Our company produces only against firm customer orders or uses the “pull” production system	Agree (88)	Agree (70)	Agree (14)	0.73
10. Our company produces for stock replenishment	Agree (84)	Agree (72)	Agree (13)	0.34
11. Our company places emphasis on the benefits of our product compared to our competitors’	Agree (91)	Agree (73)	Agree (14)	0.5
12. Our company offers wood pallets directly to the customer	Strongly Agree (99)	Strongly Agree (76)	Strongly Agree (15)	0.05
13. Our marketing team has a lot of experience	Agree (82)	Agree (72)	Agree (15)	0.3
14. Our company invests resources in new processes and products	Agree (86)	Agree (74)	Agree (15)	< 0.0001
15. Our company usually hires some experts in the pallet field for improving processes and products	Disagree (78)	Neutral (96)	Strongly Disagree (15)	0.31

*Measured using a five point interval Likert scale where 1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, and 5 = Strongly Agree.

strategy (items 1, 2, 7, and 8 in Table 12), there was statistical significance only for item 2 in this category. The Wilcoxon score for item 2 shows that large firms have better strategic planning than small and medium firms related to supplier practices. Item 1 (not statistically significant) shows low perceptions for small and medium enterprises, indicating perhaps that large firms are most used to strategic planning.

In regards to the manufacturing category (items 3, 9, and 15) only one item was found statistically significant between groups. By looking at the Wilcoxon scores to break this tie, it shows that large corporations are more sensitive of cost reduction than small and medium size corporations. The item pull production system is ranked equally in three groups (ranked as "agree") and the item consulting services for process improvement is the same in three groups but received low perception rankings (ranked "strongly disagree" in large firms, "undecided" in medium firms, and "disagree" in small firms). This result might indicate that wood pallet industries do not hire many consultants to help them with process improvement projects. These results in terms of manufacturing are consistent with the results obtained from a study by Buehlmann *et al.* [11] in the hardwood industry (a supplier to the wood pallet industry), where manufacturing issues such as quick delivery and just in time delivery were the highest rated services in the sector.

The items related with the category marketing are items 6, 11, 12, and 13. In this category, only items 6 and 12 were found statistically significant. It appears that large size industries perceive their product offerings are a lower price than competitors. The other difference was found with item 12, direct selling to customers. By looking at the Wilcoxon scores to break the tie, it appears that medium size firms perceive their capabilities to offer direct marketing of higher rank compared to small and large size firms. Finally, the three groups all agree that they all place emphasis in marketing their products as superior than their competitors.

Regarding investments (item 14), the nonparametric test shows statistically significant among the three groups. Large firms have the highest Wilcoxon scores, followed by medium size and small size firms. This indicates that large firms have better tendencies to invest in improvement of products and processes. The last category in Business management (Table 12) is inventory management (items 4 and 10), Item 4, inventory cost reduction, was found statistically significant. The Wilcoxon scores show that large firms put more attention on this issue followed by medium and small firms in that order. Item 10, stock

replenishment production, was perceived equally by all three groups where they all ranked it as agree. This might be an indication that wood pallet firms manufacture their products following a make-to-stock traditional scheme with little involvement in just in time strategies.

Customer Service

In terms of the items grouped under the category customer service, results show that there is no statistically significance in the perception of the items by industry size (Table 13). For all items, the mode is greater than 4, indicating that all industries at least agree with the statement in each item. Customer service was also identified as the most critical aspect in research by Marwaha *et al.* [41] and Jeffrey and Wesley [42] with quality as the crucial element to achieve customer satisfaction. Also, Dunn *et al.* [43] indicated that customer service is one of the most important manners to achieve company success. Buehlmann *et al.* [11] also found that manufacturers are looking to improve customer service and have realized that orders are no longer in large quantities of the same material, but they are increasingly requiring small quantities of a variety of materials or products. Results on the perceptions of the industry related to customer satisfaction indicate in general that the industry have a good relationship with their customers, they understand customer requirements, and the industry is committed to continue focusing on the customer's needs to increase their performance.

External Factors or Uncertainties

An understanding on external factors affecting the wood pallet industries is also necessary. Table 14 presents a list of items that were asked to the surveyed firms. Items were grouped by company size and a nonparametric statistics test (Kruskall Wallis with a 0.05 significance level) was used to compare the responses among the groups. The mode was used to present the rankings by group and in the case of ties when there is statistical significance, the Wilcoxon scores are used to find the ranking order.

Items in external uncertainties were categorized in supply chain management, competitiveness, policy and government, environmental issues. Items grouped in the category supply chain management are items 1, 2, 3, 4, 6, 9, 10, and 11. In this category items 1, 3, 4, 9 and 10 were found statistically significant. By looking at Wilcoxon scores,

Table 13. Comparison by Industry Size of Items in the Section Customer Service.

Customer Service Items	0 < Employees < 20		20 ≤ Employees < 100		100 < Employees		Kruskal-Wallis statistic (p value)
	Group Size	Mode (freq)	Group Size	Mode (freq)	Group Size	Mode (freq)	
1. Our company keeps track of customer needs and asks their feedback on quality/service (CS1)	98	Agree (50)	75	Agree (51)	15	Agree (47)	0.46
2. Our company asks customers about their expectations (CS2)	100	Agree (56)	76	Strongly Agree (49)	15	Agree (60)	0.18
3. Our company makes it easier for the customers to look for assistance (CS3)	92	Agree (46)	76	Agree (45)	15	Strongly Agree (47)	0.63
4. Our company can deliver the required wood pallet quantities to the customers on time (CS4)	101	Strongly Agree (63)	76	Strongly Agree (74)	15	Strongly Agree (53)	0.23
5. Our customers are happy with the quality of the products that we offer (CS5)	101	Strongly Agree (60)	76	Strongly Agree (55)	15	Agree (67)	0.19
6. Our products are only focused on the customer's needs (CS6)	99	Strongly Agree (50)	76	Agree (46)	15	Agree (73)	0.24

*Measured using a five point interval Likert scale where 1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, and 5 = Strongly Agree.

it was found that large companies rank higher (strongly agree) than medium and small size firms in regards of having multiple suppliers (item 1). The involvement of suppliers in developing strategies (rank as agree) and an openness to work with international supplier (rank as agree) were also items that rank higher for large size industries than for the other two. A similar outcome was found for item 9, partnership with consistent suppliers, where large size industries have the largest score (rank as agree). Item 10 (all "disagree," statistically significant) is an indication that industries in the wood pallet industry consider other factors than transportation and logistics aspects to select suppliers. In this particular case, small firms rank the highest (using the Wilcoxon scores) than medium and large in that order.

Items 2 and 6 (trust and communication with supplier) in the supply chain management category were ranked by each group as "Agree" with no statistical significance among the groups. These results might be an indication that in the wood pallet industry there is a strong sensitivity to partner and collaborate with suppliers. Also, the lower ranks in the supply chain management items found in small and medium firms (where statistical significance was found) might be due to the fact that supply chain management is a complicated matter as its concepts are better understood and practiced in large size industries. In this category, it was interesting to see that small and medium firms rank item 11 (inconsistency with delivery of import materials) as undecided and the large group ranked as Disagree. Although there was not statistical significance found for this item, this could be an indication that large firms have more experience with imports than the other two groups.

In terms of the category of competitiveness (item 5) groups large and medium strongly agree with the statement that competition in the wood pallet sector is strong. The group small firms ranked this statement as "agree." However, statistical significance was not found in this item. Regarding the category policy and government where items 8 and 12 are grouped it was found that item 8, government communications, is not statistically significant. In all cases, this item is ranked as "disagree" indicating that the wood pallet industry has the perception that the government does a poor job in communicating important information to the industry. Item 12, overseas political conflicts, reflect that large size firms have more experience in working with suppliers in other countries than small and medium size industries (significant at 0.05 significance level).

The last category, certified products (item 7), reflects earlier findings (Table 10) where there is little interest in the sector for the use of en-

Table 14. Comparison by Industry Size of Items in the Section External Factors.

External Uncertainties	Mode Response (group size)			Kruskall-Wallis test (p value)
	0 < Employees < 20	20 ≤ Employees < 100	100 < Employees	p-value
1. Our company works with more than 3 suppliers	Agree (97)	Strongly agree (73)	Strongly agree (14)	0.002
2. Our company trusts its suppliers	Agree (99)	Agree (73)	Agree (14)	0.74
3. Our company involves suppliers when planning strategic goals	Agree (89)	Agree (71)	Agree (14)	0.05
4. Our company is open to work with suppliers from other countries	Agree (88)	Agree (71)	Agree (12)	< 0.0001
5. Competition in the wood pallet sector is strong	Agree (104)	Strongly agree (73)	Strongly agree (15)	0.15
6. There is a high level of communication and coordination with our suppliers	Agree (4)	Agree (4)	Agree (14)	0.25
7. Our company uses certified wood for manufacturing pallets	Disagree (92)	Agree (68)	Strongly dis-agree (12)	0.75
8. Our company is informed by the government about important aspects that can affect our business	Disagree (94)	Disagree (71)	Disagree (13)	0.40
9. Our company would like to work with suppliers who have availability of resources and consistency of supply	Agree (95)	Strongly agree (73)	Agree (14)	0.01
10. Our company thinks that logistics and transportation is the number one criterion when selecting suppliers	Disagree (95)	Disagree (73)	Disagree (14)	0.03
11. The delivery of imported wood pallet materials can easily go wrong	Undecided (79)	Undecided (67)	Disagree (14)	0.35
12. 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	Undecided (79)	Undecided (66)	Strongly disagree (13)	0.0003

*Measured using a five point interval Likert scale where 1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, and 5 = Strongly Agree.

vironmentally certified materials for the manufacturing of wooden pallets. There were no statistical significances found in this item. However, large companies ranked the item as "strongly disagree" and small and medium as "disagree" and "agree."

CONCLUSIONS

The objective of this research was to identify and understand current business practices affecting the U.S. wood pallet industry in five main categories: general information, raw materials, customer service, business management, and external uncertainties. Information was collected through a nationwide survey of 1,500 companies. A total of 202 usable responses were received, yielding an adjusted response rate of 14%, and representing 8% of U.S. wood pallet and container manufacturing according to the U.S Census Bureau [34]. A non-response bias evaluation concluded that medium and large companies (measured by number of employees, gross sales, and pallet output) were more likely to respond to the survey. Data was analyzed using nonparametric procedures and presented by industry size.

It was found that small companies reported for 2009 an average production of 135,276 units, while medium size reported 982,707 units, and large companies 4,134,888 units. Previous research by Bush and Araman [10] had reported 512,533 production units in 2006 as an aggregate. It is difficult to conclude a trend for 2009 production given that the scales are different for each study.

Not many industries reported to purchase raw pallet materials (cants, lumber or pallet parts) from international suppliers. In those cases, the raw materials came mostly from Canada (Spruce, pine, fir, Douglas fir) and from South America (eucalyptus and radiata pine). However, surveyed industries were asked about their main known barriers to import pallet raw materials. Most of the answers from small and medium enterprises show that they are "undecided" and could not tell what factors might be critical or not leading to conclude that mostly large size firms are purchasing raw pallet materials from international suppliers. Large companies indicated that price and tariffs are critical for imports while paperwork, quality, and language are not considered a barrier. This information could be very useful for small and medium size firms that wish to start purchasing raw pallet materials to overseas suppliers.

When industries were asked about their perception regarding local suppliers, in general the surveyed firms had an acceptable opinion of

local suppliers. Most important factors impacting purchasing decisions are business related: cost, quality, reliable supplier, delivery on time, and availability of materials (no statistical significance among groups). Technical aspects such as machinability, durability, density, strength, and stiffness came in second place. When firms were asked to compare local suppliers to international suppliers, the general agreement in three groups is that they do not perceive a better performance or advantage from international suppliers over local suppliers. Interesting was also the indication that neither group considers much of environmental certified raw materials, (only 14% reported they believe their customers will pay more for this type of product). Same results have been obtained in similar studies in other wood products industries [44].

Business management trends in the wood pallet industry are very similar as in other forest products industries. Results confirm that wood pallet manufacturers are demanding short lead times in their orders to suppliers (mean averages 7.26 days, 7.44 days, and 7.57 days small, medium, and large size firms). This leads to the conclusion that large orders of the same material or product are no longer the standard practice; but rather a mix of small quantities of different materials. Thus, wood pallet industry suppliers have to accommodate to this trend in order to be competitive. When the industries were asked about supply chain management practices such as number of suppliers, supplier trust and communication, and involvement of suppliers in strategic planning, there was an indication that large firms tend to understand and practice these activities more than small and medium size companies. Given that the wood pallet industry has been relatively insulated from the fierce competition from low-cost imports (such as the furniture industry), this sector should take advantage of strong relations with suppliers and closeness to customers in order to improve their competitiveness. Sanders and Premus [45] concluded that information sharing with supply chain partners is one of the tenets of supply chain management, and has shown to reduce costs by reducing transaction costs and uncertainty. If wood pallet firms could get into a higher level of engagement with their suppliers, more benefits might be withdrawn.

Opportunities for improvement at the manufacturing level can be identified in the low ratings given to manufacturing cost, use of pull production system, little access to consultants for continuous improvement, and investments in process and products. Innovation can be achieved not only in physical products, but in the manufacturing process and the service, by providing more and better services to customers, like flex-

ibility in volume and time. For instance, information technology has been shown to benefit other sectors in the wood products industry [46]

Outputs of this study can be used by manufacturers to make strategic decisions about their business processes and practices (strategic planning is very important especially for small and medium enterprises). Also, organizations that support the industry can benefit by designing more effective assistance programs to improve the industry's competitiveness. Nevertheless, the wood pallet industries perceived that policy and government regulations are not communicated in the most appropriated manner. This is critical for the long stability of the sector considered that all surveyed firms perceived the industry as very competitive.

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