Identifying Success Factors In The Wood Pallet Supply Chain

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ABSTRACT

Pallets are a critical component of logistics infrastructure. Approximately 1.9 billion pallets are used each year in the United States for transportation of goods, from raw materials to finished products. Solid wood pallets represent 90% to 95% of the pallet market. To run their operations, wood pallet companies deal with suppliers, customers, and other supply chain components. Each of the steps is important to deliver the right products, with the required quality, and in a timely fashion. However, there is little research about the industry's supply chain practices. The objective of this research is to increase the understanding of the U.S. wood pallet manufacturing industry, its supply chain management practices, and factors affecting the supply chain management processes. To accomplish the research objectives, a nationwide mail survey of wood pallet manufacturers was carried out. In total 1,500 companies were sent questionnaires and the response rate was 14%. A model for supply chain success factors was developed based on previous research and was analyzed using the results from the survey.

Results of the survey provide an up-to-date profile of the US wood pallet industry. It was found that pallet production per company was 727,229 units on average during 2009. Out of the 1500 respondents, 38.6% indicated they were medium-sized companies (20 to 99 employees) and 53.9% small companies (1 to 19 employees). Thirty five percentage of respondents indicated that their sales were less than one million dollars and 43% from one to five million dollars. Also, 45% of respondents were involved in pallet recycling or repair, and these companies indicated that, on average, 42% of the material in a recycled pallet is, in fact, new material.

Regarding Supply Chain practices, close to three-quarters (73.1%) of respondents sold their products directly to customers and the order lead time for raw materials to shipment was 1 to 10 days for 81.9% of companies. The most important factors for purchasing decisions are availability, cost, and reliability of supplier (all rated 4.4 in an importance scale from 1 to 5, respectively). Respondents' answers suggest a preference to work with domestic materials (rated 4.3); however, respondents also indicated that there is currently a high level of competition for raw materials (rated 4.3). Results also indicated that information technology (IT) appears to receive little attention from wood pallet manufacturers, given that the importance of items in this area were rated relatively low, especially the use of internet for purchasing and training in IT (rated 2.2 and 2.1, respectively). Lastly, 86.0% of respondents did not believe that their customers would be willing to pay a premium for environmentally certified pallets, citing cost as the major barrier for a higher demand of these products.

Also, a theoretical framework of supply chain management was designed, developed, and tested with factor analysis, allowing identification of seven factors in the wood pallet supply chain: (1) environmental uncertainty, (2) information technology, (3) supply chain relationships, (4) value-added process, (5) supply chain management performance, (6) business management, and (7) customer satisfaction. Relationships between factors were tested using multiple linear regression. Results show that value-added process positively affects supply chain relationships, and these in turn are positively correlated to supply chain management performance and customer satisfaction.

Results from this research are useful for the industry to formulate a well-informed supply chain management strategy by understanding the connections between the different supply chain management practices and the business performance and customer satisfaction. The information presented is also useful for organizations supporting the wood pallet industry to design more effective assistance and educational programs.

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Chapter 1. INTRODUCTION AND LITERATURE REVIEW

1.1 Industry Background

International trade has grown greatly in the last decade, mostly due to developments like the fall of barriers to international trade, deregulation, and improvements in information technology. Information obtained from the World Trade Organization (World Trade Organization, 2010) mentions that the global trade growth will increase 9.5% from 2009 to 2010. This growth has made it necessary to improve not only transportation infrastructure and technology, but also the elements used during the transportation process, such as handling, loading, unloading, and warehousing. One of these elements is the pallet. 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 method of transportation. Pallets reduce handling costs and facilitate transportation of raw and in-process materials or finished products from the supplier to the manufacturer, from the manufacturer to the wholesaler, and then to the retailer.

About 93% to 95% of unit loads in the United States include a pallet (White and Hamner, 2005). Each year, 1.9 billion pallets are used in the United States. Pallets and containers are manufactured with a variety of materials such as wood, wood-based composites (i.e., plywood, OSB), plastic, paper, and metal. Wood is by far the most common material used to make pallets; 90% to 95% of all pallets used in the U.S are made from wood (Rupert, 2009).

There were about 2,657 wood pallet and container manufacturers firms in the U.S. in 2006 (U.S. Census Bureau, 2010f). Wood pallet manufacturers use a variety of wood species such as Spruce-Pine-Fir, Hem-Fir, Douglas Fir, Yellow-Poplar, Southern Yellow Pine, and Ash to produce pallets. These materials come from recently sawn logs or recycled pallets. Recycled pallets are increasing in importance because recycling reduces costs and is a more environmentally friendly practice.

Although small, imports play a role as a source of pallets and pallet components. There is very little or no information about the types and sizes of pallets being imported, wood species, prices, and volume when searching for information in the U.S. Census Bureau (2010e) and other sources of information. Moreover, according to the literature review, there was no information available about the factors that move a domestic producer or importer to purchase pallets from overseas. This is important considering the effect that imports have had on other U.S. industries, like furniture and flooring, causing many plant closures and layoffs. Part of this research attempts to address this lack of information by investigating the importance of imported wood pallets and pallet components for the U.S. market.

According to historic data of U.S. wood pallet production (U.S. Census Bureau, 2009), it seems that wood pallet production is expected to grow; therefore, the sourcing of wood materials for pallet manufacturing could become critical. It is believed that wood pallet manufacturers will face increasing competition for raw materials from producers of wood-based composites, paper and paperboard, and biomass-based energy (Accentur, 2010). This is already happening to wood composite manufacturers that use wood particles to manufacture their products. Some sawmills and lumber wholesalers understandably prefer to sell their byproducts to the highest bidder, and sometimes composite wood manufacturers might not appear as an attractive market (Sonenklar, 2010).

The above-mentioned problem could also affect the wood pallet industry. Assuming that biomass demand increases, competition for wood fiber will not only increase the price of raw materials but also reduce its availability for pallet production (RISI Inc., 2010), potentially causing pallet manufacturers to look for resources in other countries.

1.2 Rationale and Justification

The descriptive and analytical methods of this research will allow the development of a profile of the U.S. wood pallet supply chain industry. Competition for raw materials has increased, especially with the subsidy given by the Biomass Crop Assistance Program (BCAP) for finding more sources of energy, which as a result made the price of low-grade lumber increase (RISI Inc., 2010). This research also can help domestic and international suppliers to understand the needs of U.S. wood pallet manufacturers, not only regarding volumes required, but also about the main attributes that are critical in the purchasing decisions of raw materials.

Regarding wood pallet manufacturers, companies need to deal with suppliers, customers, and other supply chain components to run their operations (Hassan, 2006). Each of the steps is important to deliver the right products, with the required quality, in a timely fashion. Thus, companies are not competing by themselves; they are competing as part of a supply chain (Lambert and Cooper, 2000). Understanding the wood pallet supply chain in terms of material flow will provide information to wood pallet manufacturers that could help to reduce costs and to increase business profitability by understanding how their supply chain management processes are related to business management and customer satisfaction. Lastly, this research will provide knowledge to wood pallet manufacturers about the factors affecting the wood pallet supply chain.

This study will be one of the few regarding the identification of factors in the wood pallet supply chain. It can also help to design better focused industry support programs that allow companies to formulate system-wide strategies for improving customer satisfaction.

1.3 Goal and Specific Objectives of the Research

This research is focused on identifying factors that affect the wood pallet supply chain, specifically the link between wood pallet manufacturers and suppliers. Of special interest was the understanding how these factors can affect business management and customer satisfaction.

The goal is to identify success factors in the wood pallet supply chain. To accomplish this objective, the following specific objectives are proposed:

1) Estimate production volumes, major suppliers, and species distribution of wood pallet material imports and domestic production in the U.S.
2) Compare characteristics of imported and domestically produced pallets from a business perspective.
3) Increase the understanding of the U.S. wood pallet manufacturing industry, its supply chain management practices, and factors affecting the supply chain management processes.
4) Identify and understand supply chain management success factors and their relationships in the wood pallet industry.

1.4 Research Methodology

The population of interest for this research is U.S. wood pallet manufacturers. A telephone survey, case study, and a nationwide survey were conducted to accomplish the objectives of the research. The results allowed an understanding of the wood pallet supply chain through descriptive statistics and exploring the relationship among supply chain factors through a proposed research model that uses statistical multivariate techniques.

Several techniques were used to analyze the data. For descriptive statistics, spreadsheet software was used to create most of the charts elaborated during the research. The statistical analysis was carried out using SAS® for processing the data and presenting results. T-test and Chi-square were used to analyze non-respondent

bias, the former for interval data and the latter for categorical data. Descriptive statistics were used to: 1) estimate production volumes, major suppliers, and species distribution of wood pallet material imports and domestic production in the U.S., 2) compare characteristics of imported and domestically produced pallets from a business perspective, and 3) develop a profile of the U.S. wood pallet supply chain.

To understand the supply chain success factors, SAS® was used for preparing, analyzing, and showing the data and results. Specifically, statistical methods such as Cronbach's alpha, factor analysis, multiple regression analysis, and hypothesis testing were used to test the relationship among variables. The methods were used to 4) identify and understand success factors and their relationships in the wood pallet supply chain.

The specific details of each step of the general methodology will be explained with greater detail in each chapter. Specifically Chapter 2 presents a profile of the U.S. wood pallet supply chain, and Chapter 3 presents the results from the analysis of factors affecting the supply chain of wood pallets in the U.S. The general research methodology is presented in Figure 1.1 and contains two main outputs: 1) descriptive statistics which it can be seen in Chapter 2 and 2) success factors model which is addressed in Chapter 3.

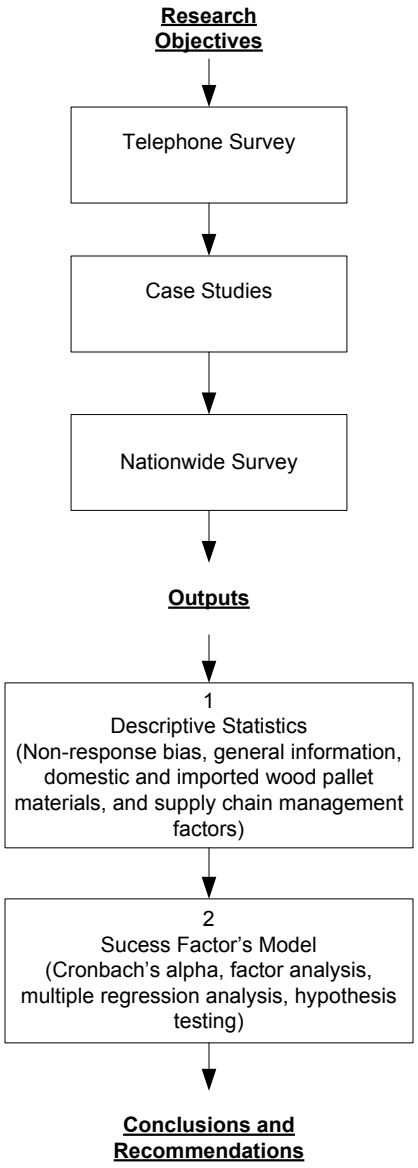


Figure 1.1. General research methodology

1.5 Literature Review

1.5.1 *The Wood Pallet Industry*

1.5.1.1 Pallet Definition

"*Pallets are the interface between packaging and the unit load handling equipment*" (White and Hamner, 2005). Another simpler definition is that pallets are "*portable platforms,*" which facilitate the movement and storage of unitized goods (Kator, 2008).

A unit load is the system comprised of pallets, packaging materials, and unit load stabilizers (stretch wrap, tie sheets, corner posts, load adhesives, and strapping). Figure 1.2 shows two examples of pallets and unit load.

Figure 1.2. Pallets and unit load

The rapid growth of the market and the need to fulfill customers' orders on time, and in the required amount are some of the main drivers for the increasing use of pallets, which allow transporting of greater quantities of goods in unit loads more efficiently.

About 441 million new wood pallets were manufactured in the U.S. in 2006 (Bush and Araman, 2008), 1.9 billion are used in the country, and 300 million pallets are recovered by pallet recyclers (Rupert, 2009).

1.5.1.2 Pallet Types

There are a variety of dimensions and two types of U.S. pallets. The most typical are stringer and block pallets. Stringer pallets are two-way or partial four-way entry pallets. Three parallel pieces of lumber form a frame, the same as separate the top and bottom deckboards. Block pallets are four-way entry pallets that are made with solid wood blocks that support the top deckboard (see Figure 1.3).

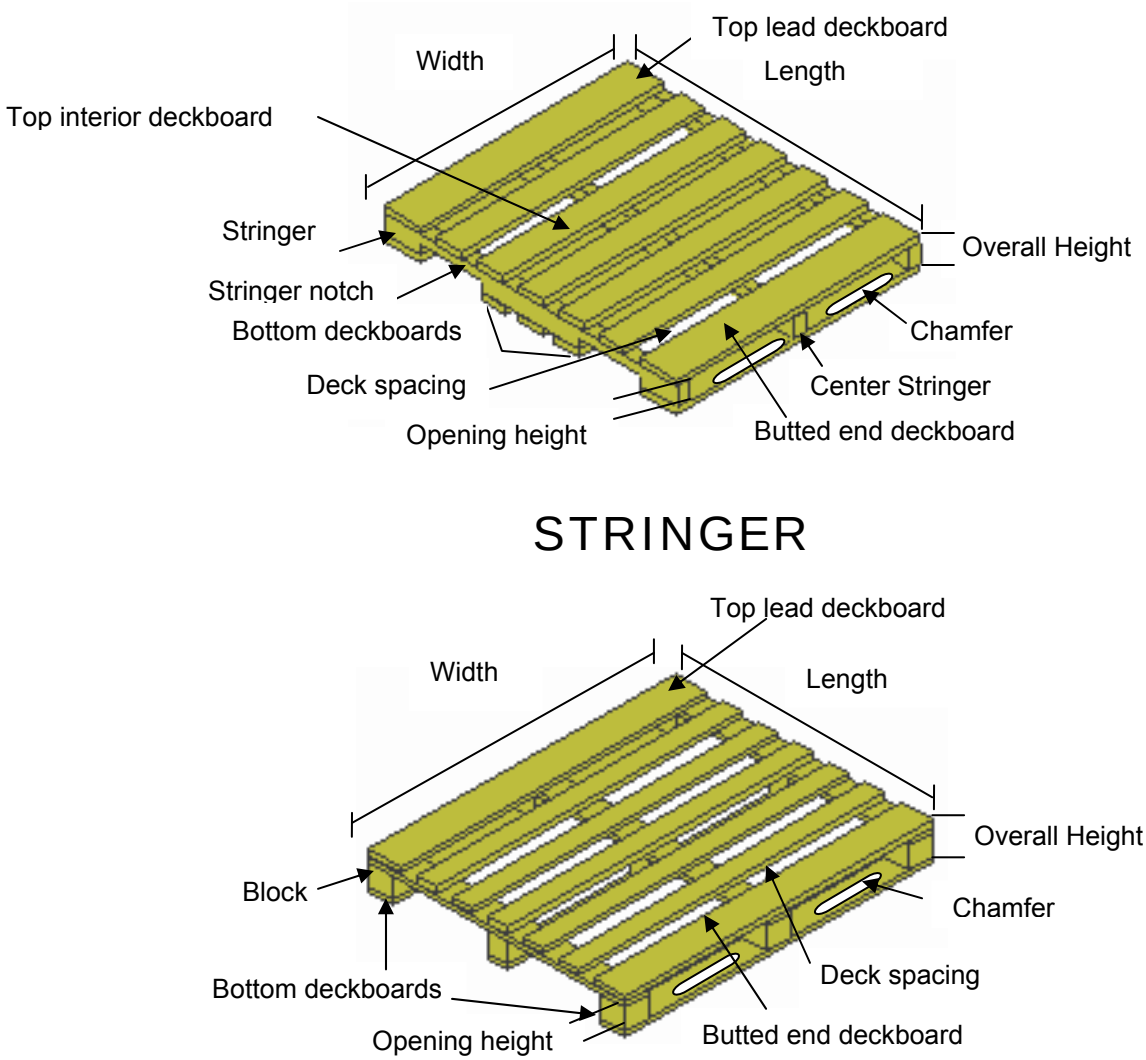


Figure 1.3. Stringer and block pallets

1.5.1.3 Wood Pallet Manufacturing Process

The process to obtain wood pallets begins with the acquisition of raw material, often in cant form. Figure 1.4 shows the manufacturing process for a stringer wood pallet according to White and Hamner (2004).

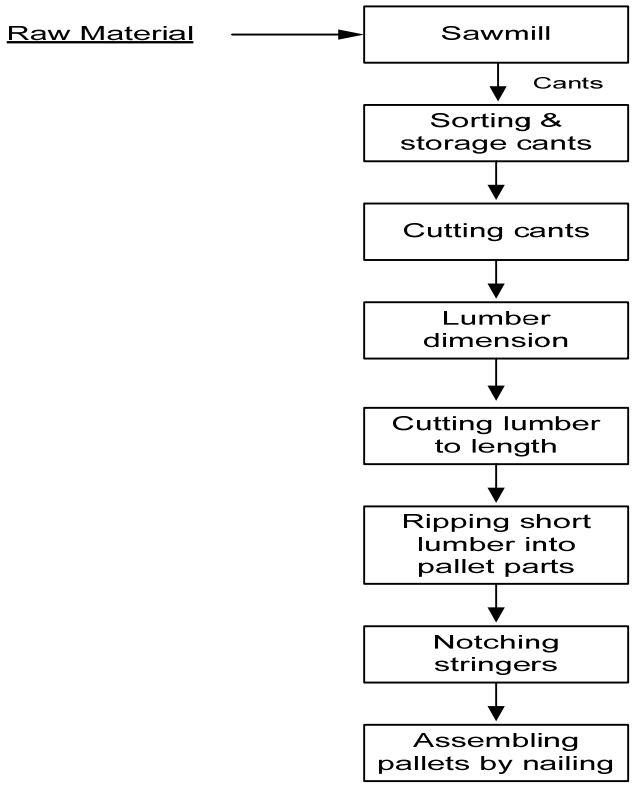


Figure 1.4. Wood stringer pallet manufacturing process

1.5.1.4 Wood Pallet and Container Production in the U.S

Figure 1.5 shows the sub-product classes for the Wood Pallet and Container product class (U.S. Census Bureau, 2009). The percentages represent the average share of each sub-class as a percentage of the total value of shipments from 2002 to 2008. Wood pallet and container, and wood-metal combinations made up 62% of the total product class' value of shipments.

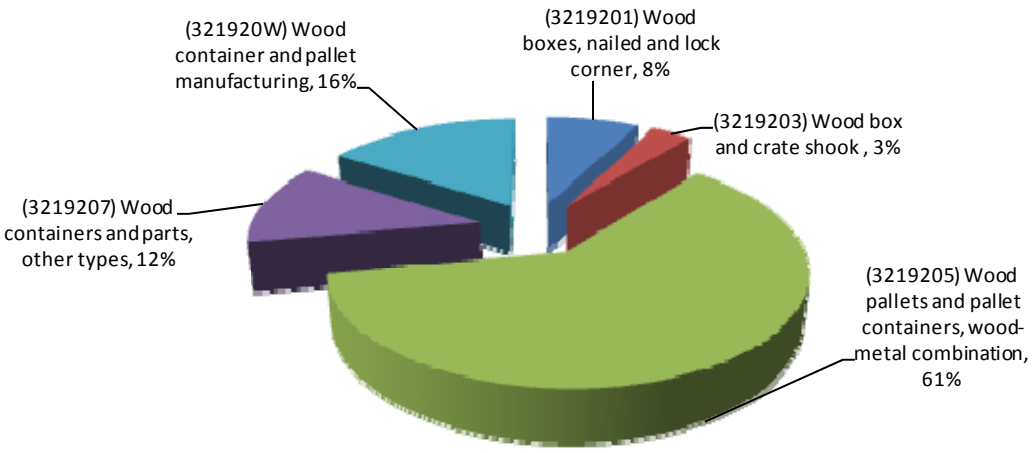


Figure 1.5. Share of product sub-categories of total wood pallet and container manufacturing product class

1.5.1.5 Economic Significance of the Pallet Industry

The U.S. Census Bureau categorizes the Pallet and Container subsector (NAICS code 321920) within the Wood Products Industry (NAICS 321). Pallet and container manufacturing is a significant share of the wood products sector in the U.S. (U.S. Census Bureau, 2010b), as shown in Table 1-1. The pallets and containers represented an average of 5.8% of the total value of wood products shipments (NAICS 321) from 2000 through 2008.

Table 1-1. Share of pallet and container manufacturing in the wood products industry

Industry Sector	Value of Shipments (Million $US/Year)								
	2000	2001	2002	2003	2004	2005	2006	2007	2008
Pallet and Container	4,858	4,526	4,809	4,712	5,200	5,702	6,224	6,945	7,024
Wood Products	93,669	87,250	89,019	92,069	104,135	112,018	107,211	97,477	84,553
Share of Pallet and Container	5.2%	5.2%	5.4%	5.1%	5.0%	5.1%	5.8%	7.1%	8.3%

The economic importance of the pallet and container industry on the U.S. economy can also be understood by looking at employment statistics. Table 1-2 lists employment for the industry and the wood products sector from 2000 to 2008 (U.S. Census Bureau, 2010a; U.S. Census Bureau, 2010f). The pallet and container subsector accounted for an average of 11.1% of the total employment in the wood products industry (NAICS 321). From 2005 to 2008, this share has steadily increased, from 10.5% to 12.5%.

Table 1-2. Employment in pallet and wood products industry

Industry Sector	Number of Employees per Year								
	2000	2001	2002	2003	2004	2005	2006	2007	2008
Pallet and Container	68,400	64,600	59,700	59,200	59,400	58,500	59,600	59,500	57,400
Wood Products Sector	613,000	574,100	554,900	537,600	549,600	559,200	558,800	515,300	459,600
Share of Pallet and Container/Wood Products Sector	11.2%	11.3%	10.8%	11.0%	10.8%	10.5%	10.7%	11.5%	12.5%

Figure 1.6 shows the employment characteristics of pallet and container firms (U.S. Census Bureau, 2010f). Pallet and container manufacturers are rather small, with more than two-thirds of establishments having less than 20 employees. A typical firm in this sector has only one establishment.

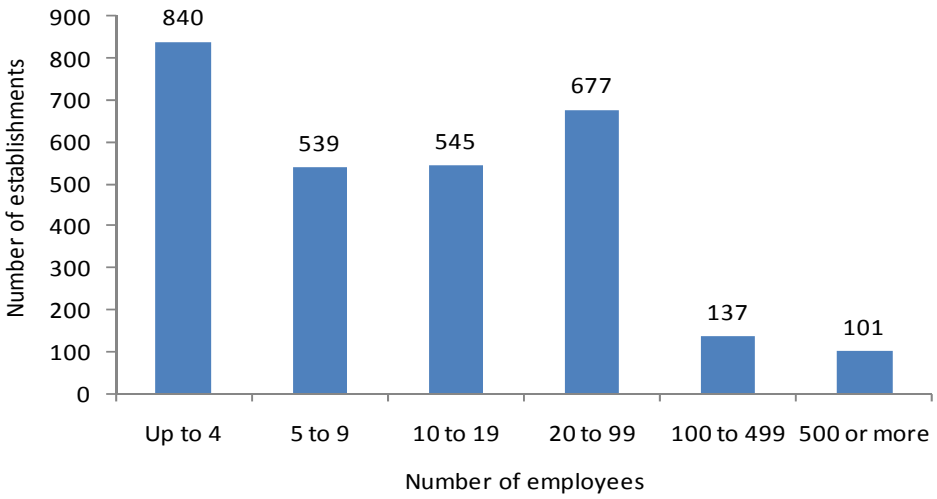


Figure 1.6. Employees per establishment in 2006

Lastly, the economic significance can also be understood by looking at the value of shipments in the U.S. As can be seen in Figure 1.7 (U.S. Census Bureau, 2010c), value of shipments has increased almost 45% over the period shown (2000-2008), or at an annual growth of 5%.

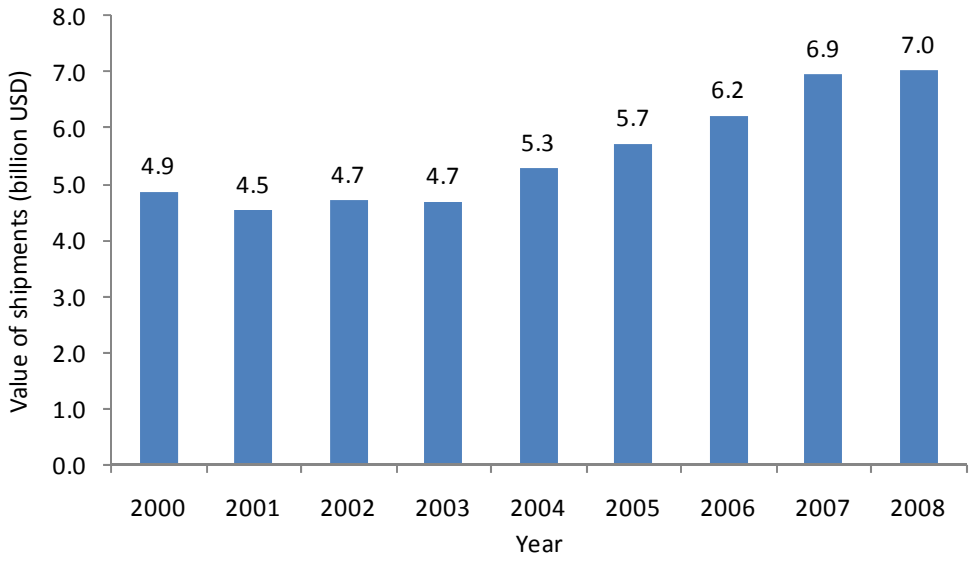


Figure 1.7. U.S. pallet and container value of shipments

1.5.1.6 Pallet Sizes

The growth of domestic and international trade, and the need to plan operations for the transportation, warehousing, and handling of materials throughout the supply chain have required the standardization of dimensions for pallets. If every manufacturer or transportation agent would create and use its own dimensions, there would be significant costs added to the logistics operations; costs at the end would be transferred to the final customer as higher product prices. Standard dimensions also facilitate the mass production of pallet parts, reducing their unit cost.

There are a variety of pallet sizes, depending on their major use and the geographic region where they are manufactured or used. The most common sizes used in the U.S. according to Bush and Araman (2008) are listed in the Table 1-3 below.

Table 1-3. Size of new wood pallets produced in 2006

Common use	Pallet Size (in.)	Share of annual production (%)
Grocery	48x40	26.9
Military	40x48	5.3
Chemical	42x42	4.8
Drums	48 x 48	4.3
Chemical, beverage	48 x 42	3.7
Automotive	48 x 45	2.1
Beverage	37x37	1.6
Beverage, shingles, packaged paper	48 x 36	1.5
Other sizes		50.0

1.5.1.7 Grading of Pallet Parts and Wood Species

Wood pallets are made from low-grade hardwood cants and lumber from the center of hardwood logs. Initially discarded, this part of the tree is significance for pallet manufacturing. Also softwood lumber of 2x4 inches (1-1/2x3-1/2 actual) and 2x6 inches (1-1/2x5-1/2 actual) dimension economy and utility grade are purchased by wood pallet manufacturers as pallet part raw material. When cants are sawn, pallet parts are graded according to the presence of sound knots, unsound knots, loose knots, holes, splits, checks, shake, wane, manufacturing errors, and others.

Grades go from low to high quality in terms of strength, stiffness, and durability, and they are graded as economy, utility, standard, premium, and select (Rupert, 2009). This can be seen in Table 1-4.

Table 1-4. Pallet Design Sistem (PDS) pallet component grades/lumber characteristic restrictions

Lumber Characteristic	Pallet Component Grade				
	Select	Premium	Standard	Utility	Economy*
Sound Knots	1/4 of Cross Section Stringer Notch Area: 1/8 of Above Notch Cross Section	1/3 of Cross Section Stringer Notch Area: ¼ of Above Notch Cross Section	1/2 of Cross Section Stringer Notch Area: 1/3 of Above Notch Cross Section	3/4 of Cross Section Stringer Notch Area: ½ of Above Notch Cross Section	7/8 of Cross Section Stringer Notch Area: 5/8 of Above Notch Cross Section
Unsound Knots, Loose Knots, Holes	1/8 of Cross Section	1/4 of Cross Section	1/3 of Cross Section	1/2 of Cross Section	1/2 of Cross Section
Cross Grain	1 in 10	1 in 8	1 in 6	1 in 4	Not Limited
Localized Grain Disorientation	1/4 of Cross Section	1/3 of Cross Section	1/2 of Cross Section	2/3 of Cross Section	Not Limited
Splits, Checks, Shake	1/4 of Part Length	1/3 of Part Length	1/2 of Part Length	3/4 of Part Length	Must not completely separate Component
Wane	1/16 of Cross Section Stringers or Blocks: 1/16 Nail Face x ¼ Height Boards: 1/8 Width x 1/3 Thickness (Any Length)	1/8 of Cross Section Stringers or Blocks: 1/8 Nail Face x 1/3 Height Boards: 1/6 Width x 1/2 Thickness (Any Length)	3/16 of Cross Section Stringers or Blocks: 1/3 Nail Face x 1/3 Height Boards: ¼ Width x 2/3 Thickness (Any Length)	1/4 of Cross Section Stringers or Blocks: 1/2 Nail Face x 1/2 Height Boards: 1/3 Width x Full Thickness (Any Length)	5/16 of Cross Section Stringers or Blocks: 5/8 Nail Face x 2/3 Height Boards: 1/2 Width x Full Thickness (Any Length)
Unsound Wood	None	1/8 of Cross Section	1/4 of Cross Section	1/3 of Cross Section	1/2 of Cross Section
Pith	None	Not Limited	Not Limited	Not Limited	Not Limited
Mismanufacture	None	1/16 of Cross Section	1/8 of Cross Section	3/16 of Cross Section	1/4 of Cross Section

* Economy Component Grade permits lumber characteristics which prevent reliable estimates of strength, stiffness, or durability.

Many hardwood and softwood species are used as raw material for pallets, but in general those with specific gravity (oven-dry) ranging from 0.36 to 0.69 have satisfactory pallet performance. Some of the typical species in the U.S. are Spruce-Pine-Fir, Hemlock-Fir, Douglas Fir, Yellow-Poplar, Southern Yellow Pine, and Ash (MH1 Committee, 2005). Table 1-5 shows the type of wood species used for making pallets.

Table 1-5. Wood species used for manufacturing wood pallets

NORTH AMERICAN SPECIES			
Class 1 (0.69)	Maple:	**Class 12 (0.42)**	Fir:
Hickory	Silver	Hemlock:	Subalpine
Birch:	Stripped	Western	Balsam
Yellow	Magnolia	Mountain	Baldcypress
Sweet	**Class 4 (0.61)**	Fir:	Eastern Hemlock
Maple:	Oregon White Oak	California Red	Western Red Cedar
Sugar	California Black Oak	Grand Noble	Redwood
Black	Cascara	Pacific Silver	**Class 14 (0.36)**
Red	Chiquapin	White	Cedar:
Ash:	Myrtle		Alaska
Green	Pacific Madrone	**Class 13 (0.42)**	Incense
White	**Class 6 (0.45)**	Spruce:	Port Orford
Elm:	Red Alder	White	Atlantic White
Rock	Mountain	Black	Northern White
Slippery	**Class 7 (0.40)**	Red	Eastern Red
American Beech	Aspen:	Engelman	**Class 21 (0.58)**
Black Locust	Bigtooth	Sitka	Eastern Oaks
Black Cherry	Quaking	Pine:	Red Oaks
Tanoak	Catalpa	Sugar	White Oaks
Dogwood	Buckeye	Western White	**Class 22 (0.51)**
Persimmon	Butternut	Lodgepole	Southern Pine:
Eucalyptus	American Basswood	Ponderosa	Loblolly
Class 2 (0.55)	Cottonwood:	Monterey	Longleaf
Bigleaf Maple	Black	Jack	Shortleaf
Oregon Ash	Balsam Poplar	Norway	Slash
Class 3 (0.54)	Eastern	Eastern White	**Class 29 (0.48)**
Sweetgum	**Class 11 (0.51)**	Southern Pine:	Yellow Poplar
Tupelo	Douglas Fir:	Pitch	
Paper Birch	Coast	Pond	
Ash:	Interior West	Spruce	
Black	Interior North	Virginia	
Pumpkin	Interior South		
Hackberry	Western Larch		
Sycamore			

General Notes: (a) Oven-dry specific gravity shown in parentheses

(b) These species classes and class number correspond to those used as inputs in Pallet Design System (PDS), 1995 version. (a) Oven-dry specific gravity shown in parentheses North American wood species classes ranked to relative strength and stiffness (in order of strongest to weakest): 21,1,2,11,29,4,6,3,12,7,13,14

A study about the use of wood species or species groups for pallet manufacturing in the U.S was carried out by Bush and Araman (2008). Part of the results can be seen in Figure 1.8. Only 2.3% of wood pallets are manufactured with imported species outside of North America, meaning that pallet manufacturers are using more domestic wood than imported wood species for their manufacturing processes. Approximately 51% of the total volume is manufactured using mixed hardwoods.

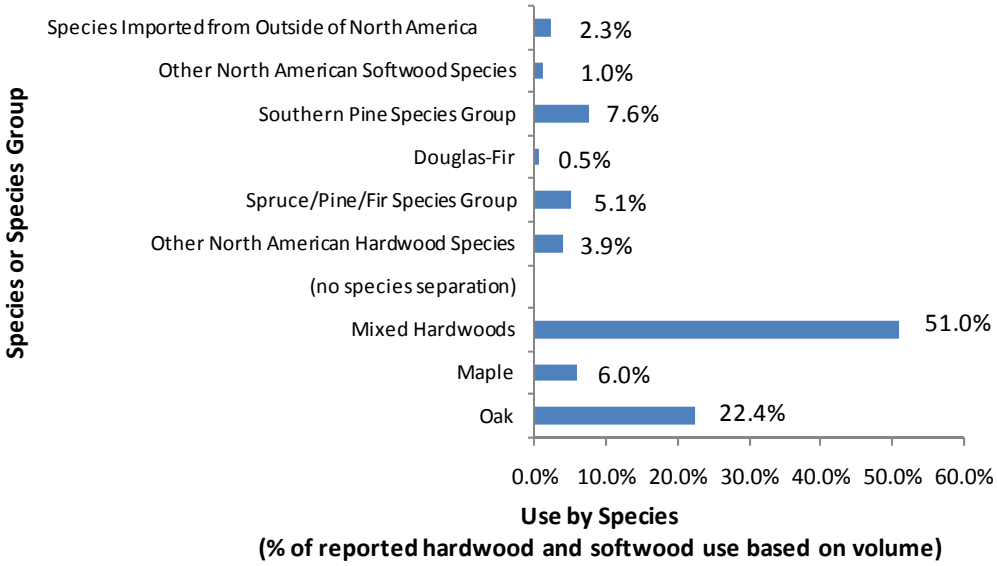


Figure 1.8. Species distribution by volume for pallet and container production

1.5.1.8 Domestic Pallet Production

In the research conducted by Bush and Araman (2008), it was found that regions in the U.S. attribute their highest primary source of revenue to new wood pallet production in the following percentages: the Midwest with 61.6%, the South with 58.5%, the Northeast with 52.6%, and the West with 45.5% (see Figure 1.9).

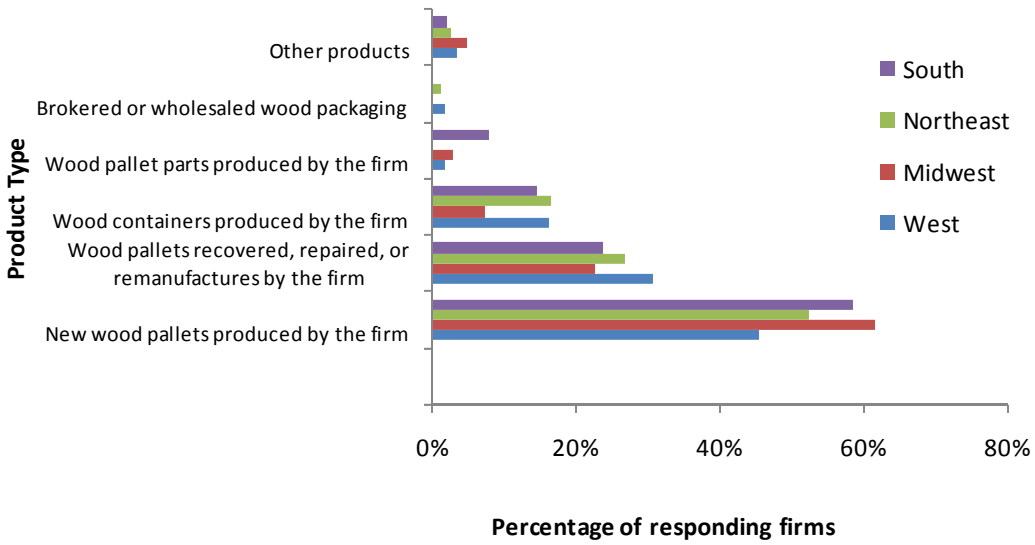


Figure 1.9. Percentage of product types production per region

1.5.1.9 Price

Wood is the most commonly used material for making pallets because of its availability and low cost, even when the raw material cost represents approximately 60% to 70% of the total cost of manufacturing and delivering a new wood pallet (White, undated). As the cost of cants and lumber increases, the cost of pallets will also increase. Depending on the type of pallet, its cost varies; however, the approximately cost of a new 48x40 inch pallet in the United States is $9 (Kator, 2008). The increase in the cost of hardwood cants from 2006 to 2008 according to the Hardwood Market Report (2010) is shown in Figure 1.10.

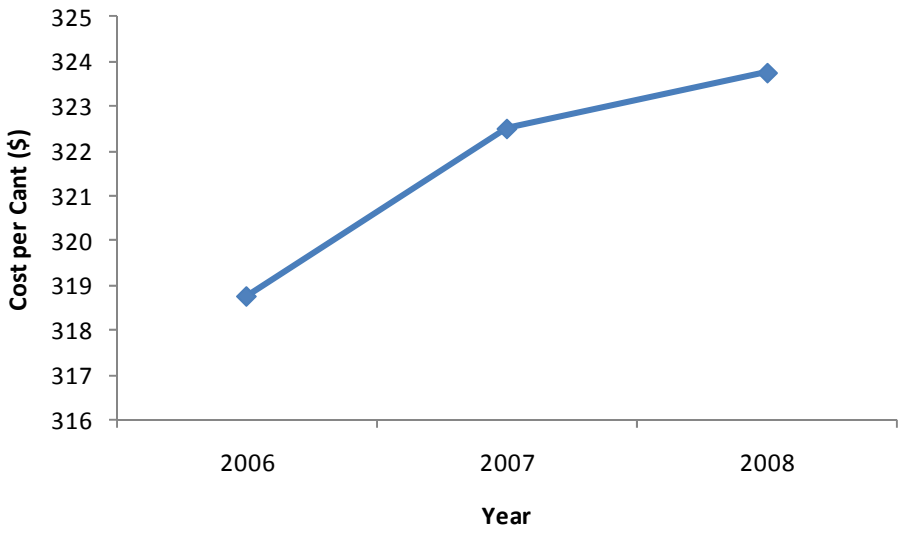


Figure 1.10. Cost per cant (4x4,4x6)

Figure 1.11 shows the pallet pricing behavior for a 48x40 inch wood pallet which is known as a Grocery Manufacturer's Association (GMA) pallet, obtained from Pallet Profile (Brindley, 2010a). According to Pallet Profile, eight regions were identified (Mid-Atlantic, Virginia, Georgia, West Virginia, Western NY, Iowa, Missouri, and East Texas) to obtain information about pallet prices. Figure 1.11 shows an increase in pallet price from 2006 to 2008, followed by a little increase in 2009, then a drop in 2010.

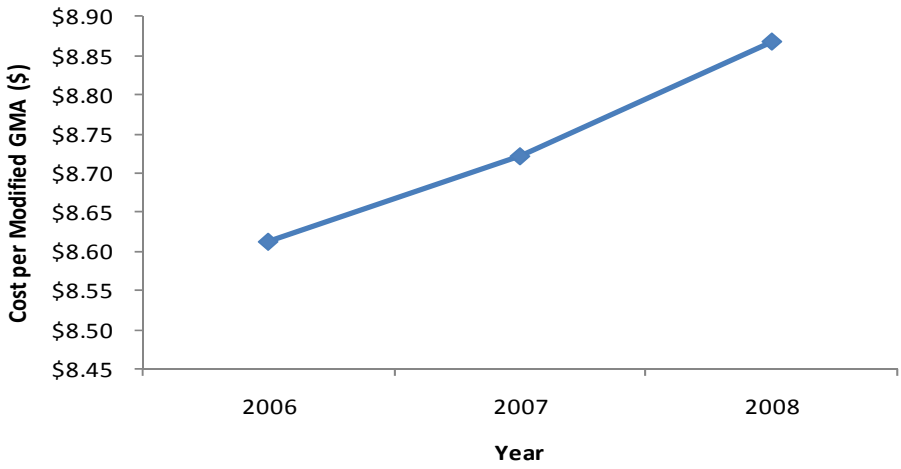


Figure 1.11. Cost per GMA stringer pallet (5/8", 1 ⅜")

1.5.1.10 New and Recycled Pallets

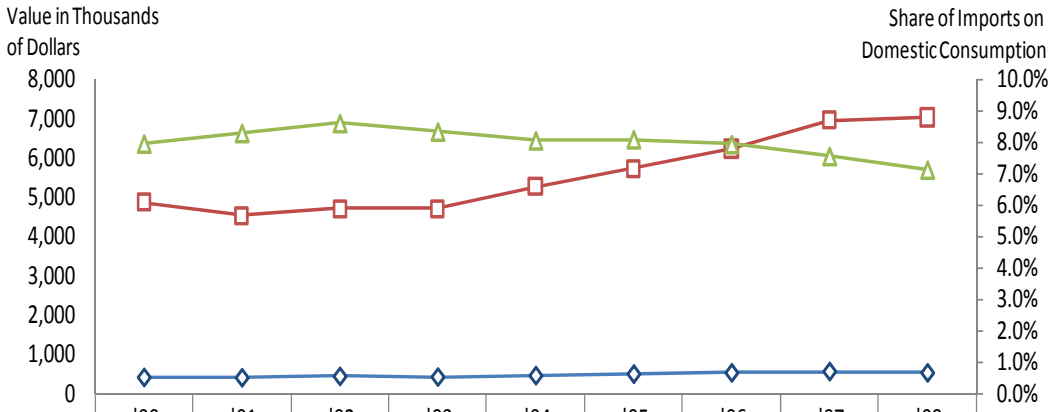
The estimated production of new pallets in 2006 was 441 million units, an increase of 2.8% from the 429 million new pallets produced in 1999. The most common pallet type produced in 2006 was the stringer pallet (Bush and Araman, 2008). Moreover, the importance of recycling pallets has grown steadily during the last decade (Brindley and Brindley, 2006). The reason is that recycling pallets reduces cost and is a more environmentally friendly practice. According to Frost and Large (1975), new wood pallets are more expensive than recycled wood pallets; the latter cost 65% less than new ones.

Pallets that show some damage can be restored with parts from old pallets, or can use new pallet parts. Recycled pallets keep the cost of buying pallet cants low, benefiting the pallet and wood industries by reducing competition for the same raw materials (Hosterman, 2000).

In 2006, the average production of used (recovered, repaired, and remanufactured) pallets was 208,375 units. When pallet manufacturers acquire pallet cores (used pallets), they have many options. For example, pallets can be reused without repair, used for repair, un-nailed (rescuing wood parts in good condition for building and/or rebuilding pallets, grounding or chipping, or for other uses), ground or chipped, sent to the landfill, or used in other tasks. According to the study by Bush and Araman (2009), firms in 2006 indicated that of the recovered pallets, 67% were repaired, 10% were reused without repair, 15.7% un-nailed, 6% ground or chipped, 0.2% went to the landfill, and 1.1% were used in other tasks.

1.5.1.11 Importance of Wood Pallet and Container Imports for the U.S. Market

In this section, information about international trade of pallet and container products to the U.S. is presented. Most of the data was retrieved from the U.S. Census Bureau database (U.S. Census Bureau, 2010c; U.S. Census Bureau, 2010d; U.S. Census Bureau, 2010e). Figure 1.12 shows the total imports and value of shipments (domestic production) of wood pallet and container, and the share of imports over total domestic consumption. The latter was obtained by adding imports and value of shipments. The value of product shipments (domestic production) has grown from about $5 billion to $7 billion over the 9-year period. Imports have stayed almost constant throughout those years. As a result, the share of imports on the domestic consumption of wood pallet and container has decreased from 7.9% in 2000 to 7.1% in 2008 — a drop of 11%.



	'00	'01	'02	'03	'04	'05	'06	'07	'08
Imports $	402,494	394,883	429,776	413,016	448,624	487,597	518,440	551,084	518,274
Domestic $	4,857,587	4,525,782	4,705,048	4,693,266	5,269,237	5,722,840	6,224,603	6,945,977	7,024,255
Share of Imports	7.9%	8.3%	8.6%	8.3%	8.0%	8.1%	7.9%	7.5%	7.1%

Figure 1.12. Wood pallet and container imports and domestic production

1.5.1.12 Type of Species and Prices

Markets in the U.S. are constantly growing and demanding more pallet quantities, and with competitors in the wood sector, pallet manufacturers have to look for new options to meet demand (Brindley, 2004). Thus, they had to consider new wood species at affordable prices. Availability and price are not the only factors to consider when making purchase decisions for imported material (Cossio, 2007); it is necessary to take into account the availability of roads, transportation costs, and political, social, and other issues. According to Brindley (2004), South America has been exporting pre-cut pallet lumber to the U.S. As an example, a large pallet manufacturer makes use of South American pre-cut Radiata Pine that was imported from Chile. Also, eucalyptus and softwoods, such as Southern Yellow Pine, were imported from Brazil. Argentina, Uruguay, and Brazil had 10 to 15 million board feet available of pallet grade hardwood, demonstrating a potential for supplying raw material to the U.S.

1.5.1.13 Regulations for Imports

Insects are the main issue when importing wood from other countries. Wood must be treated (heat or chemically) against insect attacks. The international standards for wood packaging material were put in practice by the United States and other countries in September 2006 (Jabara et al., 2007), which indicates that wood pallets used for international trade must comply with “The International Standards for Phytosanitary Measures” (ISPM 15).

According to ISPM 15, wood for pallets must be heat-treated by reaching a core temperature of 56ºC for 30 minutes, or fumigated with Methyl Bromide (chemical treatment) for a certain amount of time, ranging from 0.5 to 22 hours, according to the dosage level and temperature required (FAO, 2009). Wood pallets used for exports to the U.S., are also required to present a stamp, which includes the IPPC trade marked regulation. It also includes country of origin and a unique number given by the National Plant Protection Organization (NPPO) assuring that the wood is approved for its use, and the initials for the applied treatment (HT or MB). A sample of the stamp can be seen

in Figure 1.13, where XX represents the country code, 0000 a specific number given by the National Plant Protection Organization (NPPO), and YY is the type of treatment (FAO, 2009). Also a trademark for the American Lumber Standard Committee accredited agency is required.

Figure 1.13. Certification stamp for wood packaging material

1.5.1.14 Raw Material Supply

This section presents an overview of U.S. and global roundwood production from 1997 to 2008.

U.S. and Global Roundwood Production

Roundwood production is divided in two types: hardwood and softwood. Figure 1.14 shows the respective quantities and trends of hardwood and softwood production through 1997 and 2008 (FAO, 2010b). There has been a decrease over the years of hardwood production; however, softwood production increased from 2002 until 2005, and decreased through 2008.

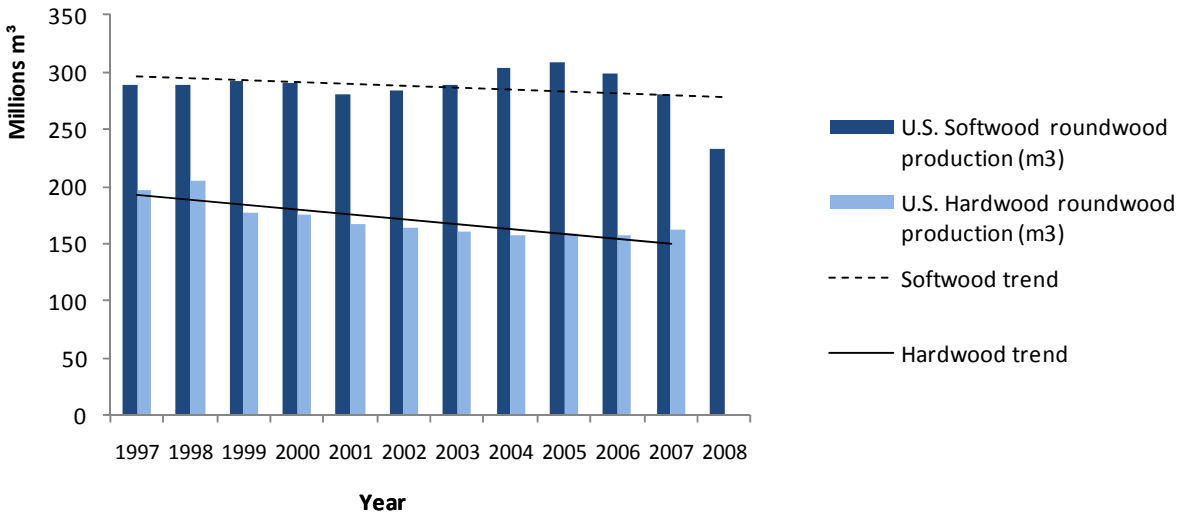


Figure 1.14. Roundwood production in the United States

It is also important to identify the amount of available roundwood in the world as possible new resources of raw material in the future in the U.S. Figure 1.15 shows an apparent increase of roundwood production over the years (FAO, 2010a).

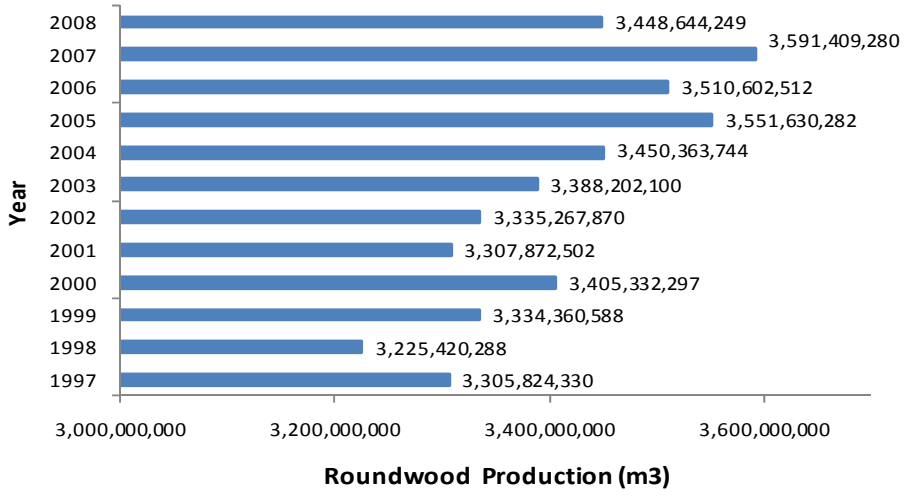


Figure 1.15. Global roundwood production

In order to identify possible future sources of pallet raw materials, Figure 1.16 shows the 10 main roundwood producing countries and their share of production in respect to the total amount (expressed in m³) of production in the world (FAO, 2010a).

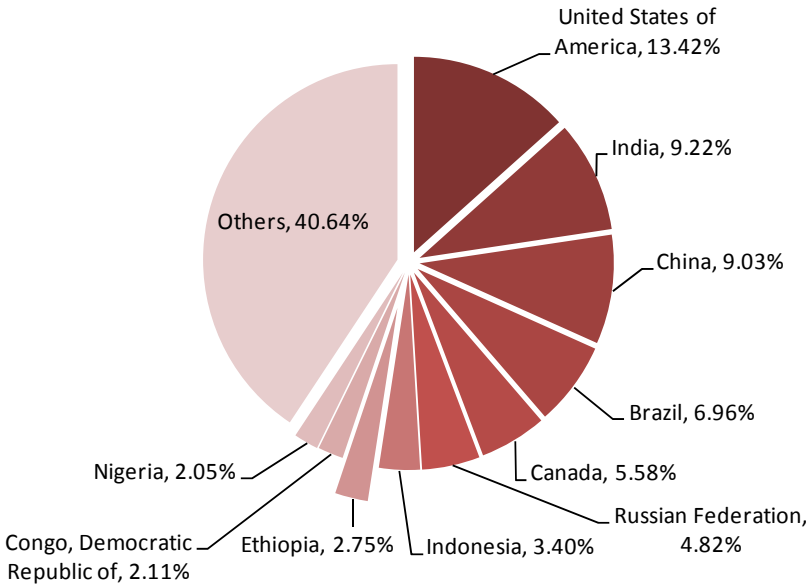


Figure 1.16. Roundwood production of main countries

Information regarding roundwood stocks and production in all countries is not of great importance for this research; however, it gives general information about the availability of raw material for wood pallet production in the U.S. Data about global and U.S. roundwood production was collected. Table 1-6 shows that global timber production increased slightly over the decade of the analysis, from 3.2 billion m³ in 1998 to 3.6 billion m³ in 2007. On the other hand, timber production in the U.S. decreased during the same time span. U.S. timber production represents approximately 13.5% of the global timber output.

Domestic pallet production in the U.S. showed a significant increase from 2003 to 2008, of about 35%. Pallet imports to the U.S. have also increased, although at a much lower rate than domestic production. Imports represent 8.7% of domestic pallet production in the U.S.

Table 1-6. Pallets and timber production in the U.S. and the world

Description	Millions of m³/year								
	2000	2001	2002	2003	2004	2005	2006	2007	2008
Domestic pallets in U.S.	13	13	13	13	14	16	17	20	19
Pallet imports to U.S.	1	1	1	1	1	1	1	2	1
Roundwood production in U.S.	467	449	448	449	462	467	457	444	380
Global timber production	3,405	3,308	3,335	3,388	3,450	3,552	3,511	3,591	3,449

1.5.2 *Supply Chain Management*

Ensuring domestic or imported resources will require wood pallet manufacturers to improve not only their business management but also how they manage their supply chain business processes. Supply chain relationships play an important role, from supplying raw materials and manufacturing or producing products and services, to delivering the final product to customers. The following paragraphs define supply chain and supply chain management as part of the literature review for the research.

Supply chain is defined by Towill (1996b) as a "*system whose constituent parts include material suppliers, production facilities, distribution services and customers linked together via the feed forward flow of materials and the feedback flow of information.*"

According to Lambert and Cooper (2000),"*Supply Chain Management is the integration of key business processes from end user through the original suppliers that provides products, services, and information that add value for customers and other stakeholders."*

Tan, Kannan, Handfield, and Gosh (1999) mentioned that building up strategic supplier-buyer and customer relationship practices, and outsourcing resulted in benefits to companies; however, only a few companies succeed in this. Li (2002) suggested this is because companies do not always have a clear understanding of the concept of supply chain management.

Li (2002) mentioned that most supply chain studies were focused only to one side of the supply chain, upstream or downstream. However, both sides must be taken into account at the same time. Research by Tan et al. (1998) investigated the relationship between supplier management practices, supplier performance, and company performance, which led the company to achieve more benefits. Elmuti (2005) mentioned that successful execution of supply chain management has been recognized as the tool for reducing costs, enhancing technological innovation, improving profitability and productivity, diminishing risk, and improving organizational competitiveness. Balsmeier and Voisin (1996) stated that it can also improve customer service, reduce inventory levels, inventory costs, and paperwork. According to Lambert and Cooper (2000), working with an integrated supply chain involves the constant flow of information, which will aid to build better products. The main focus is the customer, thus all processes and systems must be focused on customers in order to get precise and timely information that will help to quickly react to variations in customer requirements. As a result, managing uncertainties, manufacturing processes, and supplier performance are a key part of successful supply chain management (Lambert and Cooper, 2000).

The main purpose of supply chain management is to improve the organization and the complete supply chain performance (Li et al., 2005). This allows firms to leverage the use of technology, suppliers' processes, and abilities to improve their competitive advantage with the way to use logistics, transportation, distribution, and manufacturing within organizations in an efficient and effective manner (Tan et al., 1999). Supply Chain Management (SCM) is recognized by many organizations as a significant element for creating a sustainable competitive framework for their products or services (Jones, 1998).

1.5.2.1 Supply Chain Management (SCM) in the Forest Products and Wood Pallet Industry

Supply chain management is applied by companies across the globe due to its demonstrated results such as time reduction, better financial performance, improvements in customer satisfaction, trustworthy suppliers, and others. According to D'Amours, Ronnqvist, and Weintraub (2008), the forest products companies resort to supply chain practices to improve their performance. Thus, it is better to first understand how their supply chain works. Figure 1.17 shows a generalized supply chain in the forest products industry (Campbell and Kazan, 2008).

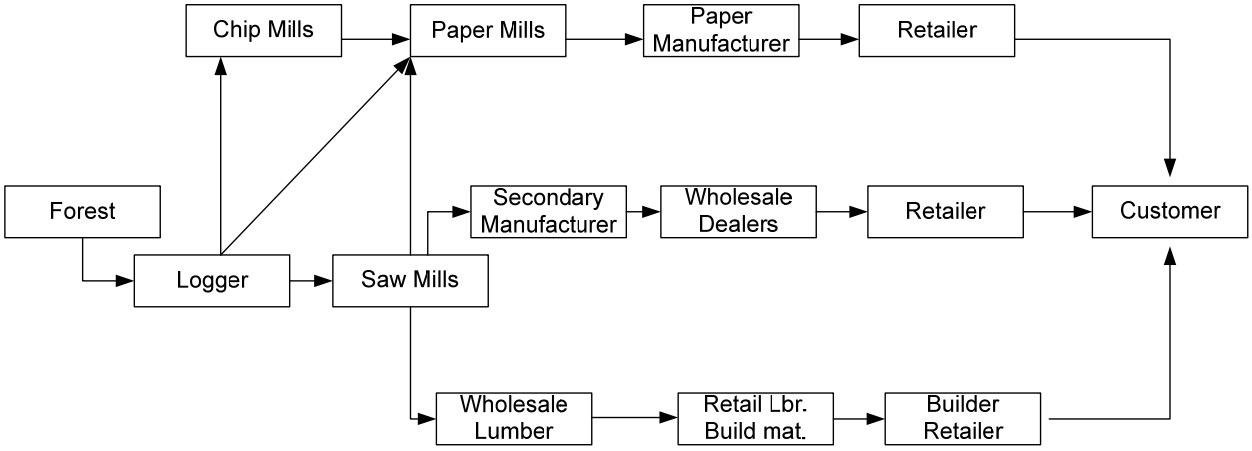


Figure 1.17. Forest and wood products supply chain

Figure 1.18 illustrates the steps of the wood pallet manufacture supply chain. 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.

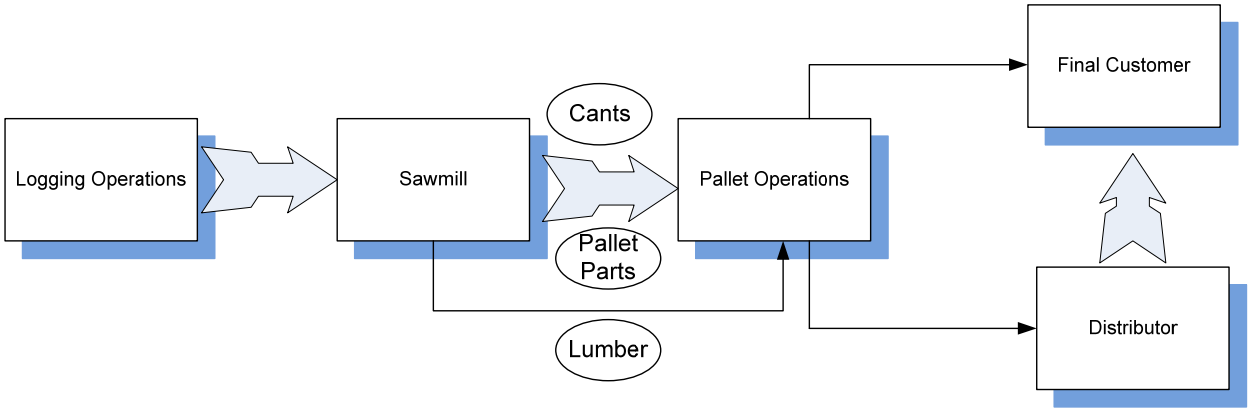


Figure 1.18. Hypothesized wood pallet manufacturing process

1.5.2.2 Wood Pallet Supply Chain Management Factors

To accomplish the objectives of this research, the factors affecting the wood pallet supply chain must be identified first in order to build the research tool, second to carry out data analysis of factors and sub-factors, and third to test relationships among factors. Then, based on previous research conducted by Li (2002),and Quesada and Meneses (2010), some supply chain factors were identified, also literature review supported other factors that were included in the research. The following sections show a generic supply chain management factors and sub-factors that might affect wood pallet supply chain, and which were obtained from secondary sources of information:

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 (2007) 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. This factor

contains three sub-factors: company environment, government support, and uncertainty aspects from overseas.

- 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 expectations about quality and on time delivery and to competition in the sector, as well as the level of rivalry among firms. In order to answer 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.

- 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 includes the use of norms, regulations, policies, and advice for the sector. The research conducted by Elzarka et al., (2011) mentions how government can make a series of reforms to encourage manufacturing exportations with the objective to increase manufacturing sector competitiveness in the international market by creating logistics competency. The increase of international trade for acquiring resources from other countries makes language barriers, transportation, transportation costs, exchange rates, tariffs, and administrative practices complicated matters (Quayle, 2006).

- Uncertainty aspects from overseas

When requiring the outsourcing of raw material or products, it is important to include the presence of environmental uncertainties such as political uncertainties in other countries that can risk 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).

Information Technology

Telecommunications and computer technology allow all the actors in the supply chain to communicate amongst 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 reductions and lead time with the purpose of improving the level of service.

Also, the 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. There are two sub-factors: communication tools and planning tools.

- Communication tools

Electronic Data Interchange (EDI) is used for procurement (order purchase, order status, and follow orders). EDI serves as electronic catalogs for customers who can get information, dimensions, and cost about a specific product. Also, 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 has 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 recommends that the use of ICT is a strategic communication tool improves the organization's competitiveness, allowing cost reduction and permitting the company's effectiveness.

- Planning tools

Enterprise Resource Planning (ERP) allows the order management and fulfillment, and replenishment in a company. It is the backbone of the logistic systems for a variety of firms (Bowersox et al., 2007).

Supply Chain Relationship

Supply chain relationships play an important role for achieving the firm's goals. The coordination and integration of activities with suppliers and understanding the customer's needs gives better 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 relationship 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 relationship with customers.

- Relationship with suppliers

Companies are inclined to work with different suppliers in different ways. It is important that the relationship with suppliers satisfies them and company needs. Hines mentions 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 is significant to network the supplier, meaning to develop partnerships and alliances that will benefit partners. This could be based on production, personal, and or symbolic networking, that will turn on strategic alliances (Hines, 2004), allowing the information sharing, sharing risks, obtaining mutual benefits and coordinating plans, permitting the improvement of the supply chain.

- Relationship 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 and Hoek, customers look for more choices, better service, higher quality, and faster delivery (Burgess, 1998; Hoek, 1999). The relationship with customers turns strategic for the company.

Value-Added Process (Manufacturing)

Value-added products can be commodity process 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 improve 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 part of the value-added process.

- 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 competent firm is measured by how well it is able to accommodate to unpredicted situations.

- 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 with 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.

- Production system

A study made in the automotive glass business showed how changing the industrial structure of the production system add 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, will give value-added to the products (Mehta, 2009).

Supply Chain Management Performance

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 improve 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 wood pallet materials.

- 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 in 2008, mentioned by McGinnis, Khon, and Spillan (2010) establishes that logistics must be focused on the coordination and collaboration of activities, logistics social responsibility, strategic distribution planning, and technology and information systems.

- Supplier markets

According to Yushan and Cavusgil, 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 (Yushan and Cavusgil, 2006). 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).

- Supplier performance

When looking for successful supplier performance, it is important to emphasize relationship quality. Researchers such as Walter (Walter et al., 2003) and Kaufman (Kaufman et al., 2006), propose relationship quality as a "multi-dimensional construct consisting of trust, satisfaction, and commitment", according to Steward, Wu, and Hartley (2010). He also 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."

- Wood pallet materials

Companies in the wood pallet sector are 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).

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 as "*the process of managing networking between companies*" (Ford and Mouzas, 2010).

Fast changes in customer demand, globalization of markets, and changing technology require companies focus their efforts in improving competitiveness, trying to meet 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).

- 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 ofresources for the plan's implementation.

- 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).

- 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 in financial returns on marketing (Rust et al., 2004).

- 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.*"

Customer Satisfaction

The customer's perception is not always the same as the product manufacturer perception. Customers may give more value to low cost, on time delivery, delivery date certainty, and to receive 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 relation management improves operational performance and customer satisfaction. The sub-factor in this research to be analyzed is customer service.

- 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.

1.6 Summary of the Literature Review

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. According to the literature review, the top wood pallet imports 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%, followed by India and China with around 9% each, and Brazil with approximately 7% of the world's roundwood production. 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 due to the subsidy given by the Biomass Crop Assistance Program (BCAP) for alternative energy markets, leading to create demand for low-grade lumber.

Regarding supply chain, companies no longer compete as individual entities but as part of complex networks, they compete as supply chains. Both sides (downstream and upstream) of the supply chain must be taken into account at the same time, when managing supply chains.

Building up strategic supplier-buyer and customer relationship practices and outsourcing resulted in benefits to companies, but only a few companies succeed in this. Companies need to have a clear understanding of the concept of supply chain management. Thus, supply chain relationships play an important role, from supplying raw materials, manufacturing or producing products and services, to delivering the final product to customers.

Supply chain management can help companies to reduce costs and improve financial performance. And also supply chain integration can allow improving performance in quality, delivery, and cost effectiveness.

Looking at the wood pallet industry, seven factors which might affect the wood pallet supply chain were identified from previous research and literature review. These factors are:

- Environmental uncertainties,
- Information technology,
- Supply chain relationship,
- Value-added process,
- Supply chain management performance,
- Business management,
- Customer satisfaction

The following Table 1-7 shows a summary of factors and their respective sub-factors.

Table 1-7. Identification of 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., 2009) • 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) (Bishop, 1990)	• Flexibility (Bowersox et al., 2007) • Production system (Bishop, 1990), (Juran, 1988) • Quality (Dramm, undated),(Bishop, 1990), (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 Co-Operation and Development, 2005), (Schramm, 2008)
Customer Satisfaction (Bowersox et al., 2007)	• Customer service (Handfield and Nichols, 1999), (Lambert and Cooper, 2000)

Chapter 2. PROFILE OF THE U.S. WOOD PALLET SUPPLY CHAIN

Part of the research objectives was to increase the understanding of the U.S. wood pallet manufacturing industry, its supply chain management practices, and factors affecting the supply chain management processes. For that reason, a profile of the U.S. wood pallet supply chain was developed to increase the understanding of the U.S. wood pallet industry and its supply chain. To accomplish the objectives of this chapter, the research tool used was a nationwide survey of 1,500 companies. This survey was conducted to collect the necessary information to develop a profile of the US wood pallet supply chain. Collected information included company demographics, wood pallet manufacturers organization, and wood pallet manufacturers supply chain, as part of the questionnaire's structure. An adjusted response rate of 14% was obtained, representing approximately 8% of US wood pallet and container manufacturing companies. 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.

Results show that respondents had in average a pallet output of 727,229 units, 20 to 99 employees, and gross sales between 1 and 5 million dollars. In 2009, respondents indicated that 58% of a recycled/repaired wood pallet is manufactured with recycled wood pallet material, and 42% with new wood pallet material. Thus, the ratio of recycled to new wood pallet material was approximately of 6 to 4. About their monthly raw material input, the average use of lumber, cants, pallet parts, and pallet cores was 2.16 million board feet (MMBF), 1.55 MMBF, 2.12 MMBF, and 110,000 units, respectively. Regarding supply chain management practices, 73.1% of respondents are likely to sell their products to manufacturers (pallet users) without the intervention of a middle-man. Lead time for raw material purchasing is relatively short, with 48.6% of respondents reporting 1 to 5 days. Among the most important factors for purchasing decision were availability, cost, reliable supplier, quality, delivery on time, strength, and workmanship. A great majority of respondents indicated that customers are not willing to pay a

premium for environmentally-certified pallets (86.0%). Lastly, companies identified as most important factors the preference to work with domestic wood pallet materials (average rating of 4.3), and high competition for the acquisition of raw materials (average rating of 4.3).

Results provided pallet manufacturers with information useful to improve their supply chain management practices, such as when determining order-to-shipment lead time, which occurs when manufacturers request supplier's raw material, respondent companies reported a lead time of 1 to 5 days. Also on average, factors such as investments in communication tools and the use of internal computer network were rated highest (average of 3.5 each). On the other hand, internet use for business processes, personnel training on information technology, and Enterprise Resource Planning (ERP) use received relatively low ratings. Regarding business management factor, the highest ratings were given to offer wood pallets directly to the customer (4.5), to offer competitive wood pallet prices (4.3), to work with differentiation strategy (4.1), and to emphasize the benefits of the product compared to competitor's (4.0). Outcomes from this research can also be used by suppliers to the industry, concentrating on those factors that are most important for wood pallet manufactures. Lastly, educational institutions and industry support organization can use this information to develop effective assistance programs.

2.1 Introduction

One of the major business developments of the last decade is the emergence of supply chain management (Espinoza, 2009; Lambert et al., 1998; Tan et al., 1999). A supply chain is a system constituted by materials, suppliers, facilities, and customers, connected by the flow of materials and information (Lambert and Cooper, 2000). 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 (Lambert and Cooper, 2000). Successful companies realize the need to work in close relationship with their suppliers and customers, pursuing the same objective: customer

satisfaction (Fynes et al., 2005). Research has demonstrated that collaboration between supply chain members provide significant competitive advantage (Tan et al., 1999). Typical benefits from supply chain management practices are shortened lead time, reduced costs, improved design, and overall improved customer satisfaction (Fynes et al., 2005). 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) (Retailing Today, 2010), where the appropriate information can improve companies' operations. Other researchers mentioned that it is difficult for firms to give up their private information regarding cost, manufacturing and warehousing capacity data, inventory levels, demand forecasts, which is required to make joint-decisions (Bagchi and Skjoett-Larsen, 2005; Fawcett et al., 2004). Therefore, some tools were created, such as secure multi-party computation, which allows the secure use of information between customer-supplier and the achievement of financial benefits (Pibernik et al., 2011).

The U.S. wood pallet industry faces several challenges to its competitiveness; among these, the competition for wood fiber with other users (Sonenklar, 2010); competition from substitute products such as plastic and steel pallets (Hamner, 2007); lobby from competitors to limit their use for food safety reasons (Brindley, 2010b); 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 (Lambert and Cooper, 2000). However, according to the literature review, studies about supply chain management in the pallet industry are scarce, and there is a lack of information about channels of distribution, importance of imported materials, and supplier and customer relationship management. This chapter is an attempt to fill this gap in the research by accomplishing the following objectives:

1) Estimate production volumes, major suppliers, and species distribution of wood pallet material imports and domestic production in the U.S.
2) Compare characteristics of imported and domestically produced pallets from a business perspective.
3) Increase the understanding of the U.S. wood pallet manufacturing industry, its supply chain management practices, and factors affecting the supply chain management processes.

The outputs of Chapter 2 will provide wood pallet manufacturers with useful information about raw materials (types, volumes, and potential sources), characteristics of wood pallets, and their supply chain practices. The outputs about supply chain management factors will supply them with knowledge about key practices that companies can adopt, taking into account those that were rated as the most important. Additionally, timely information is needed to help suppliers and customers to better understand the industry, and for academics to plan future research.

2.2 Methodology

The major tool used in this study is a nationwide mail survey of wood pallet manufacturers. The research process is illustrated in Figure 2.1, which is showed in the general methodology in Figure 1.1, as part one of outputs. The individual steps are explained in detail in the following sections.

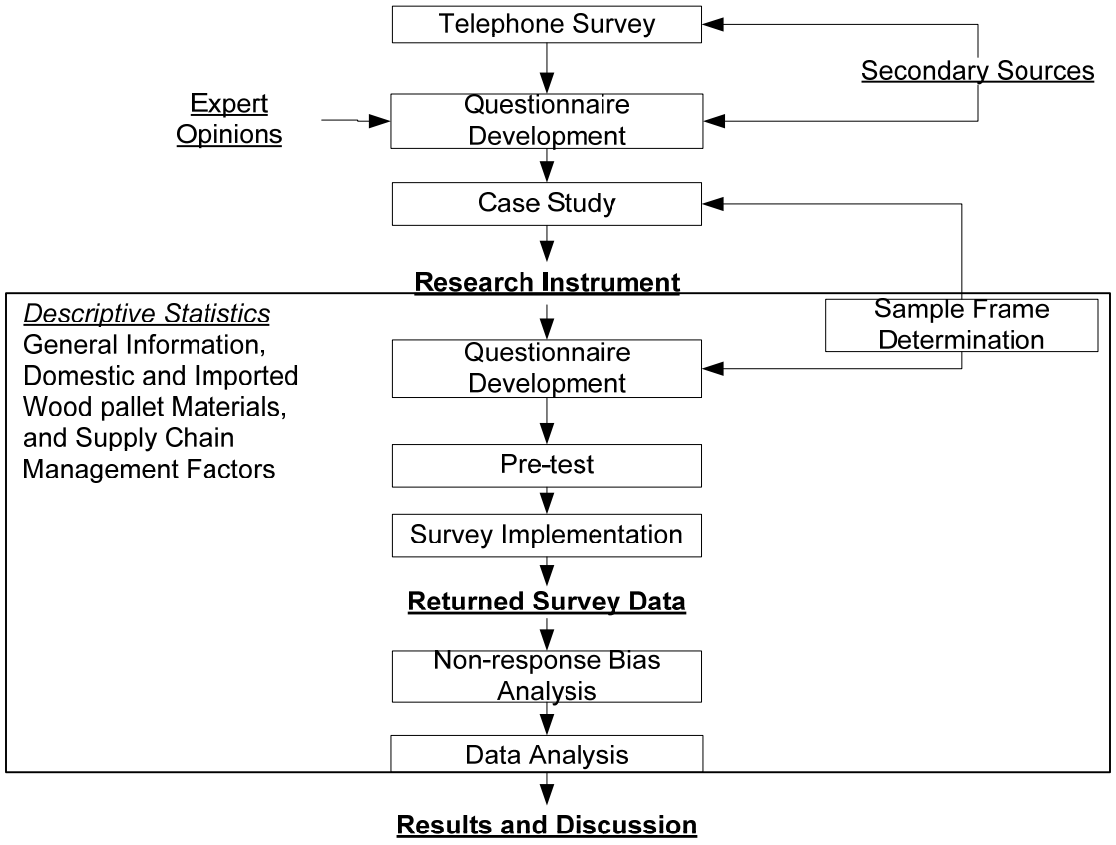


Figure 2.1. Survey research methodology

2.2.1 *Survey Inputs*

2.2.1.1 Experts' Opinions

Professionals related to the wood pallet industry were asked for opinions and advice referent to information about wood pallets. They also helped with the reviewing of the questionnaire content, giving suggestions for the improvement of the survey tool.

2.2.1.2 Analysis of Secondary Sources

The objective of the literature review was to find out how much information is available about the U.S. wood pallet industry, specifically productions volumes, types of pallets manufactured, species of raw materials, imports, and channels of distribution. The

information collected was useful in identifying information needs and to design the questionnaires for the survey.

The consulted sources were the Census Bureau, the National Wooden Pallet and Container Association (NWPCA), Western Pallet Association (WPA), Food and Agriculture Organization, opinions of experts, theses, journals, articles, and other web pages related to the research topic.

2.2.1.3 Telephone Survey

From the literature review, it was found that there is a lack of information about the importance of wood pallet imports (or materials for wood pallet manufacturing) and the number of companies importing pallet materials. Therefore, before developing the questionnaire for the mailed survey, it was decided to conduct a telephone survey to estimate the number of companies importing raw materials or wood pallet parts, in order to estimate how much of questionnaire space to dedicate to questions about imported pallet materials. A list of 771 companies was compiled randomly from trade associations lists, available through the Internet. Specifically lists from the National Wood Pallet and Container Association (640 companies) and the Western Pallet Association (131 companies) were used. The sample represented 30% of the total number from the lists and 8.7% of the total number of wood pallet manufacturing companies, according to the Census Bureau (U.S. Census Bureau, 2010f).

Based on the objectives of the research the two questions were included in this survey: 1) does you company manufacture wood pallets? and 2) does your company import wood pallets, or wood pallet materials? These questions were addressed to the available person from the production area. Each call lasted 5 to 10 minutes.

2.2.1.4 Case Study

After the literature review, three case studies were conducted with the purpose of collecting in-depth information needed to meet the objectives and to design a questionnaire for the next stage of the research. The results from the case studies were

an important input for the development of the questionnaires to be used in the nationwide survey of wood pallet manufacturers. Multiple case studies are more convincing and robust than a single case design (Yin, 1989).

For the case studies, a number of companies were selected and contacted to ask for their participation. The case study was applied to companies in the U.S. that have experience working with domestic and imported wood pallet materials. Three companies agreed to participate.

The research instrument used during the case studies was developed using three basic inputs: the secondary sources, experts' opinions, and the telephone survey. Experts consulted came from the academic world and the industry. The research instrument consisted of semi structured questionnaires contained three main parts: (1) demographic information, (2) wood pallet material imports, and (3) factors affecting purchase decisions, and enclosed 19 questions. The questions are listed below:

- Do you import lumber/wood pallets/pallet parts (all of them)? Why?
- How long has your company been working with imported material?
- Do you purchase your materials directly from a supplier overseas or through an intermediary? Why?
- What imported wood species are you using? What are the countries of origin?
- How does the system work for importing?. For example, some company asked you to bring some type of lumber/pallet/pallet parts and gives you the name of the company of overseas to deal with. Can you explain, please?
- According to your experience, rank from 1 to 7, the importance of the following factors on your purchase decision of lumber/wood pallets/pallet parts (1 is the most important and 7 the least important).
- During importing what trade barriers such as regulations, procedures, reliable delivery, part of entry, or other occur?
- Do you expect/plan to increase the volume of imported lumber/wood pallet/pallet parts in the next 6, 12, or 24 months? Why?

- What is your opinion about working with lumber/wood pallet/pallet parts from overseas?

Results from the case studies were essential input for the development of the questionnaire to be used in the nationwide mailed survey of wood pallet manufacturers.

2.2.2 *Survey Design*

In this step of the research process, a nationwide survey was conducted among wood pallet manufacturers in order to identify volumes, imported and domestic wood species, as well as perceptions of importers and producers in regards to product technical performance and business characteristics, and also to understand the supply chain and supply chain success factors.

The survey process is summarized in Figure 2.2, and a brief explanation follows. This is an adaptation of Dillman's Tailored Design Method (Dillman, 2000).

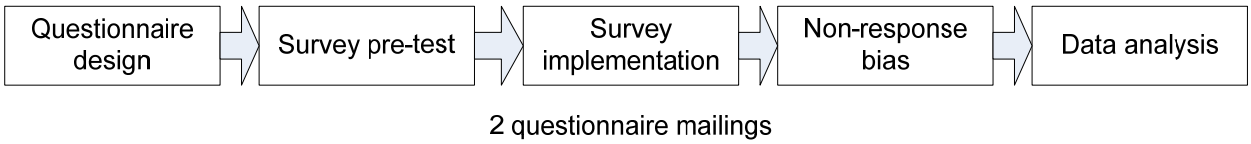


Figure 2.2. Survey process

2.2.2.1 Sample Frame Determination

According to the Census Bureau, there were about 2,600 companies in the U.S that produce wood pallet and container in 2006 (U.S. Census Bureau, 2010f). 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. The mailing list was initially compiled resorting to sources like the National Wooden Pallet and Container Association (NWPCA), the Western Pallet Association (WPA) and forest

products company directories found from the Internet, and from state governments' directories. Due to the possibility that many companies in the compiled list might not have actualized address information, it was possible to have access to an up-to-date mailing list through the help of a wood pallet magazine.

After identifying the target population, it was necessary to determine the sample size. This could be accomplished by using the following mathematical relationship for proportions (Rea and Parker, 2005)

$$n = Z^2 p(1-p)/H^2$$

Where: Z= Z value in normal distribution tables (1.96 for 95% confidence level)

p= estimated proportion of the population that presents the characteristic (0.5 is used as a conservative value, higher or lower values yield a smaller required sample size)

H= the precision level or margin of error, expressed as decimal (e.g., 10% = 0.1)

Then, $n = (1.96)^2 0.5(1-0.5)/0.1^2$

$$n = 96.04 \approx 96$$

Therefore, approximately 96 complete questionnaires were needed. Based on the sample size of 1,500, and not considering wrong addresses, this corresponds to about a required 6.5% response rate.

In the case of interval data , according to Rea and Parker (2005), the minimum sample size for a population of 3,000 (approximate number of wood pallet manufacturers in the U.S., according to the Census Bureau) for a 95% of confidence level and ±10% of confidence interval is 94, as it is shown in Table 2-1:

Table 2-1. Minimum sample sizes for interval data

Population Size	Sample Size Needed 95% Confidence Level and ±10% Confidence Interval
1,500	91
2,000	92
3,000	94

2.2.2.2 Questionnaire Development

The questionnaire was developed taking into account experts' opinion, secondary sources, telephone survey, and results from the case studies. The questionnaire had three sections: (1) general information, (2) importance and characteristic of imported and domestic wood pallets, and (3) supply chain management factors. A first draft was subject to review by experts in the academic world and industry. Their feedback was used to improve the questions, eliminate 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. This last version was approved by the Institutional Review Board (IRB) at Virginia Tech and used in the nationwide survey.

Questionnaire Design

Regarding questions in the questionnaire, these were designed based on experts' opinions, secondary sources of information (literature review), telephone survey, and case studies. As mentioned before in the general methodology in Chapter 1 (Figure 1.1) and the methodology in Chapter 2 (Figure 2.1), descriptive statistics will be the output for this chapter. Therefore, it was thought that the questionnaire will contain three parts: (1) general information, (2) domestic and imported wood pallet materials, and (3) supply chain management factors. Regarding supply chain management factors, the identification of possible factors affecting the wood pallet supply chain were required to be included in the questionnaire. The process of identification of factors can be seen in Section 1.5.2.2 in Chapter 1. Table 2-2 shows the sections of the questionnaire that are covered in this chapter and their respective citations.

Table 2-2. Questionnaire design

Questionnaire Structure			
Section	**Questions**		**Citations**
1. General Information	1. Type of business 2. Major products 3. Ratio of recycled and new wood pallet materials in a recycled wood pallets 4. Number of employees 5. Average pallet production 6. Annual average gross sale		(Bejune, 2001), (Bush and Araman, 2008), (Cossio, 2007), (Li, 2002), (Quesada and Meneses, 2010)
2. Domestic and Imported Wood Pallet Materials	7. Domestic wood pallet materials factors 8. Purchasing raw materials factors 9. Monthly raw material input 10. Average lead time 11. Average order frequency 12.Major customers 13. Wood pallet materials from overseas 14. Environmentally certified wood pallets 15. Barrier imports factors 16. Imported wood pallet materials factors 17. Comparison of domestic and overseas suppliers 18. Wood species and origin		(Bejune, 2001), (Celestino, 1999), (Cossio, 2007), (Li, 2002), (Michael and Smith, 1995), (Pakarinen, 1999), (Parhizkar, 2008), (Yin, 1998)
3. Supply Chain Management Factors (Factors and sub-factors)	19. Environmental uncertainties	Company environment Government support Uncertainty aspects from overseas	(Wu, 2006), (Ambrose et al., 2010), (Chen et al., 2004),(Quayle, 2006), (Bized, 2007), (Dwivedi and Butcher, 2009)
	20. Information technology	Communication tools Planification tools	(Bowersox et al., 2007; O'Neill, 2008), (Tan et al., 2009), (Simchi-Levi et al., 2003), (Tim,2007), (Turner,1993)
	21. Supply chain relationships	Relationship with suppliers Relationship with customers	(Hines, 2004), (Li et al., 2005), (Burgess,1998), (Hoek, 1999), (Fraza, 2000)
	22. Value-added process (manufacturing)	Flexibility Production system Quality	(Bishop, 1990), (Juran, 1988), (Dramm, undated), (Benetto et al., 2009), (Bowersox et al., 2007), (Mehta, 2009), (Just-Auto, 2010)
	23. Supply chain management performance	Logistic issues Supplier markets Suppliers performance Wood pallet materials	(McGinnis et al., 2010), (Yushan and Cavusgil, 2006), (Eltantawy, 2005),(Steward et al., 2010), (Lockamy and McCormack, 2010), (Canbolat et al., 2008), (Simchi-Levi et al., 2003),
	24. Business management	Process strategy Process performance Marketing strategy Innovation	(Thomas et al., 2008), (Sultan, 2006), (Pakdil, 2010), (Hung, 2010), (Ford and Mouzas, 2010), (Linzalone, 2008), (Peterson, 1989), (Thomas et al., 2008), (Verhees and Meulenberg, 2004), ,(Meeus and Oerlemans, 2000), (Organization for Economic Co-Operation and Development, 2005), (Schramm, 2008)
	25. Customer satisfaction	Customer service	(Handfield and Nichols, 1999), (Lambert and Cooper, 2000), (Quayle, 2006), (Kurata and Num, 2010), (Ou et al., 2010)

2.2.2.3 Pre-Test

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.

2.2.2.4 Survey Implementation

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 1,500 wood pallet manufacturers, with a four week-separation between each mailing (Cossio, 2007; Dillman, 2000). Questionnaires were mailed during the fall of 2010.

2.2.2.5 Non-Response Bias

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, 1997; Lahaut et al., 2003).

Three company characteristics were selected for the non-response bias analysis: number of employees, revenue, and pallet production output.

2.2.2.6 Data Analysis

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.

2.3 Results and Discussion

2.3.1 *Telephone Survey*

From 771 companies contacted, 186 companies agreed to participate. Most of the respondents were wood pallet manufacturers (74.7% of respondents). One hundred seven companies mentioned that they were currently working with domestic wood pallet material, and 36 companies with imported wood pallet materials. Thirty-two companies were importing from Canada and 4 from Chile and Brazil. It has to be considered that Canada has many species similar to the U.S., and the imports from other countries without taking into account Canada did not seem to be significant. Results from this phone survey were important to decide how much of the questionnaire for the national survey to dedicate to imports issues. Table 2-3 shows the results of this first telephone contact.

Table 2-3. Telephone survey results

	NWPCA	WPA
Uses solely domestic materials	65	42
Uses both domestic and imported	77	62
Imports materials from Canada	12	20
Imports from other than Canada	2	2

2.3.2 *Case Study*

Results from the case study showed that one company is still importing wood pallet parts for domestic pallet assembly, and the other companies are not importing wood pallet materials at the time of the case study (see

Table 2-5). Of the three, two companies sourced both types of wood, softwood and hardwood domestically and internationally, depending on commodity price fluctuations and demand. All these companies were working with imported materials for at least for 15 years. They bought their raw material directly from the exporter. Among the purchased imported species were illiatus, taeda, radiata, and caribean pine. Table 2-4 shows the species and country of origin.

Table 2-4. Origin of raw materials

Species	Country
Elliottii Pine	Brazil
Taeda Pine	Brazil, Argentina, and Uruguay
Radiata Pine	Chile, Ecuador
Caribean Pine	Venezuela
Eucaliptus	Brazil, Argentina, and Chile
Cedar	China

Firms also indicated that there exist some advantages when using imported wood pallet materials, such as: price, long term pricing programs offered, and availability, sometimes producing items that U.S. sawmills do not make. On the other hand, logistics, lead times, consistency, ocean freight problems, and material damage, due to so much handling were identified as disadvantages. It is also necessary to mention that the most important factors to take into account for purchase decisions were price, quality grade, volume, and workmanship. About increasing imports in the short-term, two companies seemed to feel satisfied to work with reliable suppliers, and one company mentioned that this depends on two factors: (1) availability and (2) cost. The three companies indicated that they feel attracted to create relationship with countries from overseas, because it is a challenge that give them not only profit satisfaction but experience getting involved with other cultures.

Table 2-5 shows the respective responses by company.

Table 2-5. Case study results

Case Study			
Topic	**Company 1**	**Company 2**	**Company 3**
1.Main business	New wood pallet manufacturer	New wood pallet manufacturer	Recycle wood pallets
2.Major products	New wood pallet	New wood pallet	Recycled wood pallets
3.Association member	NWPCA	No answer	No answer
4.Wood pallet material type imports	Lumber, because it is another competitive source of materials	Lumber, because its price and availability	Pallet parts, depending on commodity price and supply and demand
5.Percentage of imported wood pallet materials (wpm) in business	Not importing at this time	Not importing at this time	No answer
6.Time working with imported wpm	15 – 20 years	18 years	Several years
7.Raw materials purchase channel	Directly from the supplier	Directly from the supplier	Directly from the supplier
8.Wood species and origin	Elliottii and taeda pine from Brazil Radiata pine from Chile Caribean pine from Venezuela Eucaliptus from Brazil	Illiatus and taeda pine from Brazil, Argentina, and Uruguay Radiata pine from Chile and Equator Cedar from China Eucalyptus from Brazil, Argentina, and Chile	No answer
9.Advantages and disadvantages of imported wpm	Advantages: Logistics and consistency of availability Disadvantages: Cost variations	Advantages: Cost, availability, long term pricing programs Disadvantages: Lead times, ocean fright issues, material damage, custom delays	No answer
10.Purchasing decision factors (from the highest rate to the lowest rate)	Price, quality grade, and workmanship	Quality grade, price, and volume	Quality
11.Pallet price	Depends on the product	Depends on the product	No answer
12.Imported wpm price	It depends	Average Pine cost in South America is $220-$220 cbm FOB	No answer
13.Barrier imports	Consistency, reliability, and competitiveness	Volume, quality grade, price, strength, stiffness	No answer
14.Volume increase for imported wpm in the future	Depends on availability and cost	Plan to increase imports	No answer
15.Perception about working with imported wpm	Positive experience	Enjoy the experience	Positive experience Reliable suppliers
16.Purchasing wpm with environmental certification	No answer	More on plywood than lumber	No answer
17.Regulation compliance for wpm imports	Heat treatment	Only SFI (Sustainable Forestry Initiative)	All the applicable laws of each country
18.Treatment Type	Heat treatment	No answer	Heat treatment
19.Customer contact and exporter company name from overseas	No answer	Company supplier: Arauco Wood products	No answer

2.3.3 *Nationwide Survey of Wood Pallet Manufacturers*

Previous to conducting a nationwide survey, a research questionnaire was developed using experts' opinions, secondary sources of information, telephone survey, and case study, as major inputs. The questionnaire contains three sections: (1) general information, (2) domestic and imported wood pallet materials, and (3) supply chain management factors. Descriptive statistics were used to show the results of these sections from question 1 to question 25.

2.3.3.1 Survey Results

Response Rate

A mail survey was carried out to collect the data from U.S. wood pallet manufacturers. Fifteen hundred questionnaires were sent nationwide to wood pallet manufacturer firms. Two hundred forty nine questionnaires returned. Of those returned, forty one were questionnaires that were delivered to wrong addresses, five were out of business, one declined, and two hundred two were completed questionnaires, which were evaluated. The rest could not be evaluated due to their lack of information. The response rate was 14% used for data analysis, as seen in Table 2-6. It can be said that the response rate was satisfactory, taking into account the economic problems that the industry is facing and the difficulty to find companies willing to share their data. In total, and taking the information from the U.S. Census Bureau (2007), this survey was completed by 8% of all US wood pallet and container companies.

Table 2-6. 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 decline to fill out	1
Undeliverable	41
Non-respondents	1,251
Adjusted response rate	14%

Non-Response Bias

A non-response bias was carried out to evaluate if respondents tend to have different characteristics than non-respondents, in which case the conclusions from this study might not apply to all companies in the target population. To accomplish this, company characteristics of early respondents were compared to those who returned the questionnaire late (Etter and Perneger, 1997). Early respondents were defined as those who responded after the first mailing, and late respondents were those who responded after the second mailing. Chi-square test was applied for question 4 (number of full time employees) and question 6 (annual gross sale), and Mann-Whitney test was applied for question 5 (wood pallet production).

Number of Employees. Data for number of full time employees was categorical, thus, the difference between the number of employees between early and late respondents was tested with a Pearson Chi-square, resulting in a p-value of 0.002 (significant at alpha=0.05), thus showing that non-respondents had different number of employees than respondents. In Figure 2.3 the frequency distribution of number of employees is illustrated, and suggests that respondents to this survey were in average larger companies than non-respondents, as measured by the number of employees. This has implications for the application of the results and conclusions from the study.

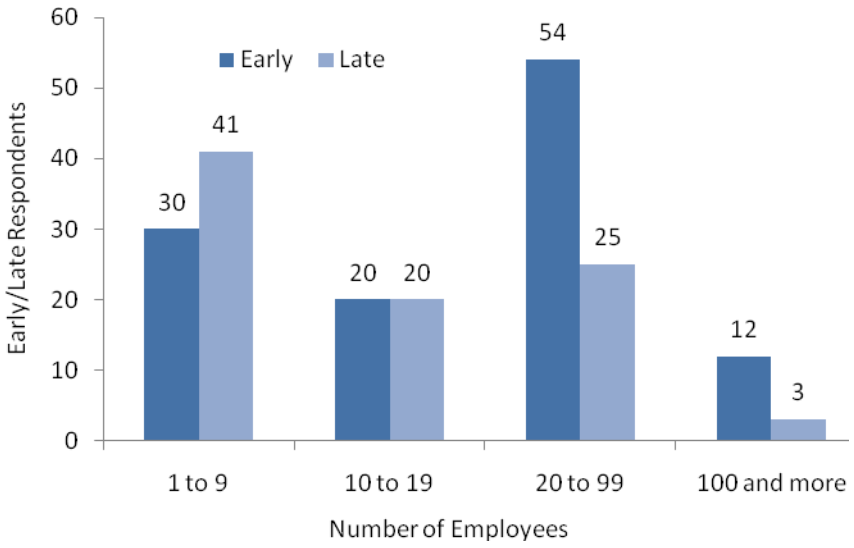


Figure 2.3. Frequency distribution of number of employees

Revenue. The average gross sale was categorical data. Pearson Chi-square was used for testing early and late respondents, yielding a p-value of 0.004. This means that there is significant difference in revenue between respondents and non-respondents (see Figure 2.4). In Figure 2.4, respondent companies were more numerous in larger revenue categories, similarly to number of employees, suggesting that larger companies were more likely to complete and return the questionnaire.

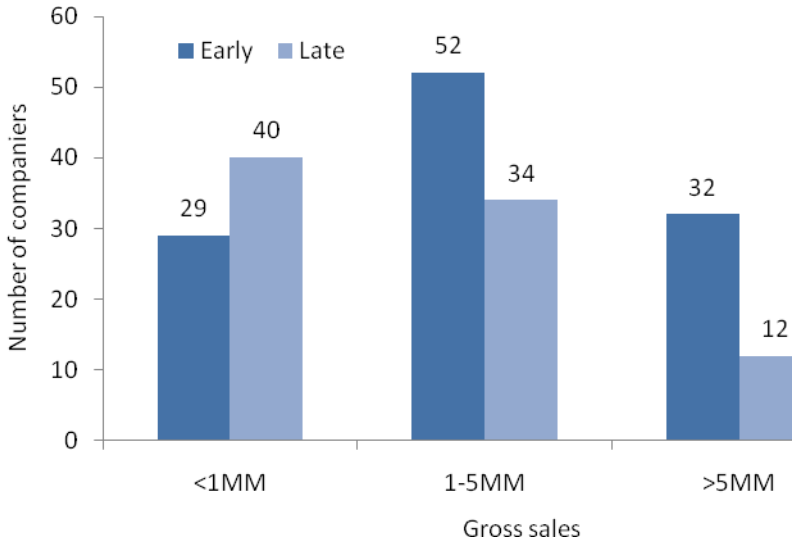


Figure 2.4. Gross sales frequency (Millions).

Pallet Output. The difference of pallet production data for early and late respondents was tested for normality, as this was not a categorical data in the questionnaire, using a Kolmogorov-Smirnov test, which yielded a p-value <0.01, meaning that the data is not normally distributed. Consequently, a non-parametric Mann-Whitney test was carried out to compare the means; this test resulted in a p-value of 0.023, which denotes significant difference between the average pallet output for early and late respondents. Since this non-response bias assessment uses late respondents as a proxy for non-respondents, these results suggest that non-respondents tend to have smaller output than respondents (average output of 822,939 and 574,004 pallets, respectively). Results from the non-response bias tests are summarized in Table 2-7.

Table 2-7. Non-response bias results

Variable	Test	p-value	Result
Gross sales	Chi-square	0.004	Significant difference between respondents and non-respondents
Number of employees	Chi-square	0.002	Significant difference between respondents and non-respondents
Pallet output	Mann-Whitney	0.023	Significant difference between respondents and non-respondents

Regarding significant difference between early and late respondents, the research carried out by Cumbo (2000) shows the existence of bias similar to what was found in this research. Results from the non-response bias assessment appear to show that larger companies were more likely to respond to this survey. This means that conclusions from this study will mostly apply to medium-sized and large companies.

According to the Bureau of Labor Statistics (U.S. Census Bureau, 2010a), the wood pallet and container industry had around 22 employees in average per firm (57.400 employees in 2006), and shipped a total value of $7 billion in 2008 (U.S. Census Bureau, 2010c). The respondents to this survey had the range with the highest percentage of employees from 20 to 99 employees and annual revenue from $1 to $5 million in 2009.

General Information

The first section of the questionnaire corresponded to general information about the respondents, such as major activities, number of employees, quantity of pallet production, and annual average gross sale.

- Type of business

Figure 2.5 shows that 93% of firms who responded to the questionnaire were manufacturers of new wood pallets, followed by 45%, which corresponded to a pallet recycler or repairer. Pallet broker, lumber broker and pallet material importer accounted to 8%, 5%, and 3% of respondents respectively. “Other” type of business accounted to 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. Respondents may be involved in multiple business activities.

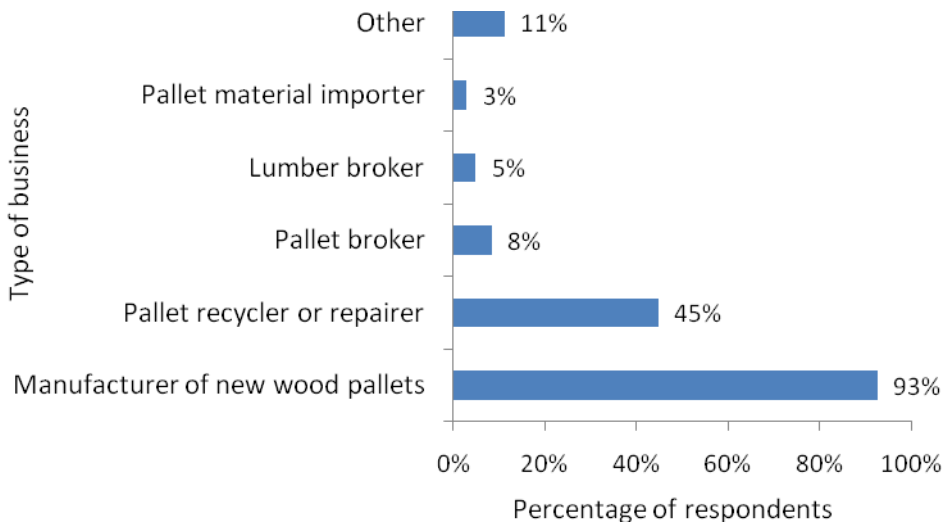


Figure 2.5. Distribution of respondent by type of business

- Major products

Companies were asked to report their major products in 2009. Approximately 70% of companies reported new wood pallet production as their primary activity, followed by recycled/repaired wood pallets with approximately 18%. Nevertheless, there were many companies who were dedicated to other business activities such as lumber, wood pallet parts, railroad ties, wood containers, and other types of production (see Figure 2.6). According to respondents, “other” activities included production of dunnage (wood packaging material to secure a commodity), survey stakes, firewood, mulch, sawdust, chip, bark, plywood, and specialty wood packaging. Also services such as pallet disposal and heat treatment were identified in the research. The report of 2006 done by Bush and Araman (2008) indicated that 57% of companies reported new wood pallet production as their primary activity, similar to results from the survey.

This difference between 2006 and 2009 seems to be reasonable because according to the data obtained from Census Bureau (2010c), the domestic production of wood pallets went through an increase of about 11% in the 2006-2008 periods, even though the economic recession of 2009 reduced business activity for the wood industry.

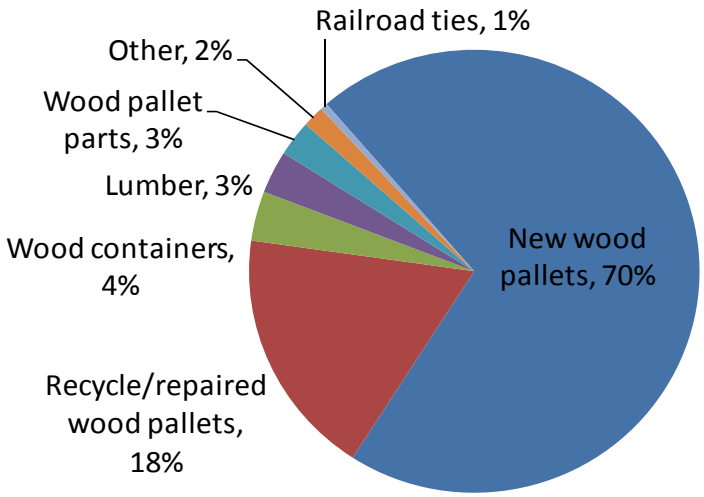


Figure 2.6. Companies' major products

- Recycled and new wood pallet material

Figure 2.7 illustrates the percentage of participation of new and recycled wood pallet material used when manufacturing recycled wood pallets. According to respondents, 58% of a recycled wood pallet is manufactured with recycled wood pallet material, and 42% with new wood pallet material. Therefore, the ratio of recycled to new wood pallet material was approximately 6 to 4. According to Bush and Araman (2008) the production of recycled wood pallets has shown an increase due to their advantages in cost, and technical characteristics compared to new wood pallets. They also reported that in 1999 the U.S. domestic production of 223 million recovered, repaired, remanufactured pallets and 321 million in 2006 an increase of approximately 44%.

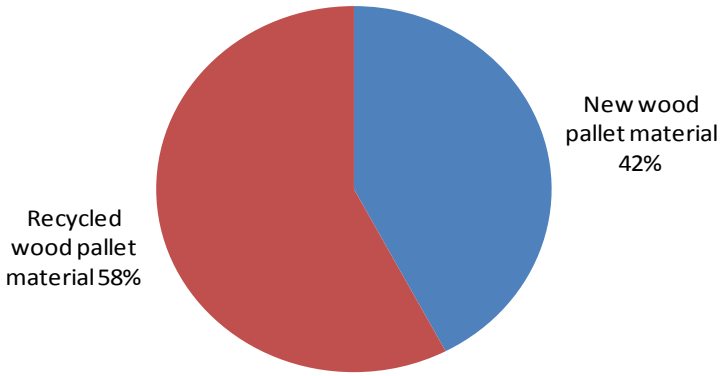


Figure 2.7. Percentage of firms recycling, manufacturing new wood pallet material

- Number of employees

Figure 2.8 shows the distribution of number of employees among respondent companies. The highest frequency (38.6% of respondents) corresponded to companies with 20 to 99 employees. Seventy eight companies indicated that they had from 20 to 99 employees, representing 38.6% of the respondents.

Companies that worked with 19 or fewer full-time employees represent 54.0% of the respondents. Only 7.4% indicated that they worked with more than 99 employees. Comparing these figures to the Census Bureau's (2010f), the highest frequency corresponded to the smallest range of number of employees per establishment (1 to 4) followed by 20 to 99 employees per establishment (see Figure 1.6). As the non-response bias assessment demonstrated, smaller companies were less likely to respond to this survey than larger companies.

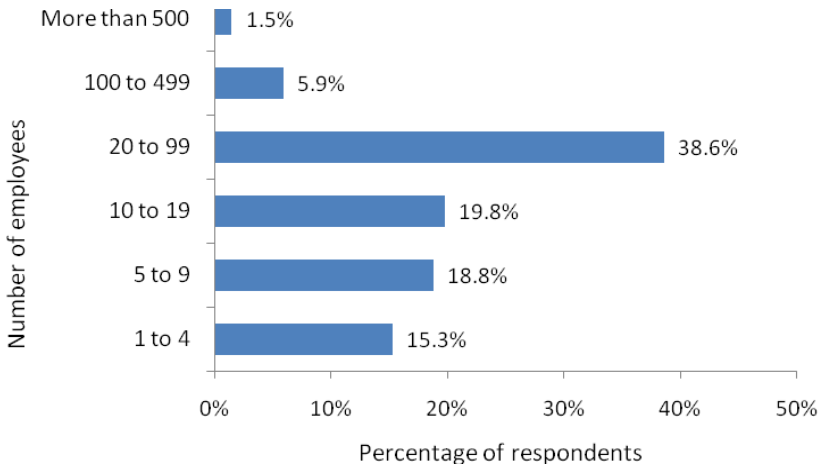


Figure 2.8. Number of full-time employees

- Pallet production

The wood pallet production distribution is shown in Figure 2.9. Thirty five percent of companies made less than 100,001 wood pallets in 2009. A little over a fifth of respondents (21.3%) produced between 100,001 and 1,000,000 wood pallets in 2009. Thirteen percent of companies produced more than 1,000,000 wood pallets. The average pallet production per year was 727,229 units, approximately 42% more than the amount that Bush and Araman (2008) indicated in their 2008 report, which was 512,533 units for 2006. The difference can have two potential explanations: as was found in the non-response bias assessment, larger companies were more likely to respond to this survey, and thus this is reflected in Figure 2.10. The other potential explanation is an increase in production from 2006 to 2009.

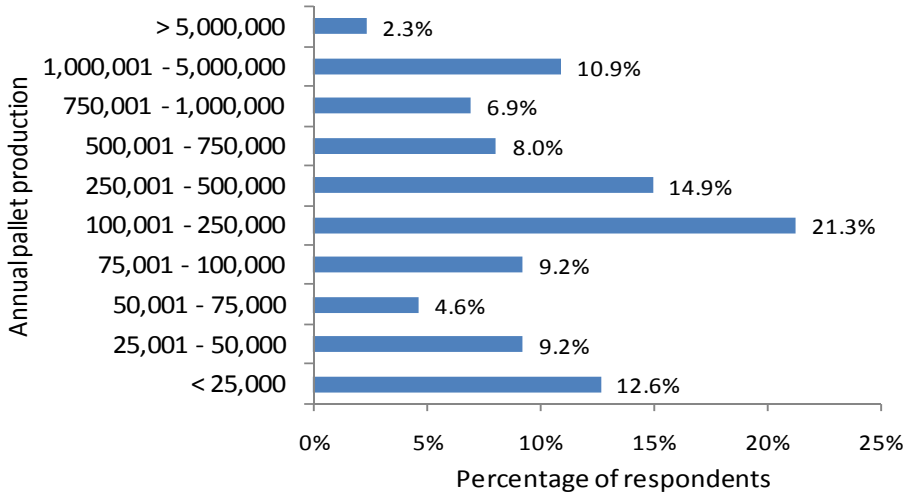


Figure 2.9. Wood pallet production per company

- Gross sales

Figure 2.10 shows the annual average gross sale for 2009. Forty three percent of respondents reported having gross sales from 1 to 5 million dollars, followed by 35% indicating less than 1 million dollars in revenue. Sales between 5 and 30 million dollars were reported by 22% of companies.

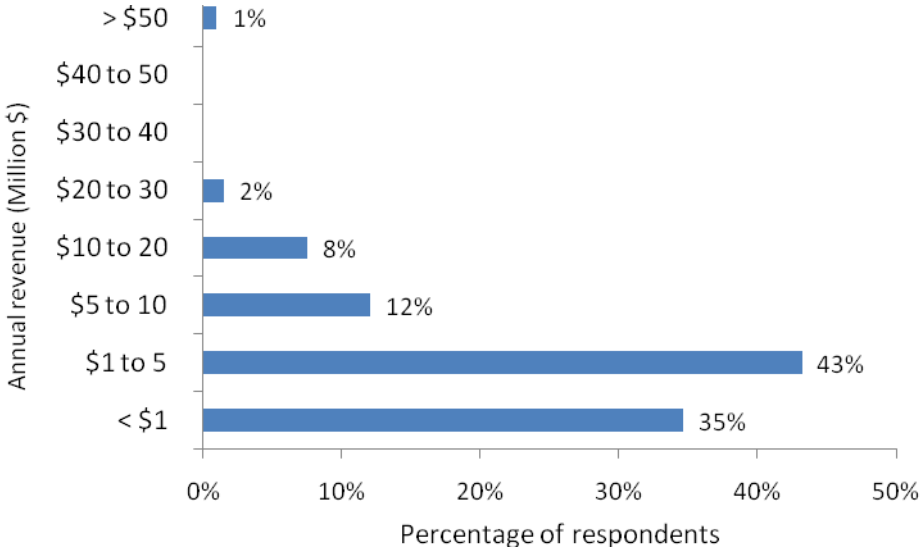


Figure 2.10. Annual average gross sales (Million $)

Domestic and Imported Wood Pallet Materials

The second section of the questionnaire was about wood pallet manufacturers perceptions (as seen in Table 2-2) regarding domestic and imported wood pallet materials, species type and quantity of raw material, supplier's lead time from order to shipment of raw materials, raw materials' order frequency, customers distribution, importance of environmentally certified wood pallets, and identification of barrier imports.

- Domestic wood pallet materials

The question was focused on the perception of wood pallet manufacturers' regarding the use of domestic wood pallet materials. It was asked to rate in a five-point Likert scale (1 being strongly disagree, and 5 being strongly agree) the rated factors regarding wood pallet materials. Figure 2.11 shows that the items "domestic wood pallet materials are of high quality", and "domestic wood pallet materials supply is not consistent" received the highest average ratings (3.2); indicating that although respondents are satisfied with the quality of the raw materials they use, they are less impressed by the consistency of the supply. Timeliness of deliveries, transportation issues, and information from suppliers do not seem to be a problem for respondents, as reflected in the relatively high disagreement with these statements (Figure 2.11). It is important to note, however, that no factor was rated higher than 3.2.

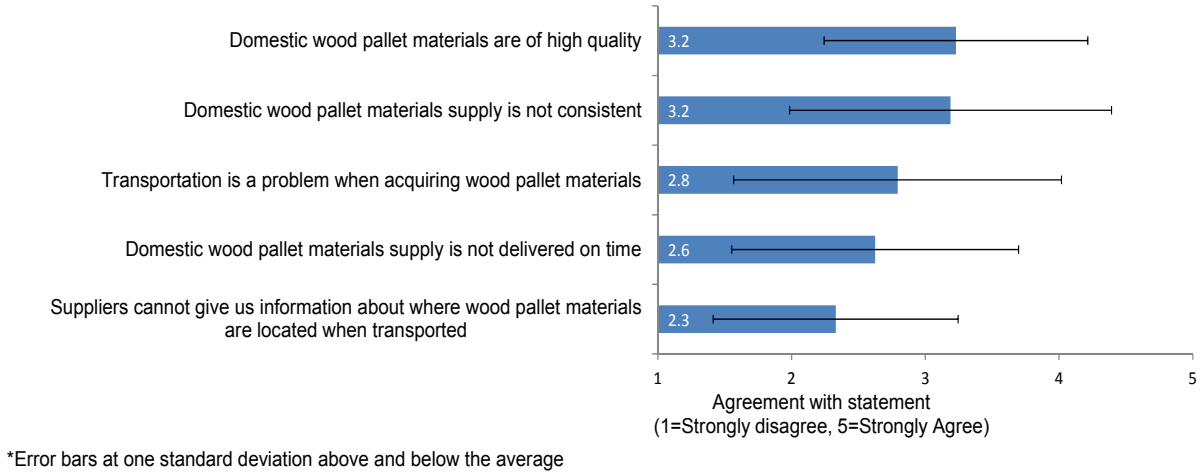


Figure 2.11. Rated factors regarding domestic wood pallet materials

- Purchasing decision

Companies were asked about the factors that they consider important at the moment of purchasing raw materials. Respondents indicated (see Figure 2.12) that “availability, cost, reliable supplier, quality, and deliver on time” were the most important, followed by “strength and workmanship” factors. Answers in general showed high consistency, as measured by the standard deviation of approximately 1 for all factors. Somewhat surprisingly, environmental certification received the lowest rating (3.1), considering that this topic is gaining momentum in the wood products industry (Espinoza and Bond, 2010). Also, relatively low rating was given to species, stiffness, mechanical properties, and density. This probably because pallet producers only purchase certain species that already provide the mechanical properties needed for their product.

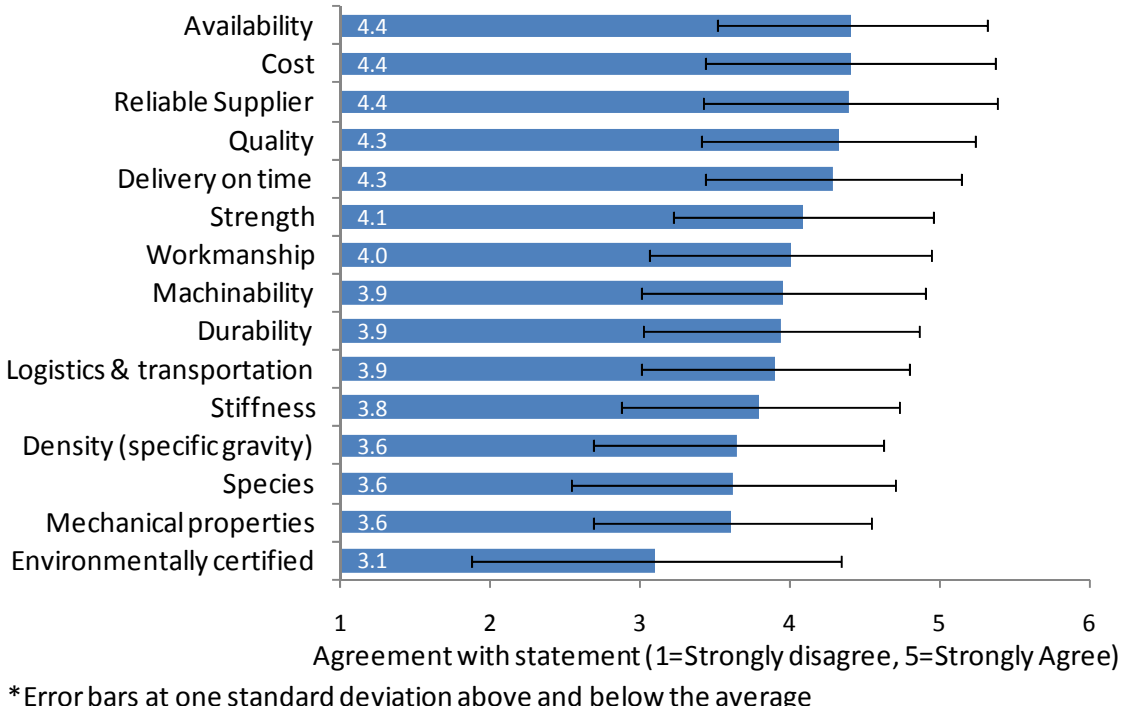


Figure 2.12. Rated factors regarding importance when purchasing raw materials

- Raw material

According to the respondent, most of them make use of lumber and cants for manufacturing wood pallets. Approximately the same number of companies reported using cants and lumber as raw materials (63% and 67% of respondents, respectively). Similarly, the same number of companies reported using pallet parts and pallet cores (used pallets) (41% and 38%, respectively). The average raw material input was 1.5 MMBFT, 2.16 MMBFT, 2.12 MMBFT, for cants, lumber, and pallet parts, respectively. An average input of 110,053 pallet core units was reported by respondents (see Figure 2.13). Bush and Araman (2008) reported that the cores received or purchased by firms involved in recovery, repair and remanufacturing of pallets were around 394,000 units per company in 2006. This large difference might be due to the economic recession of 2009, or because the use of pallet cores as a raw materials for wood pallets has declined since the aforementioned study, or lastly because recycled pallet producers were underrepresented in this study.

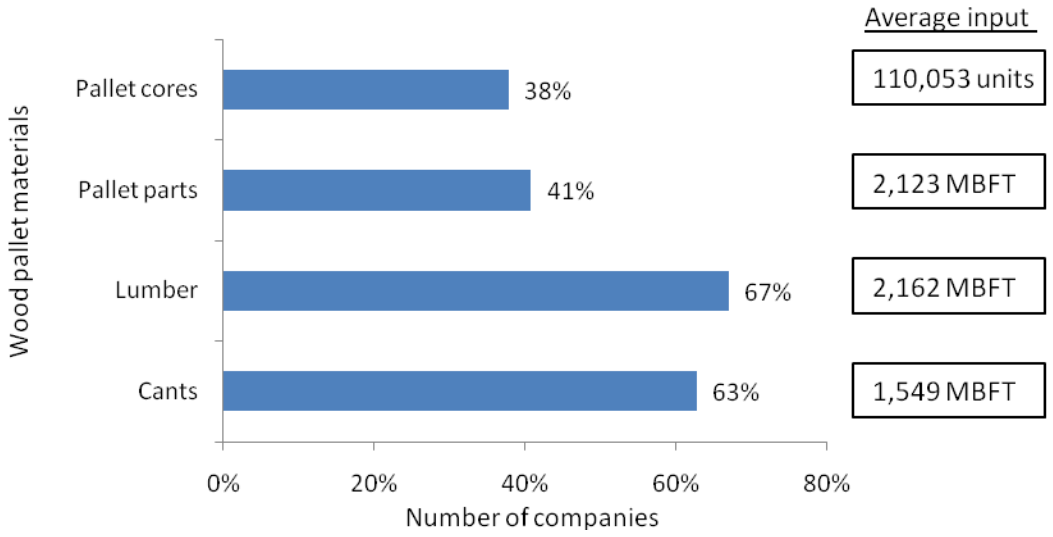


Figure 2.13. Type of wood pallet material used in the wood pallet manufacturing

- Lead time

Figure 2.14 shows the results for raw material lead time (elapsed time from order to shipment). Approximately 49% of the surveyed companies responded that it takes 5 days or less to get their wood pallet material. Forty six percent mentioned that this time is between 5 to 15 days, and 5.7% said it takes more than 15 days. The average lead time reported was 7.4 days, although highly variable, as the standard deviation of 5.5 days shows.

The relatively short lead times indicated by the respondents to this survey suggest that wood pallet manufacturers produce only to firm orders, similar to a “pull” system.

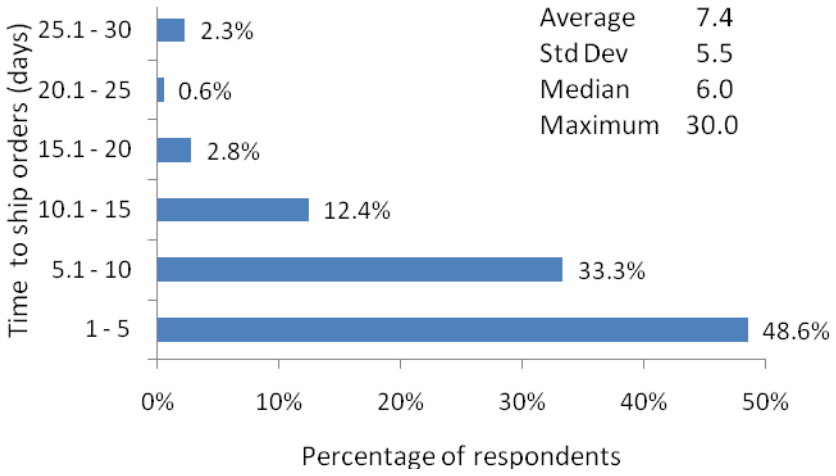


Figure 2.14. Raw material lead time

- Order frequency

In Figure 2.15 the order frequency (how often an item is ordered) distribution among respondents is presented. About two thirds (66.1%) of respondents reported ordering on a weekly or more frequent basis. This, along with lead time results (Figure 2.14), shows that typical wood pallet manufacturers with relatively high frequency and most probably in small batches.

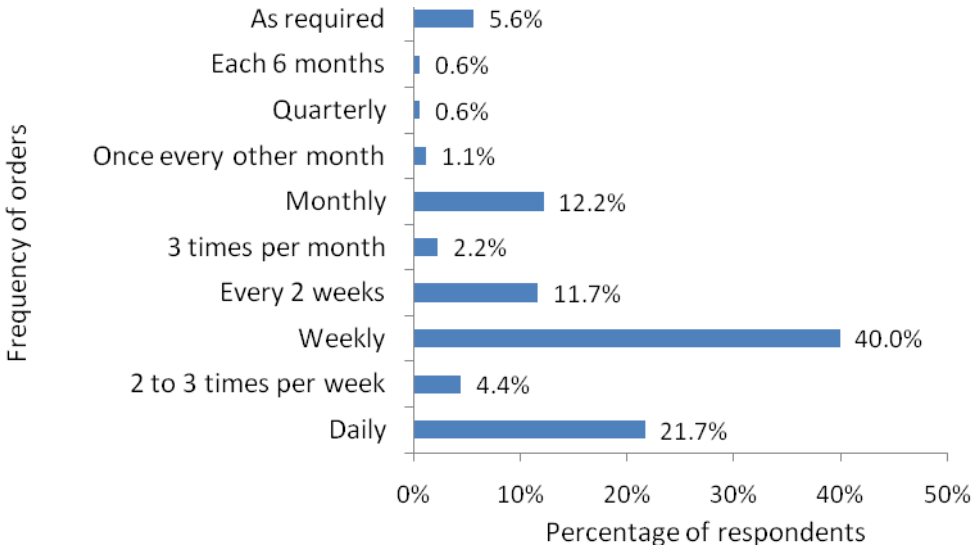


Figure 2.15. Raw material order frequency

- Major customers

Of the 197 respondent companies, a clear majority (73.1%) mentioned that they sell directly to manufacturers (pallet users), 8.1% to pallet brokers, 4.6% to retailer, and less than 5% to distributors and the government (General Service Administration (GSA) and department of Defense (DOD), which their manufacturing varies from type of species used to dimensions of wood pallet components according to product to be shipped). The “other” category (9.6%) included farmers, small business, trucking, and other pallet companies (see Figure 2.16).

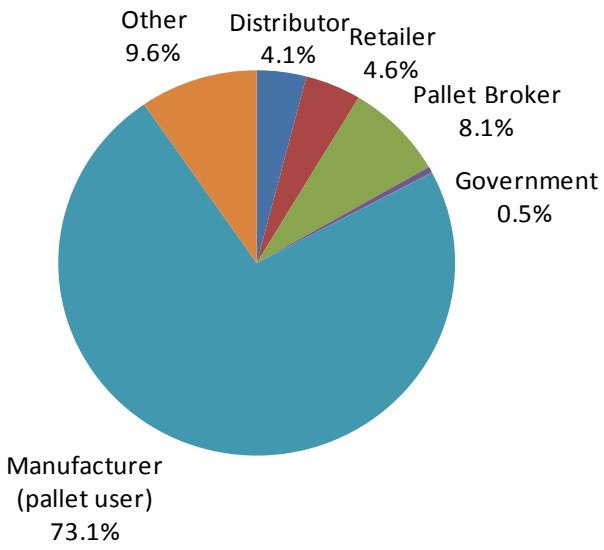


Figure 2.16. Customer’s share participation on total sales

- Imported wood pallet materials

This section of the questionnaire was devoted to questions about imports of wood pallet materials. The first question asked companies their willingness to try wood pallet materials from other countries, which results are shown in Figure 2.17. More than half (54.4%) of respondents are not interested in trying imports of wood pallet materials. Among respondents interested in trying imported materials, 31.1% were interested in working with imported wood pallet parts, 25.4% in imported lumber, 15.5% pallet kits, and 15.0% were interested in trying imported cants.

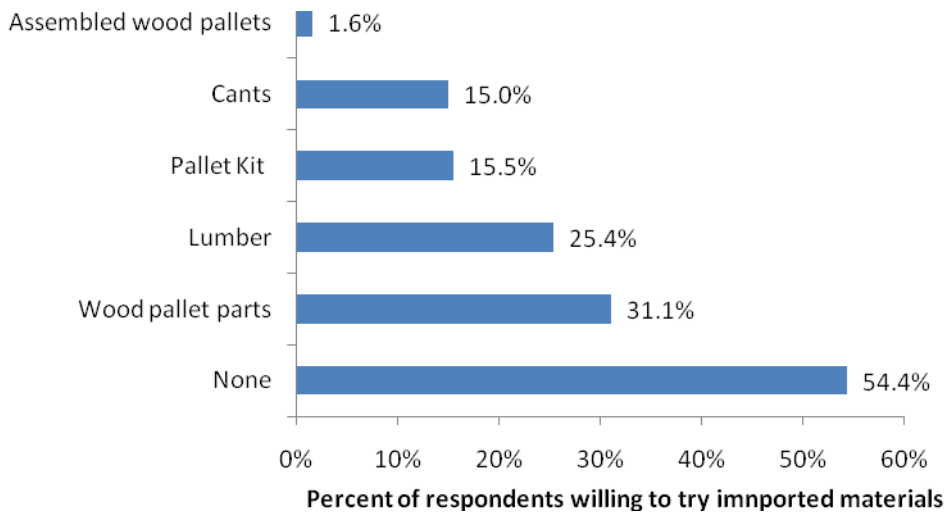


Figure 2.17. Wood pallet materials that would like to try from other countries

- Environmentally certified wood pallets

When asked about the willingness of customers to pay more for environmentally certified wood pallets, 86% indicated that they would not pay a premium for certified wood pallets (see Figure 2.18).

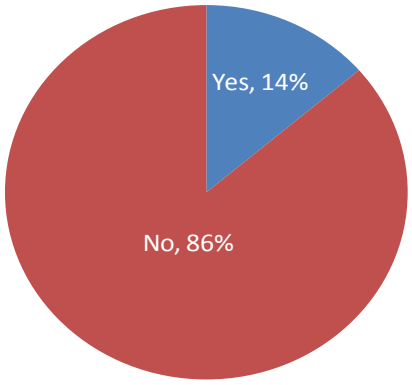


Figure 2.18. Willingness to pay a premium for environmentally certified wood pallets

For better understanding of responses, they were classified in categories of companies indicating their perceptions about customer willingness (Yes) or unwillingness to pay more for environmentally certified wood pallets (No). Four categories were created for each type of response (see Figure 2.19).

Overwhelmingly, approximately 71.0% of respondents indicated that customers will not pay more for environmentally certified wood pallets, corresponded to too expensive category, followed by customer not demanding with 10.5%. Of the companies willing to pay a premium for certified pallets, the most commonly cited reason was when it is required for sale (6.0%), and followed by safety concerns (1.5%).

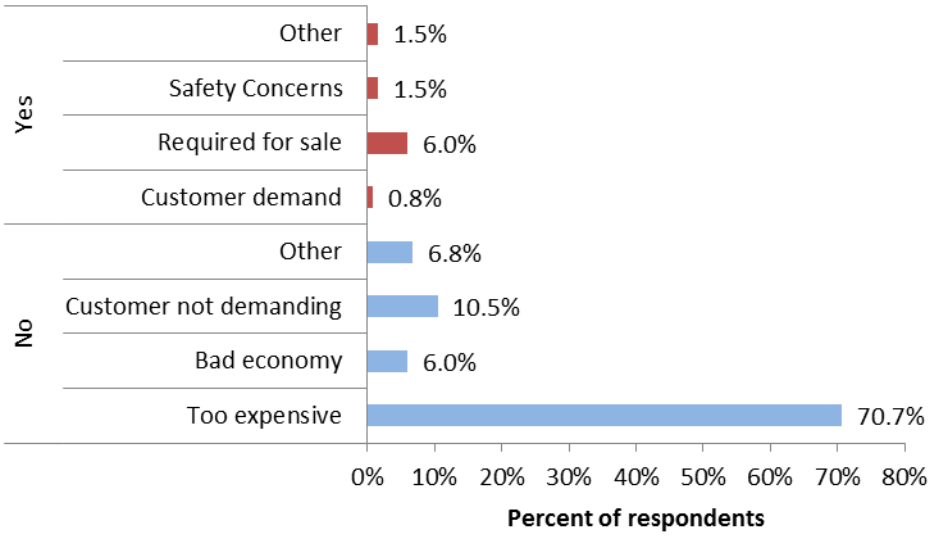


Figure 2.19. Environmentally certified wood pallets

- Barriers to imports

The following questions in the imported materials sections were aimed at companies with experience in importing wood pallet materials; a note was included in the questionnaire to ask companies to skip this section if they did not source their raw materials from overseas (see Appendix V). Companies were asked to rate in a five-point

Likert scale (1 being strongly disagree, and 5 being strongly agree), according to their experience, the barriers that would make the wood pallet materials imports difficult (

Figure 2.20). Respondents identified quality, tariffs, & transportation, on time delivery, logistics, and price, as the main import barriers (average ratings of 3.5, 3.5, 3.8, 3.9, and 4.1 respectively). Other had an average rating of 3.7 and it was concerning to metric sizes, stains, mold, U.S. loyalty, and exchange rates. For logistics and transportation factor, 70.4% of respondent companies answered in the range of 4 to 5 in the Likert scale. More than three quarters (76.9%) of respondents rated price 4 or 5 as the more important factor, with a relatively low variability among respondents (coefficient of variation, or CV, of 27%). Cossio (2007) investigated opinions about the introduction of lesser-known wood species from Bolivia to the U.S wood market. He found that the main barriers to importation were punctual delivery, production capacity, and governmental policies, in order of importance.

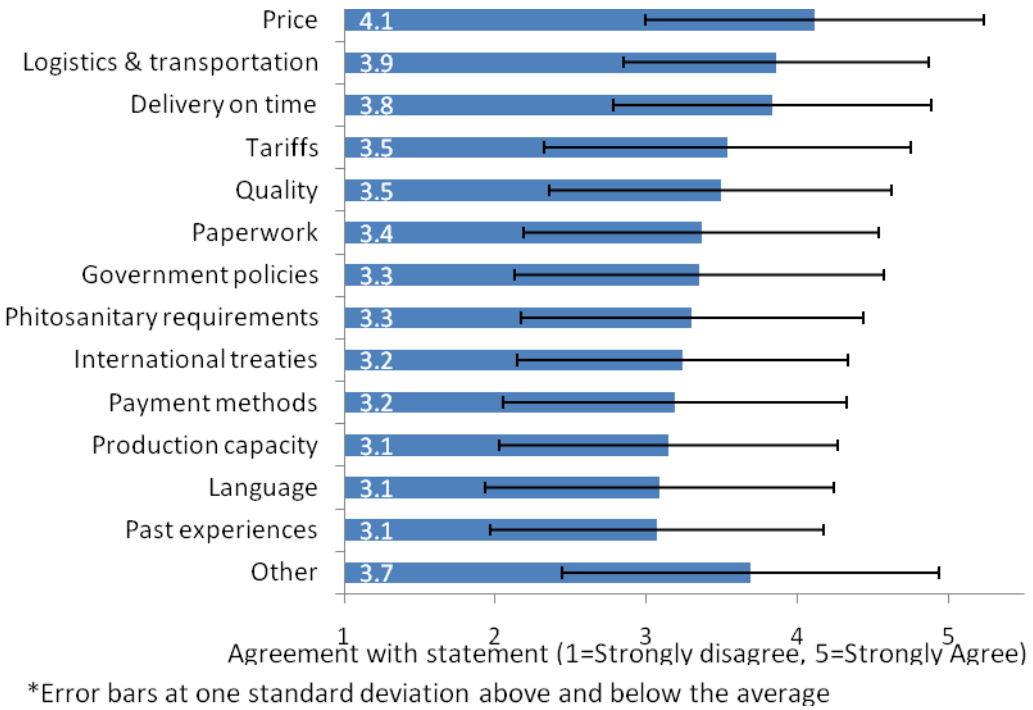


Figure 2.20. Rated factors regarding barriers when buying lumber/cants/wood pallet parts from countries outside of the U.S.

- Experience with imported wood pallet materials

Respondents were asked about their opinion about working with imported wood pallet materials. This question was directed to companies that have or had experience working with wood pallet materials. Figure 2.21 shows the results. Ratings were relatively low and similar for all options, with averages from 3.1 to 3.3. It appears that respondents did not have strong perceptions about the describers included in the question.

Figure 2.21. Rated factors regarding imported wood pallet materials

- Comparison between domestic and imported wood pallet manufacturers

Based on the experience and perceptions of some respondent companies about imported wood pallet materials, they were asked to make comparisons between domestic and imported wood pallet materials. A five-point Likert scale (1 being strongly disagree, and 5 being strongly agree) was used for rating factors, and answers are presented in Figure 2.22. Similarly to the previous questions, there was little difference between factors; but the ratings were consistently low, ranging from 2.4 to 2.6 and high variability (coefficient of variation, or CV, of 65% or higher for all answers).

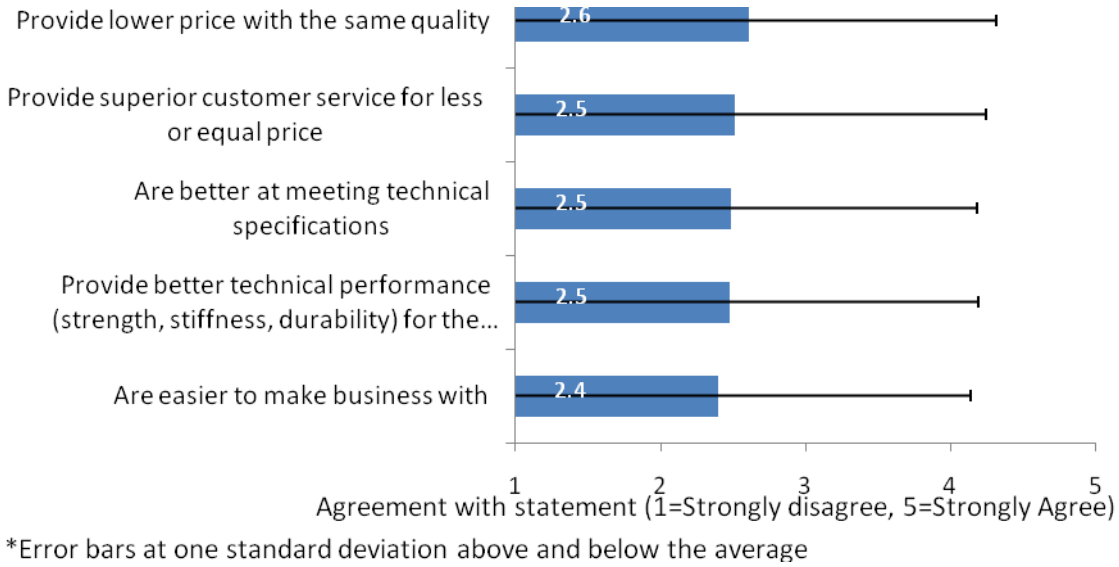


Figure 2.22. Rated factors regarding opinion about suppliers from overseas compared to domestic suppliers

A potential explanation for the low ratings provided in this part of the questionnaire is that companies with no experience in imports mistakenly answered this section; this can be estimated by the fact that between 40% and 50% of companies answered these questions and, based on the results from the telephone survey (only 25% importing, according to Section 2.3.1), it is unlikely that that is the proportion of respondents with importing experience.

- Species and origin of raw materials

In addition to the wood pallet materials volume, data about species used was collected in order to learn about the wood pallet market. Approximately 50% of respondents answered this question. 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%. “Other” species included aspen, larch, ponderosa pine, black ash, lodgepole pine, cottonwood and cedar (see Figure 2.23).

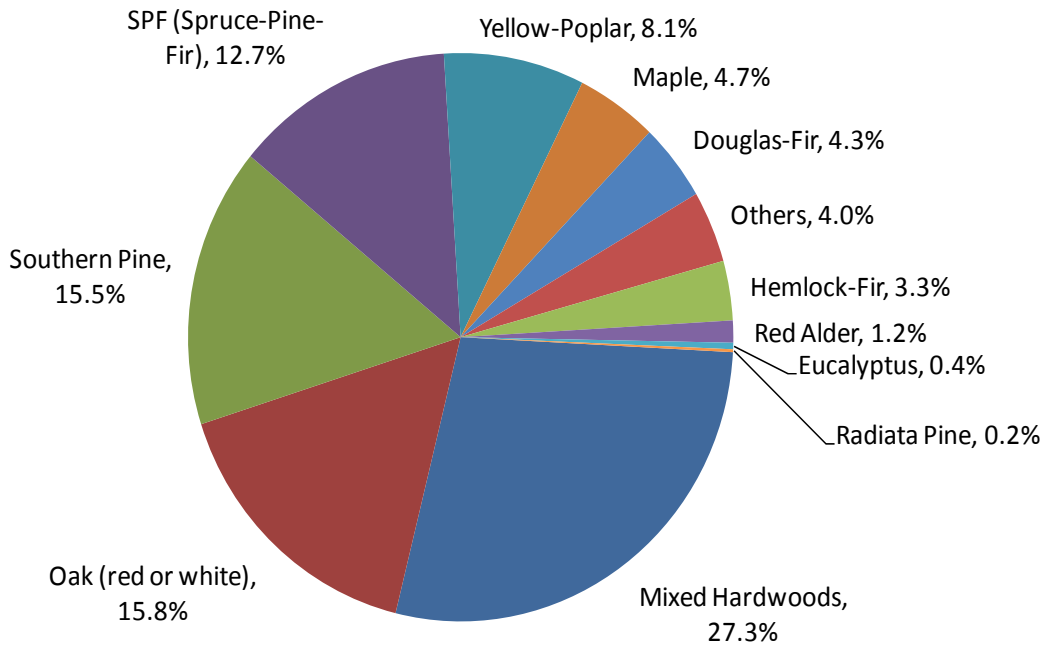


Figure 2.23. Wood species type used to manufacture wood pallet materials

The average species mix is shown in Table 2-8. An overwhelming majority of respondents purchased raw material from domestic suppliers, except from SPF which mostly came from Canada. Also, Eucalyptus and Radiata Pine were purchased from South American countries like Chile, Brazil, and Uruguay in 2009.

Table 2-8. Wood species type used to manufacture wood pallet materials and sources.

Species	% in mix	Source (percent of respondents)		
		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%
Overall	97.3%			

"Others" include: aspen, cedar, black ash, cottonwood, larch, lodgepole pine

Supply Chain Management Factors

The third section of the questionnaire was about supply chain management practices and factors, including questions regarding business management, customer satisfaction, supply chain relationship, value-added process, information technology, supply management performance, and environmental uncertainties. This section shows the descriptive statistics for the seven factors. Further analysis will be presented in Chapter 3. Respondents were asked to rate their agreement with several statements in each category using a Likert scale, ranging from 1 to 5 (1 strongly disagree, and 5 strongly agree).

- Business management

The four factors with the highest ratings were given to “our company offers wood pallets directly to the customer” (4.5), “our company offers competitive wood pallet prices” (4.3), “our company works with a differentiation strategy” (4.1), and “our company makes emphasis on the benefits of our product compared to our competitor’s” (4.0).

These last 4 factors showed relatively low variability (coefficient of variations between 15% and 22%). According to respondents, the statements with the lowest levels of agreement were “our company usually hires some experts in the pallet field for improving processes and products” (average rating equal to 2.3) and “our company forms leader groups from diverse areas for planning and developing of the strategic business plan” (2.8). The ranges for the 4 factors oscillated from 3.1 to 5.2 in the Likert scale. Results are shown in Table 2-9.

Table 2-9. Business management factors

Business management items	Avrg	Std. dev.
Our company offers wood pallets directly to the customer	4.5	0.7
Our company offers competitive wood pallet prices	4.3	0.7
Our company works with a differentiation strategy	4.1	0.9
Our company makes emphasis on the benefits of our product compared to competitors'	4.0	0.9
Our company has reduced manufacturing processes cost in the last 3 years	3.9	1.0
Our marketing team has a lot of experience	3.8	1.0
Our company produces for stock replenishment	3.6	1.1
Our company invests resources in new processes and products	3.6	1.0
Our company produces only against firm customer orders	3.5	1.2
Our company develops strategic operation plans with suppliers	3.5	1.1
Inventory costs have been reduced in the last 3 years	3.4	1.2
Our company works with a segmentation strategy	3.3	1.1
Our company offers lower prices than our competitors	3.2	1.0
Our company forms leaders from diverse areas to develop the strategic business plan	2.8	1.1
Our company usually hires experts in the pallet field to improve processes and products	2.3	1.1

- Customer satisfaction

Figure 2.24 indicates that company respondents identified “delivering on time”, and “product quality”, as the most important factors for customer satisfaction. A five-point Likert scale (1 being strongly disagree, and 5 being strongly agree) was used to calculate the mean and standard deviation for each factor. Most respondents agreed with choosing delivery on time factor, with 68% of respondents in the range of 4.0 and 5.2 in the Likert scale, showing low variability in responses (CV of 14%). The corresponding range for quality as a factor was 3.9 and 5.1, likewise with low variability in the responses (CV of 14%). Similar results about quality were found by Marwaha et al

(1993) with quality as crucial to achieve customer satisfaction. Achieving satisfied customers is essential for the organization success (Jeffrey and Wesley, 2008).

Figure 2.24. Customer satisfaction factors

- Supply chain relationships

This question was targeted at obtaining information about companies' relationships with customers and suppliers. The most important factors found were recognition of customers' loyalty (mean rating of 4.1), and periodic evaluation of customers' relationships (4.0). The lowest ratings corresponded to frequent visits from suppliers (2.6) (see Table 2-10). Wood (2008) mentioned that customer satisfaction is an indicator of the level of relationship, which has to be measured, especially in times of uncertainty. According to Jeffrey and Wesley (2008), customer satisfaction is positively related to purchase replications, and customer loyalty. Most of the supply chain relationship factors received ratings above the midpoint in the scale (3.0), thus reflecting a concern with maintaining good relationships with suppliers and customers, one of the tenets of supply chain management (Lambert and Cooper, 2000).

Table 2-10. Supply chain relationship factors.

Supply chain relationship items	Avrg.	Std dev.
Our company recognizes the loyalty of actual customers frequently	4.1	0.8
Our company evaluates periodically the relationship with its customers	4.0	0.8
Our company depends on a few reliable suppliers	3.9	1.0
Our company evaluates the customer satisfaction frequently	3.9	0.9
Our suppliers give us high quality wood pallet materials	3.9	0.7
The exchange of information between us and our suppliers is reliable	3.7	0.8
Our company shares the mission, vision and objectives with its customers	3.7	0.9
Our company shares information with its suppliers	3.7	0.9
Our suppliers share information that can affect our company	3.6	1.0
The exchange of information between us and our suppliers is precise	3.4	0.9
The exchange of information between us and our suppliers is complete	3.4	0.9
Our suppliers visit us frequently	2.6	1.1

- Value-added process (manufacturing)

This question was designed to search for the respondent's perceptions regarding to the company's flexibility, production system, and quality. Respondent companies recognized the capability to manage big or small orders (average rating of 4.4), working with cross-trained employees (4.4), and answer quickly to fast changes in the market (4.3), as the most important factors. These factors also showed low variability across respondents, with standard deviations between 0.7 and 0.8, and are both related to how fast can the company respond to changes in customer demand. On the other hand, the least important factors were the use of six sigma strategies in the manufacturing processes (2.3) and having a certification in quality system (2.8). Results can be seen in Table 2-11. According to the research conducted by Daniel, Reitsperger, and Morse (2009) conducted in the Japanese automotive sector in 2003, flexibility was a significant factor in the production process to allow quick response to fast changes in the market.

Table 2-11. Value-added process (manufacturing) factors

Value-added process items	Avrg	Std dev.
Our company is able to manage big or small orders, according to the customer's requirements	4.4	0.6
Our company has cross-trained employees, who do several tasks	4.4	0.7
Our company is able to answer quickly, to fast changes in the market, like the need of new products	4.3	0.8
Our company is able to make fast changes in the production process to accelerate or desaccelerate product production	4.2	0.7
Our company works to reduce production time	4.2	0.7
Our company measures the quality of its products	3.8	1.0
Our company keeps track of customers feedback for the pre-sales and post-sale processes	3.7	1.0
Our employees (at all levels) are frequently trained and evaluated	3.6	1.0
Our company works with indicators that measure the production process performance	3.5	1.0
Our company uses state of the art technology in equipment and machinery	3.4	1.1
Our company uses LEAN MANUFACTURING production principles	3.3	1.1
Our company makes use of special software for designing pallets	3.1	1.5
Our company has a certification in quality system or is in certification process	2.8	1.3
Our company uses SIX SIGMA in the manufacturing process	2.3	0.9

- Information technology

Respondent companies indicated that the most important factors were investments in communication tools (average rating of 3.5) and "the use of internal computer network" (3.5). On the other hand the use of software such as Enterprise Resource Planning (ERP) for the company business" (2.1) received the lowest rating, as can be seen in Figure 2.25. All information technology factors received low ratings, just above the midpoint in the scale, and showed high variability, as shown by the relatively high values for coefficient of variation (33% to 54%). Information systems in the wood pallet industry appear to be perceived as not crucial for company success. This is different than what happens in the pulp and paper industry, which has a long supply chain, and management requires updated information in all parts of the chain for decision-making (Carlsson et al., 2009). The respondents to this survey study were mostly medium and large-sized companies, with chiefly made-to-order scheduling and small, frequent

orders. The information technology used by the industry does not seem to be very complex.

Figure 2.25. Information technology factors

- Supply chain management performance

Table 2-12 shows the results for supply chain management performance factors. Companies identified the preference to work with domestic wood pallet materials (average rating of 4.3), and high competition for acquiring raw materials (4.3), as the most important factors. Variability of responses was relatively low. As for the results, it seems that on average companies prefer to work with domestic materials. One potential reason being that since they work with a commodity product, with little value-added, transportation costs can make imports uncompetitive.

Table 2-12. Supply chain management performance factors

Supply chain management performance items	Avrg	Std dev.
Our company prefers to work with domestic wood pallet materials rather than imported	4.3	0.9
The competition for raw materials is strong in the wood pallet industry	4.3	0.8
Our company knows what orders are coming and when they are going to be delivered	3.8	1.0
Our suppliers offer a reliable delivery	3.8	0.9
Our suppliers deliver on time	3.7	0.8
Our suppliers are consistent in their delivery operations	3.7	0.9
Our suppliers are flexible when we request different qualities (grades) and quantities	3.6	1.0
Our suppliers are able to respond quickly to our needs	3.6	0.9
Transportation is a problem when importing wood pallet materials	3.3	1.1
Our suppliers are able to answer quickly to our necessities	3.3	1.1
Imported wood pallet materials supply is not consistent	3.3	1.0
Domestic wood pallet materials are of high quality	3.2	1.0
We have to buy treated lumber/wood pallet parts when importing wood pallet materials	3.2	1.3
Imported wood pallet materials supply is not delivered on time	3.2	1.0
Domestic wood pallet materials supply is not consistent	3.2	1.2
Imported wood pallet materials are of high quality	3.2	0.9
International suppliers cannot give us information about where wood pallet materials are located when transported	3.1	0.9
Imported wood pallet materials show good strength performance	3.1	0.9
Our suppliers are able to make fast changes in their production process to accelerate or desaccelerate the wood material supply	3.0	1.1
Our number of suppliers have increased in the last 3 years	3.0	1.3
Transportation is a problem when acquiring wood pallet materials	2.8	1.2
Our suppliers deliver materials which their properties vary greatly within the same batch	2.7	1.0
When suppliers are transporting wood pallet materials, our company can check where they are exactly located	2.7	1.3
The cost of wood pallet materials from other countries is lower than domestic ones	2.6	1.0
Domestic wood pallet materials supply is not delivered on time	2.6	1.1
Suppliers cannot give us information about where wood pallet materials are located when transported	2.3	0.9

- Environmental uncertainties

According to the results found through the five–point Likert scale, the statements with the highest rating were those related to the strong competition in the industry (average rating of 4.4) and working with many suppliers and reliability of supplier (both with with average rating of 4.2).

According to Wood (2008), when buyers consider environmental uncertainties, they search for more options to meet their needs, and one alternative is having many suppliers. Low ratings were given to environmental certification, logistics and transportation as supplier selecting criteria, and the government as a source of information relevant to business (2.8, 2.7, and 2.5, respectively). Table 2-13 shows the results to this question.

Table 2-13. Environmental uncertainties factors

Environmental uncertainties items	Avrg.	Std dev.
Competition in the wood pallet sector is strong	4.4	0.7
Our company works with more than 3 suppliers	4.2	0.9
Our company would like to work with suppliers who have availability of resources and consistency of supply	4.2	0.8
Our company trusts its suppliers	4.1	0.7
There is a high level of communication and coordination with our suppliers	3.7	0.9
The delivery of imported wood pallet materials can easily go wrong	3.4	1.0
Our company involves suppliers when planning strategic goals	3.4	1.1
Our company is open to work with suppliers from other countries	3.2	1.3
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	3.1	1.1
Our company uses certified wood for manufacturing pallets	2.8	1.4
Our company thinks that logistics and transportation is the number one criterion when selecting suppliers	2.7	1.1
Our company is informed by the government about important aspects that can affect our business	2.5	1.2

2.4 Summary and Conclusion

The objective of this chapter was to develop a profile of the wood pallet industry by collecting information through a nationwide survey of 1,500 companies. Information was collected about (1) manufacturers' demographics,(2) wood pallet manufacturers' organization, and (3) wood pallet manufacturers' supply chain. 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 companies according to the number of firms found in the U.S Census Bureau for 2007. 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. Following, a summary of results by research objective is presented.

2.4.1 *Objective 1: Production volumes, major suppliers, and species distribution*

- Most respondents (38.6%) had between 20 to 99 employees. The same percentage of companies (38.6%) had 5 to 19 employees. Very small companies (1 to 4 employees) represented 15.3% of respondents.

- On average the total annual output of pallet units was of 727,229, and median of 200,000. This is higher to what was reported by Bush and Araman (2008) , 512,533 pallet units in 2006.

- In 2009, respondents indicated that 58.0% of a recycled/repaired wood pallet is manufactured with recycled wood pallet material, and 42.0% with new wood pallet material. Therefore, the ratio of recycled to new wood pallet material was approximately 6 to 4. The production of recycled wood pallets had grown during the last decades, because they have shown to be increasingly profitable (Brindley, 2007). About their monthly raw material input, the average use of lumber, cants, pallet parts, and pallet cores was 2.16 MMBF, 1.55 MMBF, 2.12 MMBF, and 110,000 units, respectively.

- The most common wood species used were “mixed hardwoods”, oak, , and spruce-pine-fir, southern pine, oak, and mixed hardwoods (12.7%, 15.5%, 15.8%, and 27.3% respectively). Respondents reported imported at least some of their raw materials, with an overwhelming majority importing from Canada. Spruce-pine-fir and Douglas fir are the most common imported materials. Chile and Brazil were the most cited among sources of imported materials other than Canada.

2.4.2 *Objective 2: Compare characteristics of imported and domestically produced pallets, from a business perspective.*

- More than half of respondents (54.4%) indicated that they are not interested in trying imported materials. Among respondents interested in imported materials, the most common items were wood pallet parts and lumber (31.1%, 25.4% of respondents, respectively); cants and pallets kits were of interest for 15% and 15.5% of respondents. Only 1.6% of companies were interested in trying assembled pallets. The factors perceived as most important barriers to importing wood pallet materials were price, logistics, and delivery on time, which were rated at an average of 4.1, 3.9, and 3.8, respectively (Likert scale from 1 to 5). Respondents in general do not consider that imported materials are superior to domestic ones in dimensions like technical specifications, performance, and “easier to make business with”.

2.4.3 *Objective 3: Increase the understanding of the U.S. wood pallet manufacturing industry, its supply chain management practices, and factors affecting the supply chain management processes.*

- Regarding supply chain topics, close to three quarters of respondents (73.1%) prefer to sell their product to customers without the intervention of a middle-man. On the supply side, the most important factors for purchasing decisions are availability, cost, supplier reliability, quality, punctuality, strength, and

workmanship; all with ratings 4 or higher. For most respondents their suppliers take 1 to 5 days (48.6% of respondents) from order to shipment. A third (33.3%) of respondents indicated an order-to-shipment lag between 5 to 10 days. On average, investments in communication tools and the use of internal computer network were rated highest (3.5 each). On the other hand, internet use for business processes, personnel training on information technology, and Enterprise Resource Planning (ERP) use received relatively low ratings.

- In the supply chain management factors, companies identified the preference to work with domestic wood pallet materials (average rating of 4.3), and high competition for the acquisition of raw materials (average rating of 4.3), as the most important factors. It seems that in average companies prefer to work with domestic materials, one potential reason being that since they work with a commodity product, with little value-added, transportation costs can make imports uncompetitive.

- Regarding environmental uncertainties, the highest rating were those related to the strong competition in the industry (average rating of 4.4) and working with many suppliers and reliability of supplier (both with average rating of 4.2). When buyers consider environmental uncertainties, they search for more options to meet their needs, and one alternative is having many suppliers. Low ratings were given to environmental certification, logistics and transportation as supplier selecting criteria, and the government as a source of information relevant to business (2.8, 2.7, and 2.5, respectively).

- Company respondents identified “delivering on time”, and “product quality”, as the most important factors for customer satisfaction. Most respondents agreed with choosing delivery on time factor, with 68% of respondents in the range of 4.0 and 5.2 in the Likert scale, showing low variability in responses (CV of 14%).

- When asked if respondents thought their customers will pay more for environmentally certified products, 71% gave a negative answer, citing costs as the main reason. Those that think customers will pay a premium for certified pallets said that certification is a customer requirement as the main reason.

Regarding supply chain management factors findings were:

- Regarding business management, results suggest that respondents consider marketing strategy the most important sub-factor. Offering wood pallets directly to the customer, having competitive wood pallet prices, working with a differentiation strategy, and making emphasis on the benefits of their products, had relatively high average ratings compared to process strategy, process performance, and innovation. The latter was rated the lowest by wood pallet manufacturers. A similar study confirms that marketing strategies should be developed and implemented in the pallet industry with the objective to develop and expand markets (Dunn et al., 2000).

- Results for the customer satisfaction factor showed that manufacturers thought that customer service should be based on time-delivery and product quality, as these items were highly rated. Similar results about quality were found by Marwaha et al. (1993), with quality as the crucial element to achieve customer satisfaction. Also, Dunn et al. (2000) indicated that customer service is one of the most important manner to achieve company success. Buehlmann et al. (2010) 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.

- Regarding the supply chain relationships factor, the most important item was recognition of customer loyalty (mean rating of 4.1). Results from this research were consistent with the study carried out by Kumar (Kumar et al., 2006) , which

indicated that to achieve customer loyalty, companies must look for methods or tools that allow the elimination of defects in the product. For example companies are looking to improve their processes, with the use of lean manufacturing principles (Wilson, 2010) to reduce waste, and consequently costs.

- Regarding value-added process, respondent companies recognized flexibility as the most important sub-factor. Flexibility includes the capability to manage big or small orders (average rating of 4.4), working with cross-trained employees (4.4), and answer quickly to fast changes in the market (4.3). This is consistent with the results obtained from a study by Buehlmann et al (2010) in the hardwood industry (a supplier to the wood pallet industry), where quick deliver and just in time deliver were the highest rated services in the sector. Additionally, he indicated that the current customer size was reduced in the time frame of 2003 to 2007, as was order size. This denotes that flexibility plays an important role in the value-added process factor: producing what the customers require.

- Concerning the information technology, respondent companies indicated that the most important items were investments in communication tools (average rating of 3.5) and the use of internal computer network (3.5). Zhang and Dilts (2004) indicated that the use of information technology facilitates flexibility and thus customer satisfaction, similar to the results found in this research.

- About supply chain management performance, respondents identified high competition for acquiring raw materials (4.3), as the most important factor. Similar results were found in the study made in the hardwood industry (Hardwood Publishing, 2006), where it is indicated that competition for logs and timber had increased, along with prices. This can be due in part to reductions in the North American hardwood production of the past years (American Forest & Paper Association, 2007). Moreover, the production of energy from low-grade wood biomass is another factor for competition for raw material (RISI Inc., 2010).

- Trends in the wood pallet industry are the same as in the forest products industry. Results confirm that wood pallet manufacturers are demanding high flexibility in their orders to suppliers. Large orders of the same material or product are no longer the standard practice; but rather a mix of small quantities of different materials. Suppliers to the wood pallet industry have to accommodate to this trend in order to be competitive.

- This sector has been relatively insulated from the fierce competition from low-cost imports, which has caused significant difficulties in other sectors, such as the household furniture. Moreover, wood pallet manufacturers still prefer domestic suppliers, and believe price, timely-delivery, and consistency are major constraints to increase imports.

- Opportunities for improvement can be identified in the very low ratings given to innovation, information technology, and information sharing with suppliers. Innovation can be achieved not only in physical product, but in the manufacturing process and the service, by providing more and better services to customers, like flexibility in volume and time. Similarly, information technology has been shown to benefit other sectors in the wood products industry (Stiess, 2010). 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 (Sanders and Premus, 2005).

2.4.4 *Implications for Business*

The results from this research provide wood pallet manufacturers, suppliers, and industry supporters with up-to-date information about major characteristics of companies, supply chain practices, and success factors for supplying the industry. Likewise, information is presented about perceptions of domestic and imported wood pallet materials, and customers' opinion about using environmentally certified wood pallets, species used, and their origin. This information can be used by manufacturers to

make strategic decisions about their supply chain management practices. Organizations that support the industry can benefit by designing more effective assistance programs to improve the industry's competitiveness.

According to the results, purchasing factors have been found to play an important role in the success of supplying the industry: availability, cost, reliable supplier, quality, and deliver on time. Potential suppliers, domestic or international, should take into account the critical factors identified in this study to more effectively promote their offerings. Specifically regarding imported materials, suppliers should focus on overcoming these barriers (perceived or real): price, logistics and transportation, on time delivery, tariffs, and quality, identified by this research to be of critical importance.

For both manufacturers and suppliers, it is essential to understand how critical is to communicate, and to plan jointly, giving more importance to supply chain relationships. Understanding the significance of this concept will allow manufacturers and suppliers to achieve progress towards customer satisfaction.

Wood pallet manufacturers have realized that environmental uncertainties should be taken into consideration when implementing strategic supply management plans in the acquisition of raw materials and to compete in the market. Also integration with supplier partners should be developed to improve supplier relationships.

The flow of information in a coordinated manner, access to information and data interchange, improve customer and supplier relationship, and inventory management. Then wood pallet manufacturers can use this information for making their operations more agile.

Chapter 3. SUCCESS FACTORS IN THE WOOD PALLET SUPPLY CHAIN

Companies know that to survive to competition they have to compete as supply chains, not as individual organizations. As a result, supply chain is considered a significant subject that requires being managed and controlled in order to improve the companies' daily operations. The objective of this research was to identify and understand the relationships between factors affecting the wood pallet supply chain. The lack of information regarding how wood pallet manufacturers managed their operations, relationships and uncertainties made significant to explore the wood pallet supply chain through the application of a nationwide survey. For this purpose, fifteen hundred companies were surveyed, with an adjusted response rate of 14%. It is important to mention that the same questionnaire and data obtained in Chapter 2, is used to describe the wood pallet industry, were used in this chapter to conduct analysis and purification of data, critical step to carry out before to explore the relationships among supply chain management factors. For this purpose, a model was proposed in order to identify critical factors in the wood pallet supply chain. Results from the model indicated that higher levels of value-added process will lead to higher levels of supply chain relationships, and higher levels of supply chain relationships will improve supply chain management performance.

This is one of the few studies investigating supply chain management practices in the wood pallet industry, and as such, it is an initial model that would help as basis for future research. Manufacturers should focus on the effective management of value-added process (manufacturing) since it was demonstrated that directly affects supply chain relationships, and as a consequence, also affects supply chain management performance.

3.1 Introduction

According to Lambert and Cooper (2000), supply chain is not a chain of business to business relationships, but is a complex network of a variety of businesses and relationships. Innovations in transportation and information technology, deregulation, and fall of trade barriers enables components in the supply chain to communicate more between each other, and participate more in the decision-taking 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. An efficient supply chain management can protect competitive advantage and improve organizational performance (Li et al., 2005). Integrating the supply chain facilitates achieving improvements in flexibility, delivery on time, product quality, and as a result, business performance (Rosenzweig et al., 2003).

A variety of studies have been made about supply chain in diverse industry sectors. For instance researchers have found that supply chain coordination issues and incentive mechanisms for investing in an information technology, such as RFID, can lead to improve the efficiency and security of the supply chain (Lee et al., 2011). Another result found was the integration of effective flexibility leading to strategic supply chain decision making process (Das, 2011). The relationship between environmental uncertainty, supply chain flexibility, and firm performance was also demonstrated, in a survey of 85 manufacturing companies in Germany. Companies showed that environmental uncertainty was critical and required high supply chain flexibility to achieve superior firm performance. Then a model was developed and demonstrated with the three factors previously mentioned (Merschmann and Thonemann, 2011). Supply chain management is applied by companies in the entire globe due to its demonstrated results, such as: time reduction, better financial performance, improvements in customer satisfaction, trustworthy suppliers and others. And according to D'Amours, Ronnqvist, and Weintraub (2008), the forest products industry is recurring to supply chain practices to improve their performance.

The objective of this chapter is:

- Identify and understand supply chain management success factors and their relationships in the wood pallet industry.

To accomplish this, a research model was developed based on previous research and literature review. In the following sections the research model is explained, research hypotheses, data purification and analysis, and hypotheses testing to test the significance of factors.

3.2 The Constructs of Supply Chain Management

To better understand supply chain management (SCM), the proposed research is centered in the three main components of a supply chain: raw material suppliers, manufacturers and customers. Therefore, identifying the factors affecting customer satisfaction was required for this purpose. Literature review and previous research allowed the identification of factors affecting the wood pallet supply chain. See Section 1.5.2.2 in Chapter 1. All factors and their respective sub-factor(s) are supported with literature review. As a result, seven proposed factors were identified: environmental uncertainty, information technology, supply chain relationship, value-added process (manufacturing), supply chain management performance, business management, and customer satisfaction. A summary of factors and sub-factors is shown in Table 1-7.

The proposed model can be seen in Section 3.3. The identification of factors and definitions are detailed in Section 1.5.2.2 of Chapter 1. The following paragraphs show the definition of each factor present in the research model:

a) Environmental Uncertainties, it refers to the environmental issues in the product chain (Dwivedi and Butcher, 2009). It is also defined as the lack of information with respect to external environment and is 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 those manufacturing or service steps to a commodity product which the customer perceives as increasing its value (Bishop, 1990).
e) Supply Chain Management Performance, the operational excellence to deliver leading customer experience (Simchi-Levi et al., 2003)
f) Business Management is "the process of managing networking between companies" (Ford and Mouzas, 2010).
g) Customer satisfaction, defined as "expectancy disconfirmation" (Bowersox et al., 2007)

Measures for these variables and relationship testing will be carried out once factors and sub-factors are defined. The following section shows the model development.

3.3 Model Development

The research done by Li (2002) presented a model of Supply Chain Management using variables such as facilitating factors for SCM, SCM practice, SCM performance, competitive advantage, and organizational performance. The model development use previous definitions and Li's research to create the proposed model. A modified version of Li's (2002) and Quesada and Meneses' (2010) research was developed, adding new research findings. Then, the proposed model for this research contemplates three main variables, such as: supply chain management performance, business management, and customer satisfaction; as it can be seen in Figure 3.1.

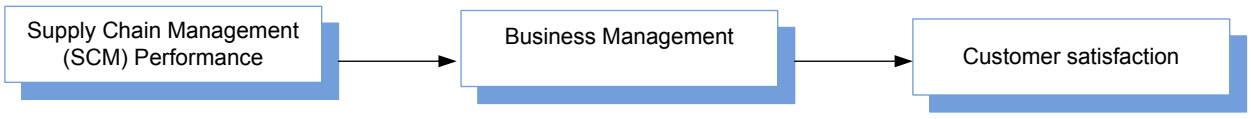


Figure 3.1. An overall supply chain research framework

In order to understand the factors that could affect the SCM, seven factors have been identified and supported with the respective literature review. The literature review and definition of each factor was included in Chapter 1 and Chapter 3, respectively. As a result, a framework was developed showing causal relationships between factors. The arrows are indicating the relationship type (positive or negative) between factors. Multiple linear regressions will test these relationships. This is shown in Figure 3.2:

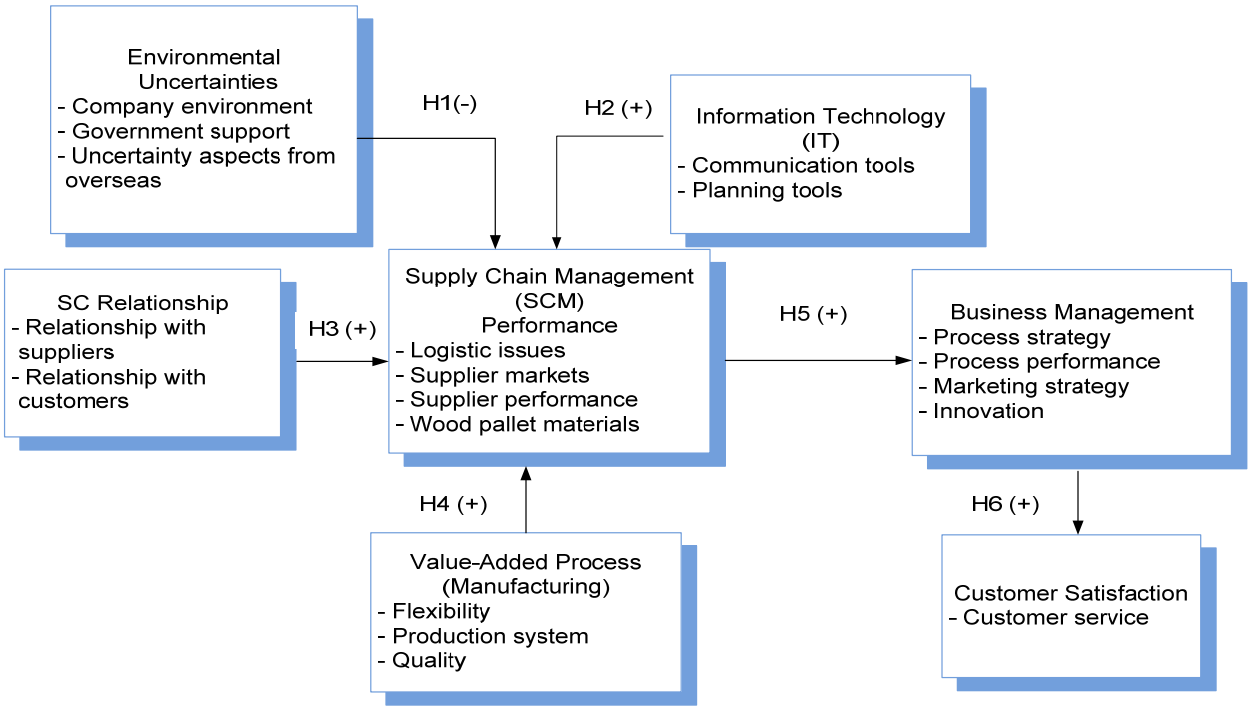


Figure 3.2. Proposed research model

3.3.1 *Research Hypotheses*

The literature reviewed supports the factors previously mentioned, and hypotheses need to be established in order to test their significance with regression analysis. The research focused 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 mentioned 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:

a) Research hypothesis 1 (H1): 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 is related to how hard it is to precisely foresee the future (Lee et al., 2009). According to Sun et al., (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:

H1: Environmental uncertainties negatively affect Supply Chain Management Performance

b) Research hypothesis 2 (H2): 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:

H2: Information Technology positively affects Supply Chain Management Performance

c) Research hypothesis 3 (H3): 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:

H3: Supply Chain Relationship positively affects Supply Chain Management Performance

d) Research hypothesis 4 (H4): Value-Added Process (Manufacturing) positively affects Supply Chain Management Performance

Jones and Womack 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 (Jones and Womack, 2002). 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:

H4: Value-Added Processes (Manufacturing) positively affects Supply Chain Management Performance

e) Research hypothesis 5 (H5): 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, 1996a). Some benefits mentioned in the literature are reduced lead times, inventories and costs, and improved customer satisfaction. This leads to the hypothesis:

H5: Supply Chain Management Performance positively affects Business Performance

f) Research hypothesis 6 (H6): 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:

H6: Business Management positively affects Customer Satisfaction

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

$SCMP = b_0 + b_1EU + b_2IT + b_3SCR + b_4VAPM + \xi$

$BM = b_0 + b_1SCMP + \xi$

$CS = b_0 + b_1BM + \xi$

Where:

b_0 = Intersection, b_1, b_2, b_3, b_4 = 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 (Manufacturing)

3.4 Methodology

Review of literature, telephone surveys, and case studies were the base to formulate factors, research hypotheses, and the proposed model. The major method of data collection for this research was the nationwide mailed survey of wood pallet manufacturers, used in Chapter 2. This research tool consisted of three sections: (1) general information, (2) domestic and imported wood pallet materials, and (3) supply chain management factors. Descriptive statistics for all sections was used to characterize the wood pallet industry (developed in Chapter 2), and the last section of the questionnaire, supply chain management factors, was also used to validate and test the proposed model shown in Chapter 3. The model of success factors was evaluated using Cronbach's alpha, factor analysis and multiple regression analysis. Figure 3.3 illustrates the methodology used in this Chapter.

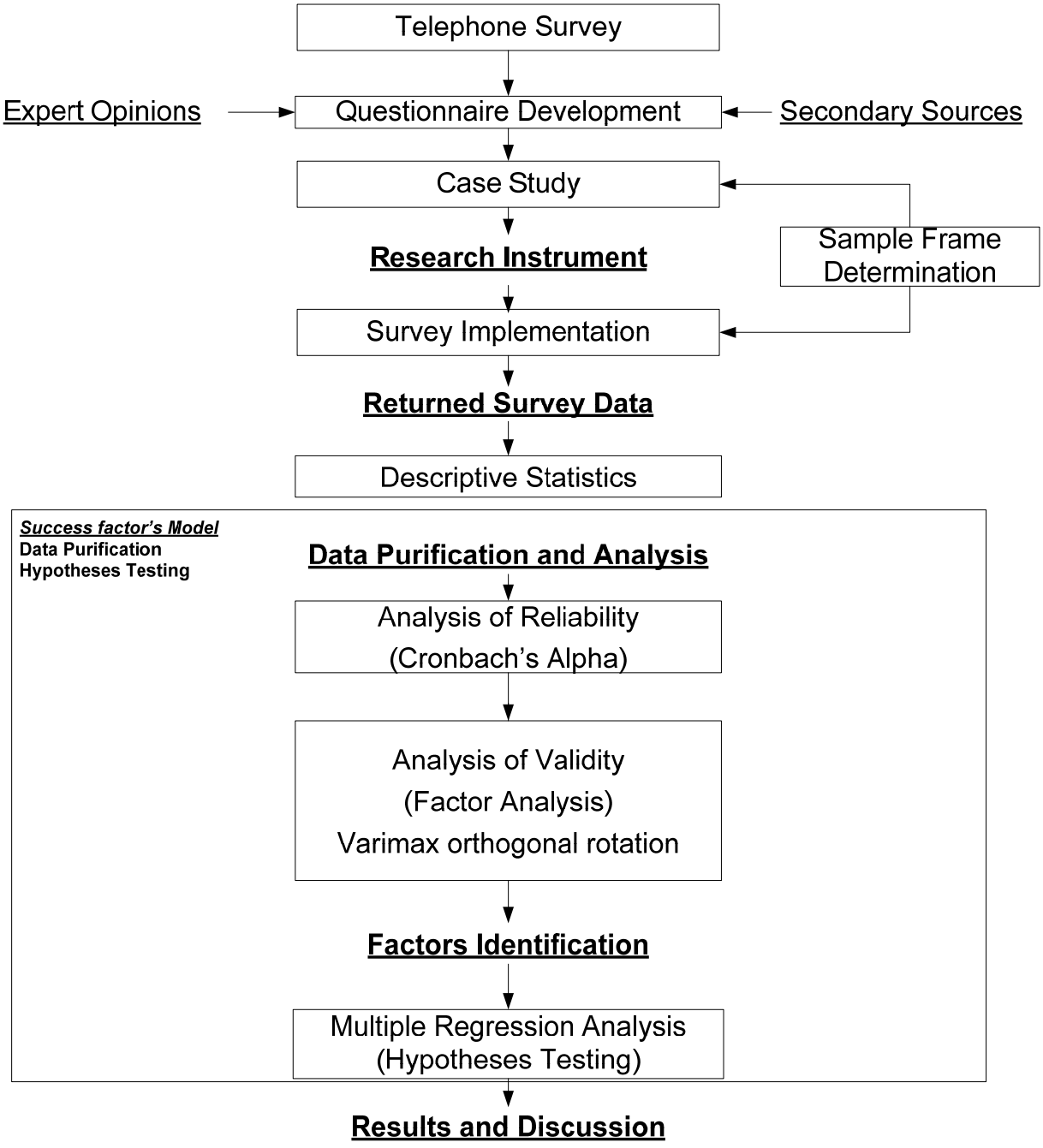


Figure 3.3. Success factors methodology

3.4.1 *Data Analysis*

Once data was obtained, statistics methods, Cronbach's alpha and factor analysis were used for purification and analysis of the data. Once these methods were applied, hypothesis testing was carried out for testing relationships in the proposed model. For better understanding, a description of Cronbach's alpha and factor analysis is shown in the following paragraphs.

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 means poor reliability, values between 0.6 and 0.7 are acceptable (DeVellis, 1991), and values equal or higher than 0.70 indicate good scale reliability .

Factor analysis is *"a statistical method for assessing the dimensionality of multivariate data"*. Factor analysis was used to validate and to reduce critical items in each factor. It will also validate the relation among the items and their respective factor and entails rotation of factors (Van-Aken, 2007). Stevens (2002) recommends the interpretation of absolute value of factor loadings bigger than 0.4. This research is focused on using factor loadings bigger or equal to 0.45 (see Table 3-1). Principal components was used as extraction method and orthogonal rotation (Varimax) for better distinguishing of factor loadings among factors (Field and Miles, 2010). Factor loadings are necessary for the calculation of factor scores. According to DiStefano et al (2009), factor scores can be calculated by using the method of sum scores by factor, this method allows researchers to obtain averaged scores which can be used in posterior analysis (see Table 3-1). The data collected was considered numerical and categorical. Questions with Likert scale answers constitute categorical data, ranging from 1 to 5 (1 strongly disagree, and 5 strongly agree).

Table 3-1. Purification and analysis of data

Statistic Methods	
Cronbach's alpha	**Purpose**
Measure internal consistency to the scale. It is the level to which items in the measurement are related to each other (Nunnally and Durham, 1975) (Pedhazur and Schmelkin, 1991)	To carry out reliability analysis, identifying relationships among items, and retaining those with values equal or higher than 0.6 (Van-Aken, 2007). Elimination of items that do not accomplish this requirement is carried out, only if this action improves the scale reliability (Field and Miles, 2010).
Factor analysis	**Purpose**
It is a statistical method for assessing the dimensionality of multivariate data. It allows the validation, reduction of critical items in each factor (Creighton et al., 1997), and extraction of factors (identifying latent factors) (Van-Aken, 2007).	To carry out validity analysis, identify which items are strongly related with a specific factor or factors. Items with loadings bigger or equal to 0.45 will be retained. The next step is rotation. To rotate factors, allowing the maximization of the loading of each item on one extracted factor and diminishing the loading on the other factors. Loadings bigger or equal to 0.4 will be retained. Lastly, factor scores will be calculated using the method of sum by factor (DiStefano et al., 2009). Then, each factor will obtain a value to be used in multiple regression analysis.

Once factor scores are calculated, they will serve as input data for regression analysis. Regression analysis was used to validate the proposed model. The regression model describes and assess 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):

$$Y = B_0 + B_1X_11 + B_2X_2 + \ldots\ldots\ldots + B\kappa Xi\kappa + \xi$$

Small sample sizes can be used for regression analysis; however, large sample sizes will provide more reliable results (Kahane, 2001). Regression analysis can be applied to a variety of areas such as: economics, finance, business, law, meteorology, engineering, and psychology (Chatterjee, 2006).This method has been used to analyze and validate proposed models by many researchers, to determine the relationships in the Technology Acceptance Model (TAM) (Davis et al., 1989). The impact of Information and Communication Technology (ICT)-based features in conference center selection and recommendation by meeting planners (Lee, 2009a), supply chain management impact on performance (Tan et al., 1999), and supplier integration into new product development (Petersen et al., 2005). Thus, regression model was utilized for hypothesis testing. Then hypotheses were tested by multiple regression analysis, and are listed in Table 3-2:

Table 3-2. Proposed hypotheses

Hypothesis	Independent Variable	Dependent Variable
H1	Environmental Uncertainties (EU)	Supply Chain Management Performance
H2	Information Technology (IT)	Supply Chain Management Performance
H3	Supply Chain Relationship (SCR)	Supply Chain Management Performance
H4	Value-Added Process (Manufacturing) (VAPM)	Supply Chain Management Performance
H5	Supply Chain Management Performance (SCMP)	Business Management
H6	Business Management (BM)	Customer Satisfaction

The main relationships between dependent and independent variables can be seen below:

$SCMP = b_0 + b_1EU + b_2IT + b_3SCR + b_4VAPM + \xi$

$BM = b_0 + b_1SCMP + \xi$

$CS = b_0 + b_1BM + \xi$

Where:

b_0 = Intersection, b_1, b_2, b_3, b_4 = 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 (Manufacturing)

Pearson (r) correlation analysis was carried out to explore the strength of the relationship between the factors. The scale for coefficients is ranged from -1 to 1. The closer the coefficient to one, the stronger relationship between variables is (Younger, 1979). After determining Pearson coefficient, the next step is to calculate the coefficient of determination (R^2), which measures the proportion of variance shared by the variables and ranges from 0 to 1 (Kahane, 2001). Values closer to 1 indicate that the regression is working well.

A flow chart containing the analysis process can be seen in Figure 3.4, which is a derivation of the general methodology shown in Figure 1.1 in Chapter 1.

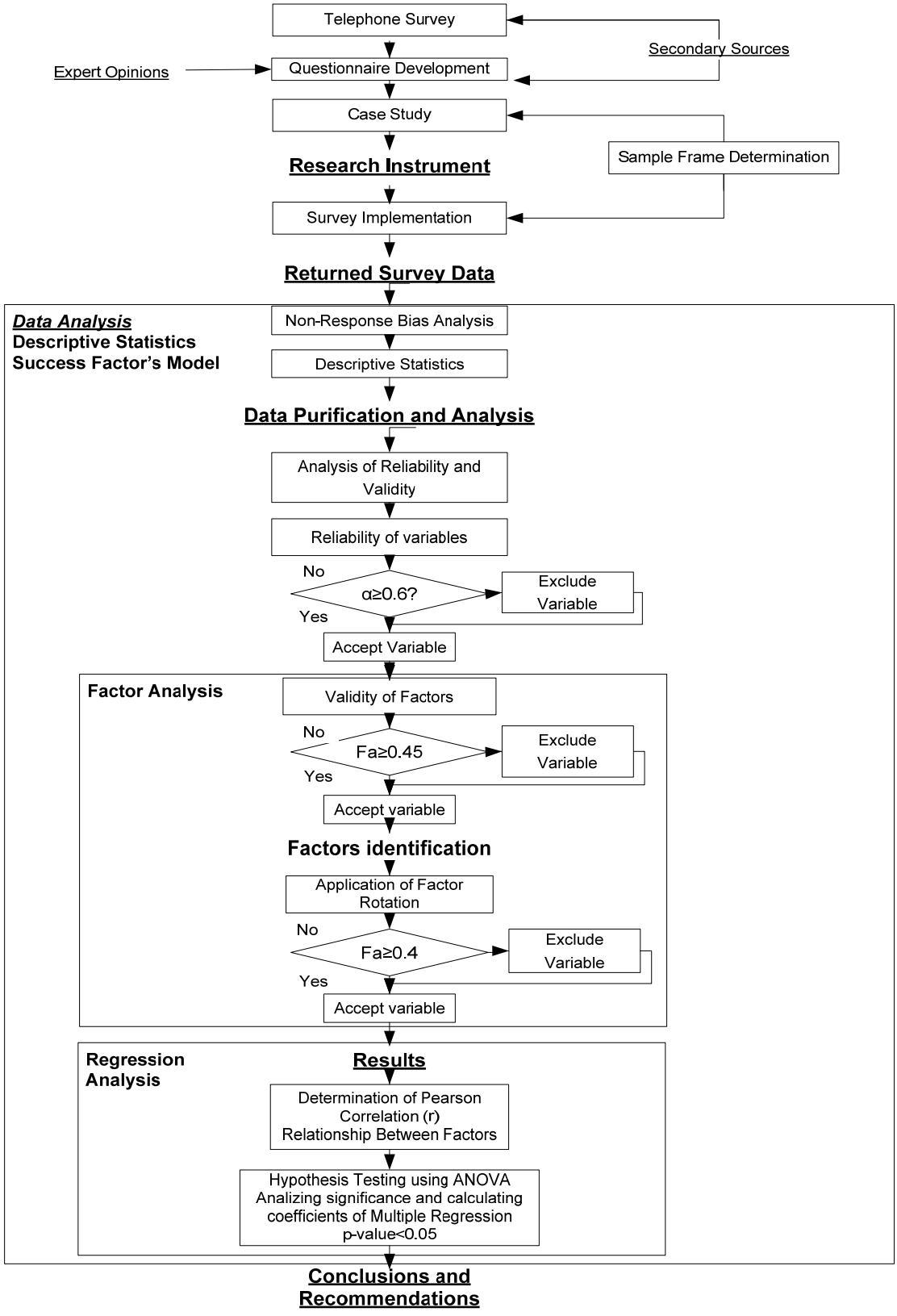


Figure 3.4. Research methodology and analysis process.

Part of the main purpose of the study is to explore the relationship among seven factors: environmental uncertainties, information technology, supply chain relationship, value-added process (manufacturing), supply chain management performance, business management, and customer satisfaction.

3.5 Results and Discussion

This section shows the results for data purification, data analysis, and hypothesis testing. Results from tests of the factors relationships listed above are presented below. Factors were subject to reliability, and validity analysis as described in the methodology.

3.5.1 *Data Purification and Analysis*

3.5.1.1 Environmental Uncertainties

The factor environmental uncertainties contemplate 3 sub-factors: company environment, government support, and uncertainty aspects from overseas (see Table 3-3). The sub-factors were under went Cronbach's alpha analysis, exploratory factor analysis, which was conducted using principal components as the extraction method, and Varimax as the rotation method. For simplicity, only loadings around 0.5 or higher were displayed in the resulted tables.

Table 3-3. Environmental uncertainties factor and sub-factors

Code	Environmental Uncertainties Factor	Sub-factor
Q251	Our company works with more than 3 suppliers	Company environment
Q252	Our company trusts its suppliers	
Q253	Our company involves suppliers when planning strategic goals	
Q254	Our company is open to work with suppliers from other countries	
Q255	Competition in the wood pallet sector is strong	
Q256	There is a high level of communication and coordination with our suppliers	
Q259	Our company would like to work with suppliers who have availability of resources and consistency of supply	
Q257	Our company uses certified wood for manufacturing pallets	Government support
Q258	Our company is informed by the government about important aspects that can affect our business	
Q2591	Our company thinks that logistics and transportation is the number one criterion when selecting suppliers	Uncertainty aspects from overseas
Q2592	The delivery of imported wood pallet materials can easily go wrong	
Q2593	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	

Company Environment

Table 3-4 shows the raw Cronbach's alpha, which was lower than 0.60, showing a low scale reliability.

Table 3-4. Reliability analysis for company environment sub-factor

Code	Company Environment	Raw Cronbach Coefficient Alpha (α)	Standardized Cronbach Coefficient Alpha (α)
Q251	Our company works with more than 3 suppliers	0.599	0.623
Q252	Our company trusts its suppliers		
Q253	Our company involves suppliers when planning strategic goals		
Q254	Our company is open to work with suppliers from other countries		
Q255	Competition in the wood pallet sector is strong		
Q256	There is a high level of communication and coordination with our suppliers		
Q259	Our company would like to work with suppliers who have availability of resources and consistency of supply		

The individual alpha values were calculated for company environment sub-factor in Table 3-5. Showing that the scale reliability can be improved eliminating question Q254.

Table 3-5. Individual Cronbach's alpha for company environment sub-factor

Cronbach Coefficient Alpha with Deleted Variable					
Raw Variables			**Standardized Variables**		
Deleted variable	Correlation with total	Alpha	Correlation with total	Alpha	Label
Q251	0.326	0.557	0.328	0.588	Q251
Q252	0.348	0.556	0.361	0.577	Q252
Q253	0.310	0.565	0.315	0.592	Q253
Q254	0.247	0.603	0.248	0.613	Q254
Q255	0.354	0.557	0.363	0.577	Q255
Q256	0.400	0.532	0.412	0.560	Q256
Q259	0.314	0.562	0.318	0.591	Q259

Once identified the possibility to improve the alpha value, and question Q254 was deleted, the raw and standardized Cronbach's alpha were 0.60 and 0.61 respectively. While it was not a big improvement, it now proves good scale reliability for the items utilized in the sub-factor (see Table 3-6).

Table 3-6. Recalculated reliability analysis for company environment sub-factor

Code	Company Environment	Raw Cronbach Coefficient Alpha (α)	Standardized Cronbach Coefficient Alpha (α)
Q251	Our company works with more than 3 suppliers	0.603	0.613
Q252	Our company trusts its suppliers		
Q253	Our company involves suppliers when planning strategic goals		
Q255	Competition in the wood pallet sector is strong		
Q256	There is a high level of communication and coordination with our suppliers		
Q259	Our company would like to work with suppliers who have availability of resources and consistency of supply		

Factor analysis was performed, which identified two factors, with Eigenvalues of 2.04 and 1.26. Results can be seen in Table 3-7:

Table 3-7. Factor analysis for company environment sub-factor

Code	Company Environment	Eigenvalue		Sub-Factor		Variance Explained	
		1	2	Sub-Factor 1	Sub-Factor 2	Sub-Factor 1	Sub-Factor 2
Q251	Our company works with more than 3 suppliers	2.047	1.267	0.494	0.483	2.047 (34%)	1.267 (21%)
Q252	Our company trusts its suppliers			0.669	-0.484		
Q253	Our company involves suppliers when planning strategic goals			0.563	-0.249		
Q255	Competition in the wood pallet sector is strong			0.559	0.379		
Q256	There is a high level of communication and coordination with our suppliers			0.673	-0.459		
Q259	Our company would like to work with suppliers who have availability of resources and consistency of supply			0.521	0.617		

When looking at the factor analysis results, it is easy to see that the highest loading of sub-factor 2 was 0.61, only for one item, compared to loadings in factor 1 (0.52). It is better to focus on one sub-factor (sub-factor1), because the loadings of sub-factor2 are not significant as in sub-factor1 (see Table 3-8). Results show that the lowest loading was 0.49 for question Q251. Then, all items were kept for posterior analysis.

Table 3-8. Recalculated factor analysis for company environment sub-factor

Code	Company Environment	Eigenvalue		Sub-Factor	Variance Explained
		1	2	Sub-Factor 1 Company Environment	Sub-Factor 1
Q251	Our company works with more than 3 suppliers	2.047	1.267	0.494	2.047 (34%)
Q252	Our company trusts its suppliers			0.669	
Q253	Our company involves suppliers when planning strategic goals			0.563	
Q255	Competition in the wood pallet sector is strong			0.559	
Q256	There is a high level of communication and coordination with our suppliers			0.673	
Q259	Our company would like to work with suppliers who have availability of resources and consistency of supply			0.521	

Government Support

Table 3-9 shows the values of 0.64 and 0.65 for raw and standardized Cronbach's coefficient alpha, meaning good scale reliability.

Table 3-9. Reliability analysis for government support sub-factor

Code	Government Support	Raw Cronbach Coefficient Alpha (α)	Standardized Cronbach Coefficient Alpha (α)
Q257	Our company uses certified wood for manufacturing pallets	0.643	0.649
Q258	Our company is informed by the government about important aspects that can affect our business		

The individual alpha values could not be calculated for this sub-factor because it contains only 2 items (see Table 3-10). Therefore, it was retained as raw Cronbach's alpha for all variables of 0.643 showed in Table 3-9.

Table 3-10. Individual Cronbach's alpha for government support sub-factor

Cronbach Coefficient Alpha with Deleted Variable					
Raw Variables			Standardized Variables		
Deleted variable	Correlation with total	Alpha	Correlation with total	Alpha	Label
Q257	0.480	---	0.481	---	Q257
Q258	0.480	---	0.481	---	Q258

After Cronbach's alpha analysis, factor analysis was carried out. Results have shown that the items build one factor with an Eigenvalue of 1.48. This can be seen in Table 3-11. Then, these items were kept for further analysis.

Table 3-11. Factor analysis for government support sub-factor

Code	Government Support	Eigenvalue	Sub-Factor	Variance Explained
		1	Sub-Factor1 Government Support	Sub-Factor1
Q257	Our company uses certified wood for manufacturing pallets	1.481	0.860	1.481 (74%)
Q258	Our company is informed by the government about important aspects that can affect our business		0.860	

Uncertainty Aspects from Overseas

Values of 0.47 and 0.48 were obtained for raw and standardized Cronbach's coefficient alpha. The result was poor due to scale reliability, see Table 3-12. Then, this sub-factor was not considered for further analysis.

Table 3-12. Reliability analysis for uncertainty aspects from overseas sub-factor

Code	Uncertainty Aspects from Overseas	Raw Cronbach Coefficient Alpha (α)	Standardized Cronbach Coefficient Alpha (α)
Q2591	Our company thinks that logistics and transportation is the number one criterion when selecting suppliers	0.472	0.484
Q2592	The delivery of imported wood pallet materials can easily go wrong		
Q2593	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		

The individual alpha values were calculated for uncertainty aspects from overseas sub-factor in

Table 3-13. Showing that, the scale reliability can be improved eliminating question Q2591.

Table 3-13. Individual Cronbach's alpha for uncertainty aspects from overseas sub-factor

Cronbach Coefficient Alpha with Deleted Variable					
Raw Variables			Standardized Variables		
Deleted variable	Correlation with total	Alpha	Correlation with total	Alpha	Label
Q2591	0.145	0.618	0.150	0.628	Q2591
Q2592	0.357	0.265	0.365	0.274	Q2592
Q2593	0.401	0.170	0.416	0.179	Q2593

The result was to obtain a raw and standardized Cronbach's coefficient alpha of approximately 0.62 and 0.63 respectively. This means good scale reliability (see Table 3-14).

Table 3-14. Recalculated reliability analysis for uncertainty aspects from overseas sub-factor

Code	Uncertainty Aspects from Overseas	Raw Cronbach Coefficient Alpha (α)	Standardized Cronbach Coefficient Alpha (α)
Q2592	The delivery of imported wood pallet materials can easily go wrong	0.618	0.628
Q2593	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		

Table 3-15 shows the results from the factor analysis with an Eigenvalue of 1.4, where items point out to one factor with high loadings for each item.

Table 3-15. Factor analysis for uncertainty aspects from overseas sub-factor

Code	Uncertainty Aspects from Overseas	Eigenvalue	Sub-Factor	Variance Explained
		1	Sub-Factor 1 Uncertainty Aspects from Overseas	Sub-Factor 1
Q2592	The delivery of imported wood pallet materials can easily go wrong	1.458	0.854	1.458 (73%)
Q2593	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		0.854	

Once Cronbach's alpha and factor analysis were carried out, factor rotation was conducted allowing the identification of items which are better related to a specific factor. Therefore, factors will be identified and items arranged according to their loadings on each factor. Table 3-16 shows that items from company environment are mixed with those ones from "government support" sub-factor, then the sub-factor was named company environment with questions Q252, Q253, Q256, Q257, and Q258. The same happened to "government support" sub-factor, which contemplates 3 questions Q251, Q255, and Q259. Then "government support" sub-factor was named "suppliers and competition", because their items are more related to this subject. And "uncertainty aspects from overseas" sub-factor remained with the same items.

Table 3-16. Orthogonal factor rotation for environmental uncertainties sub-factors (loadings ≥0.4 are painted on bold)

Code	Environmental Uncertainties Factor	Rotated Factor Pattern			Variance Explained		
		Sub-Factor 1 Company Environment	Sub-Factor 2 Suppliers and competition	Sub-Factor 3 Uncertainty Aspects from Overseas	Sub-Factor1	Sub-Factor2	Sub-Factor3
Q252	Our company trusts its suppliers	***0.643***	0.350	-0.080	2.218	1.891	1.513
Q253	Our company involves suppliers when planning strategic goals	***0.579***	0.307	0.299			
Q256	There is a high level of communication and coordination with our suppliers	***0.716***	0.225	-0.174			
Q257	Our company uses certified wood for manufacturing pallets	***0.730***	-0.229	0.145			
Q258	Our company is informed by the government about important aspects that can affect our business	***0.599***	-0.346	-0.058			
Q251	Our company works with more than 3 suppliers	0.176	***0.521***	0.027			
Q255	Competition in the wood pallet sector is strong	-0.028	***0.747***	0.006			
Q259	Our company would like to work with suppliers who have availability of resources and consistency of supply	-0.044	***0.774***	-0.056			
Q2592	The delivery of imported wood pallet materials can easily go wrong	-0.125	0.087	***0.833***			
Q2593	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	0.110	-0.109	***0.814***			

3.5.1.2 Information Technology

The factor information technology contemplates two sub-factors: communication tools, and planning tools. Table 3-17 shows all items and sub-factors that are part of the information technology factor.

Table 3-17. Information technology factor and sub-factors

Code	Information Technology Factor	Sub-factor
Q231	Our company has made investments in communication tools	Communication Tools
Q232	We use an internal computer network	
Q233	Our company has a website where customers can buy our products	
Q234	Our company requests wood pallet materials from suppliers through the internet	
Q235	Our company develops plans and strategies for information technology investments	Planning Tools
Q236	Our company is always training personnel in the use of information technologies	
Q237	Our company makes use of a software such as an Enterprise Resource Planning (ERP) for the company business	

Communication Tools

The items used in this sub-factor and Cronbach's alpha values are shown in Table 3-18. The alpha values were 0.76 for each alpha coefficient, indicating good scale reliability.

Table 3-18. Reliability analysis for communication tools sub-factor

Code	Communication Tools	Raw Cronbach Coefficient Alpha (α)	Standardized Cronbach Coefficient Alpha (α)
Q231	Our company has made investments in communication tools	0.764	0.759
Q232	We use an internal computer network		
Q233	Our company has a website where customers can buy our products		
Q234	Our company requests wood pallet materials from suppliers through the internet		

The individual alpha values were calculated for communication tools sub-factor (see Table 3-19). It can be seen that there is no need to eliminate items, even if question Q234 is deleted; this will not improve much the scale reliability. Then, four items were retained.

Table 3-19. Individual Cronbach's alpha for communication tools sub-factor

Cronbach Coefficient Alpha with Deleted Variable					
Raw Variables			**Standardized Variables**		
Deleted variable	Correlation with total	Alpha	Correlation with total	Alpha	Label
Q231	0.617	0.685	0.595	0.681	Q231
Q232	0.693	0.632	0.685	0.630	Q232
Q233	0.552	0.722	0.542	0.710	Q233
Q234	0.421	0.776	0.417	0.775	Q234

Factor analysis showed that the Eigenvalue was 2.36, where items contributed to form one sub-factor, with the lowest loading of 0.64 for question Q234. This can be seen in Table 3-20:

Table 3-20. Factor analysis for communication tools sub-factor

Code	Communication Tools	Eigenvalue	Sub-Factor	Variance Explained
			Communication Tools	
Q231	Our company has made investments in communication tools	2.362	0.805	2.362 (59%)
Q232	We use an internal computer network		0.858	
Q233	Our company has a website where customers can buy our products		0.750	
Q234	Our company requests wood pallet materials from suppliers through the internet		0.642	

Planning Tools

Table 3-21 shows the raw and standardized Cronbach's alpha values, which were 0.84 and 0.85 respectively, confirming high relationship among items.

Table 3-21. Reliability analysis for planning tools sub-factor

Code	Planning Tools	Raw Cronbach Coefficient Alpha (α)	Standardized Cronbach Coefficient Alpha (α)
Q235	Our company develops plans and strategies for information technology investments	0.840	0.854
Q236	Our company is always training personnel in the use of information technologies		
Q237	Our company makes use of a software such as an Enterprise Resource Planning (ERP) for the company business		

The individual alpha values were calculated for planning tools sub-factor (see Table 3-22). It can be seen that there is no need to eliminate some items. Then, four items were retained.

Table 3-22. Individual Cronbach's alpha for planning tools sub-factor

Cronbach Coefficient Alpha with Deleted Variable					
Raw Variables			Standardized Variables		
Deleted variable	Correlation with total	Alpha	Correlation with total	Alpha	Label
Q235	0.763	0.719	0.778	0.744	Q235
Q236	0.783	0.703	0.797	0.725	Q236
Q237	0.580	0.892	0.609	0.901	Q237

Table 3-23 shows the factor analysis with an Eigenvalue of 2.3, and the identification of one latent factor (planning tools sub-factor) with loadings of 0.91, 0.92, and 0.80 corresponding to questions Q235, Q236, and Q237.

Table 3-23. Factor analysis for planning tools sub-factor

Code	Planning Tools	Eigenvalue	Sub-Factor Planning Tools	Variance Explained
Q235	Our company develops plans and strategies for information technology investments	2.325	0.911	2.325 (77.5%)
Q236	Our company is always training personnel in the use of information technologies		0.920	
Q237	Our company makes use of a software such as an Enterprise Resource Planning (ERP) for the company business		0.804	

Table 3-24 shows the orthogonal factor rotation, which gathers the items of the two sub-factors before their identification in the individual factor analysis. Communication and planning tools had the lowest loadings of 0.61, and 0.77, respectively. It was detected the belongings of the items to each sub-factor, which were identified before in the individual factor analysis.

Table 3-24. Orthogonal factor rotation for information technology sub-factors (loadings ≥0.4 in bold)

Code	Information Technology Factor	Rotated Factor Pattern		Variance Explained	
		Sub-Factor1 Communication Tools	Sub-Factor2 Planning Tools	Sub-Factor 1	Sub-Factor 2
Q231	Our company has made investments in communication tools	***0.659***	0.402	2.358	2.323
Q232	We use an internal computer network	***0.739***	0.374		
Q233	Our company has a website where customers can buy our products	***0.612***	0.344		
Q234	Our company requests wood pallet materials from suppliers through the internet	***0.759***	0.042		
Q235	Our company develops plans and strategies for information technology investments	0.444	***0.773***		
Q236	Our company is always training personnel in the use of information technologies	0.428	***0.781***		
Q237	Our company makes use of a software such as an Enterprise Resource Planning (ERP) for the company business	0.086	***0.853***		

3.5.1.3 Supply Chain Relationships

The factor supply chain relationships contemplate two sub-factors: relationship with suppliers, and relationship with customers, as can be seen in Table 3-25. Cronbach's alpha analysis, exploratory factor analysis was conducted using principal components as extraction method, and orthogonal rotation method.

Table 3-25. Supply chain relationship factor

Code	Supply Chain Relationship Factor	Sub-factor
Q211	Our company depends on a few reliable suppliers	Relationship with suppliers
Q212	Our suppliers give us high quality wood pallet materials	
Q213	Our suppliers visit us frequently	
Q214	Our company shares information with its suppliers	
Q215	Our suppliers share information that can affect our company	
Q216	The exchange of information between us and our suppliers is precise	
Q217	The exchange of information between us and our suppliers is complete	
Q218	The exchange of information between us and our suppliers is reliable	
Q219	Our company evaluates the customer satisfaction frequently	Relationship with customers
Q2191	Our company shares the mission, vision and objectives with its customers	
Q2192	Our company evaluates periodically the relationship with its customers	
Q2193	Our company recognizes the loyalty of actual customers frequently	

Relationship with Suppliers

The items used in this sub-factor and Cronbach's alpha values are shown in Table 3-26. The Cronbach's alpha values were 0.82 and 0.83, respectively for raw and standardized coefficients. These values indicate that there is good scale reliability.

Table 3-26. Reliability analysis for relationship with suppliers sub-factor

Code	Relationship with Suppliers	Raw Cronbach Coefficient Alpha (α)	Standardized Cronbach Coefficient Alpha (α)
Q211	Our company depends on a few reliable suppliers	0.827	0.838
Q212	Our suppliers give us high quality wood pallet materials		
Q213	Our suppliers visit us frequently		
Q214	Our company shares information with its suppliers		
Q215	Our suppliers share information that can affect our company		
Q216	The exchange of information between us and our suppliers is precise		
Q217	The exchange of information between us and our suppliers is complete		
Q218	The exchange of information between us and our suppliers is reliable		

The individual alpha values were calculated for relationship with suppliers sub-factor (see Table 3-27). Even though the Cronbach's alpha values were good, it was possible to increase their value dropping the item with code Q211, which allowed increasing the raw alpha value from 0.82 to 0.84.

Table 3-27. Individual Cronbach's alpha for relationship with suppliers sub-factor

Cronbach Coefficient Alpha with Deleted Variable					
Raw Variables			Standardized Variables		
Deleted variable	Correlation with total	Alpha	Correlation with total	Alpha	Label
Q211	0.312	0.842	0.317	0.849	Q211
Q212	0.447	0.820	0.449	0.834	Q212
Q213	0.372	0.836	0.368	0.843	Q213
Q214	0.559	0.807	0.562	0.819	Q214
Q215	0.589	0.802	0.600	0.814	Q215
Q216	0.772	0.777	0.780	0.790	Q216
Q217	0.771	0.777	0.778	0.791	Q217
Q218	0.706	0.789	0.725	0.798	Q218

Then recalculating Cronbach's alpha, without question Q211, gave the following results (Table 3-28):

Table 3-28. Recalculated reliability analysis for relationship with suppliers sub-factor

Code	Relationship with Suppliers	Raw Cronbach Coefficient Alpha (α)	Standardized Cronbach Coefficient Alpha (α)
Q212	Our suppliers give us high quality wood pallet materials	0.842	0.849
Q213	Our suppliers visit us frequently		
Q214	Our company shares information with its suppliers		
Q215	Our suppliers share information that can affect our company		
Q216	The exchange of information between us and our suppliers is precise		
Q217	The exchange of information between us and our suppliers is complete		
Q218	The exchange of information between us and our suppliers is reliable		

The factor analysis results had shown the presence of one latent factor with an Eigenvalue of 3.78, and factor loadings of 0.54, 0.50, 0.68, 0.72, 0.9, 0.87, and 0.84 for each item (Q212-Q218) (see Table 3-29). Meaning that, there is high contribution from each item to the relationship with suppliers sub-factor. And, as a consequence, this sub-factor retained seven items for further analysis.

Table 3-29. Factor analysis for relationship with suppliers sub-factor

Code	Relationship with Suppliers	Eigenvalue	Sub-Factor	Variance Explained
			Relationship with Suppliers	
Q212	Our suppliers give us high quality wood pallet materials	3.788	0.539	3.788
Q213	Our suppliers visit us frequently		0.501	
Q214	Our company shares information with its suppliers		0.682	
Q215	Our suppliers share information that can affect our company		0.715	
Q216	The exchange of information between us and our suppliers is precise		0.899	
Q217	The exchange of information between us and our suppliers is complete		0.873	
Q218	The exchange of information between us and our suppliers is reliable		0.835	

Relationship with Customers

The items used in the relationship with customers sub-factor are shown in Table 3-30 The Cronbach's alpha values approximately were 0.81 and 0.81 for raw and standardized coefficients. This indicates that there is good scale reliability.

Table 3-30. Reliability analysis for relationship with customers sub-factor

Code	Relationship with Customers	Raw Cronbach Coefficient Alpha (α)	Standardized Cronbach Coefficient Alpha (α)
Q219	Our company evaluates the customer satisfaction frequently	0.808	0.809
Q2191	Our company shares the mission, vision and objectives with its customers		
Q2192	Our company evaluates periodically the relationship with its customers		
Q2193	Our company recognizes the loyalty of actual customers frequently		

The individual alpha values were calculated for relationship with customers sub-factor (see Table 3-31). And it can be seen that the scale reliability cannot be improved. Then, the four items remained for factor analysis.

Table 3-31. Individual Cronbach's alpha for relationship with customers sub-factor

Cronbach Coefficient Alpha with Deleted Variable					
Raw Variables			Standardized Variables		
Deleted variable	Correlation with total	Alpha	Correlation with total	Alpha	Label
Q219	0.626	0.759	0.624	0.760	Q219
Q2191	0.551	0.795	0.549	0.796	Q2191
Q2192	0.710	0.722	0.708	0.719	Q2192
Q2193	0.624	0.759	0.623	0.761	Q2193

When factor analysis was carried out, the Eigenvalue was 2.52, and the analysis identified one latent factor (relationship with customers sub-factor) with loadings of 0.79, 0.73, 0.85, and 0.79 for each item. Then, four items were retained for subsequent analysis. This can be seen in Table 3-32.

Table 3-32. Factor analysis for relationship with customers sub-factor

Code	Relationship with Customers	Eigenvalue	Sub-Factor Relationship with Customers	Variance Explained
Q219	Our company evaluates the customer satisfaction frequently	2.526	0.793	2.526
Q2191	Our company shares the mission, vision and objectives with its customers		0.731	
Q2192	Our company evaluates periodically the relationship with its customers		0.854	
Q2193	Our company recognizes the loyalty of actual customers frequently		0.794	

Once Cronbach's alpha and individual factor analyses were performed, it was proceeded to apply orthogonal rotation as the last procedure of factor analysis, to the supply chain relationship factor (seeTable 3-33).

Table 3-33. Orthogonal factor rotation for supply chain relationship sub-factors

(loadings ≥0.4 in bold)

Code	Supply Chain Relationships	Rotated Factor Pattern		Variance Explained	
		Sub-Factor1 Relationship with suppliers	Sub-Factor2 Relationship with customers	Sub-Factor 1	Sub-Factor 2
Q212	Our suppliers give us high quality wood pallet materials	***0.505***	0.280	3.600	2.645
Q213	Our suppliers visit us frequently	***0.455***	0.206		
Q214	Our company shares information with its suppliers	***0.677***	0.009		
Q215	Our suppliers share information that can affect our company	***0.682***	0.136		
Q216	The exchange of information between us and our suppliers is precise	***0.856***	0.243		
Q217	The exchange of information between us and our suppliers is complete	***0.844***	0.175		
Q218	The exchange of information between us and our suppliers is reliable	***0.788***	0.219		
Q219	Our company evaluates the customer satisfaction frequently	0.249	***0.769***		
Q2191	Our company shares the mission, vision and objectives with its customers	0.221	***0.675***		
Q2192	Our company evaluates periodically the relationship with its customers	0.119	***0.848***		
Q2193	Our company recognizes the loyalty of actual customers frequently	0.129	***0.774***		

3.5.1.4 Value-Added Process (Manufacturing)

The factor value-added process (manufacturing) includes three sub-factors: flexibility, production system, and quality (see

Table 3-34). These sub-factors were subject to a reliability analysis, and factor analysis.

Table 3-34. Value-added process (manufacturing) factor and sub-factors

Code	Value-Added Process (Manufacturing) Factor	Sub-factor
Q221	Our company is able to manage big or small orders, according to the customer's requirements	Flexibility
Q222	Our company is able to answer quickly, to fast changes in the market, like the need of new products	
Q223	Our company has cross-trained employees, who do several tasks	
Q225	Our company is able to make fast changes in the production process to accelerate or des-accelerate the product production	
Q224	Our company uses state of the art technology in equipment and machinery	Production System
Q226	Our company works to reduce production time	
Q227	Our company works with indicators that measure the production process performance	
Q228	Our company uses LEAN manufacturing production principles	
Q229	Our company uses SIX SIGMA strategy in the manufacturing process	
Q2291	Our company makes use of special software for designing pallets	
Q2292	Our company has a certification in quality system or it is in process of certification	Quality
Q2293	Our company measures the quality of its products	
Q2294	Our company keeps track of customers feedback for the pre-sales and post-sale processes	
Q2295	Our employees (at all levels) are frequently trained and evaluated	

Flexibility

Table 3-35 shows the items used in this sub-factor and Cronbach's alpha values. The alpha coefficient was approximately 0.77 for raw and standardized alpha values, demonstrating a strong relationship among items.

Table 3-35. Reliability analysis of flexibility sub-factor

Code	Flexibility	Raw Cronbach Coefficient Alpha (α)	Standardized Cronbach Coefficient Alpha (α)
Q221	Our company is able to manage big or small orders, according to the customer's requirements	0.768	0.768
Q222	Our company is able to answer quickly, to fast changes in the market, like the need of new products		
Q223	Our company has cross-trained employees, who do several tasks		
Q225	Our company is able to make fast changes in the production process to accelerate or des-accelerate the product production		

The individual alpha values were calculated for flexibility sub-factor (see Table 3-36). It can be seen that, there is no need to eliminate items because this operation does not improve the scale reliability. Then, the four items remained for factor analysis.

Table 3-36. Individual Cronbach's alpha for flexibility sub-factor

Cronbach Coefficient Alpha with Deleted Variable					
Raw Variables			Standardized Variables		
Deleted variable	Correlation with total	Alpha	Correlation with total	Alpha	Label
Q221	0.570	0.714	0.566	0.713	Q221
Q222	0.643	0.671	0.644	0.671	Q222
Q223	0.525	0.735	0.523	0.736	Q223
Q225	0.546	0.725	0.540	0.727	Q225

After obtaining good scale reliability among items, it was proceeded to execute factor analysis (see Table 3-37). The results show that the items contribute to create only one sub-factor with minimum load of 0.73 from question Q223. Then, all the items were kept for posterior analysis.

Table 3-37. Factor analysis for flexibility sub-factor

Code	Flexibility	Eigenvalue	Sub-Factor Flexibility	Variance Explained
Q221	Our company is able to manage big or small orders, according to the customer's requirements	2.380	0.776	2.380 (59.5%)
Q222	Our company is able to answer quickly, to fast changes in the market, like the need of new products		0.836	
Q223	Our company has cross-trained employees, who do several tasks		0.728	
Q225	Our company is able to make fast changes in the production process to accelerate or des-accelerate the product production		0.740	

Production System

The items used in this sub-factor and Cronbach's alpha values are shown in Table 3-38. The raw and standardized Cronbach's alpha values were 0.71 and 0.72 respectively, showing high correlation among items.

Table 3-38. Reliability analysis for production system

Code	Production System	Raw Cronbach Coefficient Alpha (α)	Standardized Cronbach Coefficient Alpha (α)
Q224	Our company uses state of the art technology in equipment and machinery	0.716	0.725
Q226	Our company works to reduce production time		
Q227	Our company works with indicators that measure the production process performance		
Q228	Our company uses LEAN manufacturing production principles		
Q229	Our company uses SIX SIGMA strategy in the manufacturing process		
Q2291	Our company makes use of special software for designing pallets		

The individual alpha values were calculated for production system sub-factor (see Table 3-39). It can be seen that there is no need to eliminate items. Then, the six items were retained for factor analysis.

Table 3-39. Individual Cronbach's alpha for production system sub-factor

Cronbach Coefficient Alpha with Deleted Variable					
Raw Variables			Standardized Variables		
Deleted variable	Correlation with total	Alpha	Correlation with total	Alpha	Label
Q224	0.543	0.648	0.515	0.671	Q224
Q226	0.365	0.704	0.371	0.713	Q226
Q227	0.645	0.618	0.650	0.628	Q227
Q228	0.451	0.677	0.480	0.681	Q228
Q229	0.336	0.708	0.336	0.723	Q229
Q2291	0.437	0.700	0.417	0.700	Q2291

Factor analysis was carried out, two sub-factors were identified. Analyzing sub-factor 2 and its loadings, it can be seen that question Q228 had low loading of 0.56 compared with the loading in sub-factor 1 of 0.64, then, it was seen to take into account only the loading in sub-factor 1 instead of the loading in sub-factor 2. This left us with only one loading in sub-factor 2 of 0.56, that had no much difference with loading of sub-factor 1 (0.51). This can be seen in Table 3-40:

Table 3-40. Factor analysis for production system sub-factor

Code	Production System	Eigenvalue		Sub-Factor		Variance Explained	
		1	2	Sub-Factor 1	Sub-Factor 2	Sub-Factor1	Sub-Factor2
Q224	Our company uses state of the art technology in equipment and machinery	2.559	1.147			2.559	1.147
Q226	Our company works to reduce production time			0.573	0.008		
Q227	Our company works with indicators that measure the production process performance			0.828	0.006		
Q228	Our company uses LEAN MANUFACTURING production principles			0.645	0.564		
Q229	Our company uses SIX SIGMA strategy in the manufacturing process			0.512	0.564		
Q2291	Our company makes use of special software for designing pallets			0.610	-0.496		

Having analyzed the loadings of sub-factor 2, a factor analysis was executed one more time, but only for one sub-factor. Looking at the loadings in sub-factor 1, the lowest loading was 0.51 for question Q229. Then, these six items will be used for factor rotation analysis. Results can be seen in Table 3-41.

Table 3-41. Recalculating factor analysis for production system sub-factor

Code	Production System	Eigenvalue		Sub-Factor	Variance Explained
		1	2	Production System	Sub-Factor1
Q224	Our company uses state of the art technology in equipment and machinery	2.559	1.147	0.702	2.559 (42.6%)
Q226	Our company works to reduce production time			0.573	
Q227	Our company works with indicators that measure the production process performance			0.828	
Q228	Our company uses LEAN MANUFACTURING production principles			0.645	
Q229	Our company uses SIX SIGMA strategy in the manufacturing process			0.512	
Q2291	Our company makes use of special software for designing pallets			0.610	

Quality

Raw and standardized Cronbach's alpha values for this sub-factor were 0.68 and 0.69, respectively, showing acceptable scale reliability for its good relationship among items. The values are shown in Table 3-42.

Table 3-42. Reliability analysis for quality sub-factor

Code	Quality	Raw Cronbach Coefficient Alpha (α)	Standardized Cronbach Coefficient Alpha (α)
Q2292	Our company has a certification in quality system or it is in process of certification	0.681	0.698
Q2293	Our company measures the quality of its products		
Q2294	Our company keeps track of customers feedback for the pre-sales and post-sale processes		
Q2295	Our employees (at all levels) are frequently trained and evaluated		

The individual alpha values were calculated for quality sub-factor (see Table 3-43). It can be seen that there is no need to eliminate items, even question Q2292 is eliminated; this will not improve much the scale reliability. Then, four items were retained.

Table 3-43. Individual Cronbach's alpha for quality sub-factor

Cronbach Coefficient Alpha with Deleted Variable					
Raw Variables			Standardized Variables		
Deleted variable	Correlation with total	Alpha	Correlation with total	Alpha	Label
Q2292	0.363	0.707	0.356	0.709	Q2292
Q2293	0.515	0.583	0.521	0.609	Q2293
Q2294	0.545	0.568	0.560	0.583	Q2294
Q2295	0.479	0.610	0.499	0.623	Q2295

Factor analysis was carried out showing an Eigenvalue of 2.09 and the identification of one sub-factor with a minimum load of 0.6 for question Q2292. This can be seen in Table 3-44.

Table 3-44. Factor analysis for quality sub-factor

Code	Quality	Eigenvalue	Sub-Factor	Variance Explained
			Quality	
Q2292	Our company has a certification in quality system or it is in process of certification	2.096	0.608	2.096 (52.4%)
Q2293	Our company measures the quality of its products		0.753	
Q2294	Our company keeps track of customers feedback for the pre-sales and post-sale processes		0.787	
Q2295	Our employees (at all levels) are frequently trained and evaluated		0.733	

After analyzing the individual items for each sub-factor within the value-added process (manufacturing) factor; the orthogonal rotation was carried out to evaluate the relationship of the items to each sub-factor. Table 3-45 shows the final results. Company respondents identified three sub-factors: flexibility, production system, and quality. The items identified in the flexibility sub-factor were questions Q221, Q222, Q223, Q224, and Q226. There was a mix of the items in the production system sub-factor (Q224 and Q226) with items in the flexibility sub-factor, which caused some items initially within one sub-factor to change to another sub-factor. It seemed that respondents were confused and recognized questions Q224 and Q226 as part of the flexibility sub-factor. The same occurred with production system sub-factor where questions Q225, Q2291, and Q2292 were identified instead of questions Q227, Q228, Q229 (which originally were part of this sub-factor). Then, these last mentioned items were identified as part of the quality sub-factor jointly with questions Q2293, Q2294, and Q2295.

Table 3-45. Orthogonal factor rotation for value-added process (manufacturing) sub-factors (loadings ≥0.4 in bold)

Code	Value-Added Process (Manufacturing) Factor	Rotated Factor Pattern			Variance Explained		
		Sub-Factor1 Flexibility	Sub-Factor2 Production System	Sub-Factor 3 Quality	Sub-Factor 1	Sub-Factor 2	Sub-Factor 3
Q221	Our company is able to manage big or small orders, according to the customer's requirements	***0.831***	0.021	0.113	3.449	2.852	2.105
Q222	Our company is able to answer quickly, to fast changes in the market, like the need of new products	***0.803***	0.134	0.115			
Q223	Our company has cross-trained employees, who do several tasks	***0.788***	0.123	-0.003			
Q224	Our company uses state of the art technology in equipment and machinery	***0.726***	0.291	0.172			
Q226	Our company works to reduce production time	***0.644***	0.416	0.102			
Q225	Our company is able to make fast changes in the production process to accelerate or des-accelerate the product production	0.333	0.142	***0.682***			
Q2291	Our company makes use of special software for designing pallets	0.085	-0.091	***0.900***			
Q2292	Our company has a certification in quality system or it is in process of certification	-0.056	0.293	***0.595***			
Q227	Our company works with indicators that measure the production process performance	0.239	***0.549***	0.531			
Q228	Our company uses LEAN MANUFACTURING production principles	0.087	***0.681***	0.155			
Q229	Our company uses SIX SIGMA strategy in the manufacturing process	-0.280	***0.611***	0.279			
Q2293	Our company measures the quality of its products	0.274	***0.685***	-0.066			
Q2294	Our company keeps track of customers feedback for the pre-sales and post-sale processes	0.306	***0.634***	0.119			
Q2295	Our employees (at all levels) are frequently trained and evaluated	0.337	***0.657***	0.052			

3.5.1.5 Supply Chain Management Performance

The factor supply chain management performance contemplates four sub-factors: logistic issues, supplier markets, supplier performance, and wood pallet materials (see Table 3-46). A Cronbach's alpha analysis, also exploratory factor analysis was conducted using principal components as extraction method, and Varimax as rotation method, only loadings around 0.5 or higher were displayed in the following tables.

Table 3-46. Supply chain management performance factor and sub-factors

Code	Supply Chain Management Performance Factor	Sub-factor
Q241	When suppliers are transporting wood pallet materials, our company can check where they are exactly located	Logistic issues
Q242	Our company knows what orders are coming and when they are going to be delivered	
Q248	Our suppliers deliver on time	
Q2492	Our suppliers are able to respond quickly to our needs	
Q243	The competition for raw materials is strong in the wood pallet industry	Supplier markets
Q244	Our company prefers to work with domestic wood pallet materials rather than imported ones	
Q245	The cost of wood pallet materials from other countries is lower than domestic ones	
Q246	Our number of suppliers have increased in the last 3 years	
Q247	Our suppliers offer a reliable delivery	Suppliers performance
Q249	Our suppliers are consistent in their delivery operations	
Q2491	Our suppliers are flexible when we request different qualities (grades) and quantities of wood pallet materials	
Q2493	Our suppliers deliver materials which their properties vary greatly within the same batch	
Q2494	Our suppliers are able to make fast changes in their production process to accelerate or des-accelerate the wood material supply	
Q2495	Domestic wood pallet materials supply is not consistent	Wood pallet materials
Q2496	Domestic wood pallet materials supply is not delivered on time	
Q2497	Transportation is a problem when acquiring wood pallet materials	
Q2498	Suppliers cannot give us information about where wood pallet materials are located when transported	
Q2499	Domestic wood pallet materials are of high quality	
Q24991	Our suppliers are able to answer quickly to our necessities	
Q24992	Our company has to buy treated lumber/wood pallet parts when importing wood pallet materials	
Q24993	Imported wood pallet materials supply is not consistent	
Q24994	Imported wood pallet materials supply is not delivered on time	
Q24995	Transportation is a problem when importing wood pallet materials	
Q24996	Suppliers from overseas cannot give us information about where wood pallet materials are located when transported	
Q24997	Imported wood pallet materials are of high quality	
Q24998	Imported wood pallet materials show good strength performance	

Logistic Issues

Table 3-47 allowed recognizing the items that belong to this sub-factor. The raw and standardized Cronbach's alpha values approximately were 0.69 and 0.71, respectively, being in the range of acceptability for this coefficient.

Table 3-47. Reliability analysis for logistic issues sub-factor

Code	Logistic Issues	Raw Cronbach Coefficient Alpha (α)	Standardized Cronbach Coefficient Alpha (α)
Q241	When suppliers are transporting wood pallet materials, our company can check where they are exactly located	0.691	0.709
Q242	Our company knows what orders are coming and when they are going to be delivered		
Q248	Our suppliers deliver on time		
Q2492	Our suppliers are able to respond quickly to our needs		

The individual alpha values were calculated for logistic issues sub-factor (see Table 3-48). The scale reliability does not improve eliminating one or more items, thus there is no need to reduce items, and four items were retained for factor analysis.

Table 3-48. Individual Cronbach's alpha for logistic issues sub-factor

Cronbach Coefficient Alpha with Deleted Variable					
Raw Variables			Standardized Variables		
Deleted variable	Correlation with total	Alpha	Correlation with total	Alpha	Label
Q241	0.425	0.687	0.418	0.692	Q241
Q242	0.409	0.665	0.407	0.698	Q242
Q248	0.555	0.592	0.568	0.600	Q248
Q2492	0.575	0.567	0.597	0.582	Q2492

Factor analysis results are shown in Table 3-49. The items identified one factor with loadings of 0.66, 0.61, 0.80, and 0.82 corresponding to questions Q241, Q242, Q248, and Q2492.

Table 3-49. Factor analysis for logistic issues sub-factor

Code	Logistic Issues	Eigenvalue	Sub-Factor	Variance Explained
			Logistic Issues	
Q241	When suppliers are transporting wood pallet materials, our company can check where they are exactly located	2.125	0.661	2.125 (53%)
Q242	Our company knows what orders are coming and when they are going to be delivered		0.615	
Q248	Our suppliers deliver on time		0.800	
Q2492	Our suppliers are able to respond quickly to our needs		0.817	

Supplier Markets

The items used in this sub-factor and Cronbach's alpha values are shown in Table 3-50. The Cronbach's alpha values for this sub-factor were too small.

Table 3-50. Reliability analysis for supplier markets sub-factor

Code	Supplier Markets	Raw Cronbach Coefficient Alpha (α)	Standardized Cronbach Coefficient Alpha (α)
Q243	The competition for raw materials is strong in the wood pallet industry	0.211	0.226
Q244	Our company prefers to work with domestic wood pallet materials rather than imported ones		
Q245	The cost of wood pallet materials from other countries is lower than domestic ones		
Q246	Our number of suppliers have increased in the last 3 years		

The individual alpha values were calculated for supplier markets sub-factor (see Table 3-51). The Cronbach's alpha is too low, and there is no possible to improve the scale reliability. Then, this sub-factor was not included in the analysis.

Table 3-51. Individual Cronbach's alpha for supplier markets sub-factor

Cronbach Coefficient Alpha with Deleted Variable					
Raw Variables			**Standardized Variables**		
Deleted variable	Correlation with total	Alpha	Correlation with total	Alpha	Label
Q243	0.026	0.340	0.026	0. 423	Q243
Q244	0.074	0.166	0.053	0.236	Q244
Q245	0.228	0.107	0.257	0.163	Q245
Q246	0.04	0.302	0.038	0.269	Q246

Supplier Performance

Table 3-52 shows the Cronbach's alpha values for this sub-factor. The raw and standardized alpha values were 0.67 and 0.68, respectively. It is an acceptable reliability value, but still can be increased dropping one or more items.

Table 3-52. Reliability analysis for suppliers performance sub-factor

Code	Suppliers Performance	Raw Cronbach Coefficient Alpha (α)	Standardized Cronbach Coefficient Alpha (α)
Q247	Our suppliers offer a reliable delivery	0.671	0.686
Q249	Our suppliers are consistent in their delivery operations		
Q2491	Our suppliers are flexible when we request different qualities (grades) and quantities of wood pallet materials		
Q2493	Our suppliers deliver materials which their properties vary greatly within the same batch		
Q2494	Our suppliers are able to make fast changes in their production process to accelerate or des-accelerate the wood material supply		

The individual alpha values were calculated for supplier performance sub-factor in Table 3-53. Showing that, the scale reliability can be improved eliminating question Q2493.

Table 3-53. Individual Cronbach's alpha for supplier markets sub-factor

Cronbach Coefficient Alpha with Deleted Variable					
Raw Variables			**Standardized Variables**		
Deleted variable	Correlation with total	Alpha	Correlation with total	Alpha	Label
Q247	0.618	0.539	0.634	0.546	Q247
Q249	0.656	0.517	0.678	0.524	Q249
Q2491	0.515	0.577	0.525	0.598	Q2491
Q2493	-.006	0.799	-.011	0.808	Q2493
Q2494	0.480	0.593	0.479	0.618	Q2494

Table 3-54 shows a new Cronbach's alpha value of approximately 0.8 for each raw and standardized coefficient. This was accomplished dropping question Q2493, improving the raw alpha from 0.67 to 0.80.

Table 3-54. Recalculating reliability analysis for suppliers performance sub-factor

Code	Suppliers Performance	Raw Cronbach Coefficient Alpha (α)	Standardized Cronbach Coefficient Alpha (α)
Q247	Our suppliers offer a reliable delivery	0.799	0.808
Q249	Our suppliers are consistent in their delivery operations		
Q2491	Our suppliers are flexible when we request different qualities (grades) and quantities of wood pallet materials		
Q2494	Our suppliers are able to make fast changes in their production process to accelerate or des-accelerate the wood material supply		

After Cronbach's alpha coefficient was calculated and accepted as reliable, factor analysis was carried out (see Table 3-55). Results had shown that only one factor was formed, with Eigenvalue of 2.59, explaining a 65% of the total variance.

Table 3-55. Factor analysis for suppliers performance sub-factor

Code	Suppliers Performance	Eigenvalue	Sub-Factor	Variance Explained
			Suppliers Performance	
Q247	Our suppliers offer a reliable delivery	2.595	0.870	2.595 (65%)
Q249	Our suppliers are consistent in their delivery operations		0.903	
Q2491	Our suppliers are flexible when we request different qualities (grades) and quantities of wood pallet materials		0.787	
Q2494	Our suppliers are able to make fast changes in their production process to accelerate or des-accelerate the wood material supply		0.633	

Wood Pallet Materials

The items used in this sub-factor and Cronbach's alpha values are shown in Table 3-56. A raw Cronbach's alpha coefficient of approximately 0.64 was the result of the analysis.

Table 3-56. Reliability analysis for wood pallet materials sub-factor

Code	Wood Pallet Materials	Raw Cronbach Coefficient Alpha (α)	Standardized Cronbach Coefficient Alpha (α)
Q2495	Domestic wood pallet materials supply is not consistent	0.638	0.640
Q2496	Domestic wood pallet materials supply is not delivered on time		
Q2497	Transportation is a problem when acquiring wood pallet materials		
Q2498	Suppliers cannot give us information about where wood pallet materials are located when transported		
Q2499	Domestic wood pallet materials are of high quality		
Q24991	Our suppliers are able to answer quickly to our necessities		
Q24992	Our company has to buy treated lumber/wood pallet parts when importing wood pallet materials		
Q24993	Imported wood pallet materials supply is not consistent		
Q24994	Imported wood pallet materials supply is not delivered on time		
Q24995	Transportation is a problem when importing wood pallet materials		
Q24996	Suppliers from overseas cannot give us information about where wood pallet materials are located when transported		
Q24997	Imported wood pallet materials are of high quality		
Q24998	Imported wood pallet materials show good strength performance		

The individual alpha values were calculated for wood pallet materials sub-factor in Table 3-57. Showing that, the scale reliability can be improved eliminating more than one item.

Table 3-57. Individual Cronbach's alpha for wood pallet materials sub-factor

Cronbach Coefficient Alpha with Deleted Variable					
Raw Variables			**Standardized Variables**		
Deleted variable	Correlation with total	Alpha	Correlation with total	Alpha	Label
Q2495	0.130	0.647	0.115	0.647	Q2495
Q2496	0.310	0.613	0.276	0.621	Q2496
Q2497	0.365	0.602	0.334	0.611	Q2497
Q2498	0.325	0.612	0.309	0.615	Q2498
Q2499	-0.017	0.664	-0.011	0.667	Q2499
Q24991	-0.081	0.681	-0.075	0.677	Q24991
Q24992	0.502	0.572	0.519	0.578	Q24992
Q24993	0.514	0.581	0.498	0.582	Q24993
Q24994	0.542	0.573	0.556	0.571	Q24994
Q24995	0.483	0.581	0.485	0.584	Q24995
Q24996	0.546	0.577	0.580	0.566	Q24996
Q24997	0.004	0.659	0.034	0.660	Q24997
Q24998	0.029	0.653	0.056	0.657	Q24998

Therefore, when questions Q24991, Q2499, Q24997, Q24998, and Q2495 were eliminated, the raw Cronbach's alpha value increased from 0.64 to approximately 0.80 for raw and standardized Cronbach's alpha. Results are shown in Table 3-58.

Table 3-58. Recalculation of reliability analysis for wood pallet materials sub-factor

Code	Wood Pallet Materials	Raw Cronbach Coefficient Alpha (α)	Standardized Cronbach Coefficient Alpha (α)
Q2496	Domestic wood pallet materials supply is not delivered on time	0.798	0.806
Q2497	Transportation is a problem when acquiring wood pallet materials		
Q2498	Suppliers cannot give us information about where wood pallet materials are located when transported		
Q24992	Our company has to buy treated lumber/wood pallet parts when importing wood pallet materials		
Q24993	Imported wood pallet materials supply is not consistent		
Q24994	Imported wood pallet materials supply is not delivered on time		
Q24995	Transportation is a problem when importing wood pallet materials		
Q24996	Suppliers from overseas cannot give us information about where wood pallet materials are located when transported		

Then factor analysis was performed obtaining two sub-factors, not one as was suggested before. Therefore, sub-factor wood pallet materials was divided in two: domestic wood pallet materials, and imported wood pallet materials, with Eigenvalues 3.48, and 1.35, respectively, and the lowest loading was 0.48 for question Q2496, corresponding to domestic wood pallet materials (see Table 3-59).

Table 3-59. Factor analysis for wood pallet materials sub-factor

Code	Wood pallet Materials	Eigenvalue		Sub-Factor		Variance Explained	
		1	2	Sub-Factor 1	Sub-Factor 2	Sub-Factor 1	Sub-Factor 2
Q2496	Domestic wood pallet materials supply is not delivered on time	3.486	1.358	0.260	0.480	3.486 (43%)	1.358 (17%)
Q2497	Transportation is a problem when acquiring wood pallet materials			0.466	0.702		
Q2498	Suppliers cannot give us information about where wood pallet materials are located when transported			0.325	0.689		
Q24992	Our company has to buy treated lumber/wood pallet parts when importing wood pallet materials			0.708	-0.169		
Q24993	Imported wood pallet materials supply is not consistent			0.850	-0.196		
Q24994	Imported wood pallet materials supply is not delivered on time			0.820	-0.114		
Q24995	Transportation is a problem when importing wood pallet materials			0.796	-0.149		
Q24996	Suppliers from overseas cannot give us information about where wood pallet materials are located when transported			0.750	-0.235		

After the previous analysis was executed, orthogonal factor rotation was the last step in factor analysis. When considering the sub-factor “logistics issues”, it was noted that one item in this sub-factor could be actually assigned to another sub-factor, “domestic wood pallet materials”, because question Q241 is grouped to it. Similarly, items from “logistic issues” sub-factor were grouped to “supplier performance” sub-factor (Q242, 248, 2492). The same occurred with one item from “supplier performance” sub-factor (Q2494), which was grouped to “domestic wood pallet materials” sub-factor. Also questions Q2497 and Q2498 that initially corresponded to “domestic wood pallet materials”, now are grouped to “logistic issues” sub-factor. The sub-factor “imported wood pallet materials” remain with the same items. Results can be seen in Table 3-60.

Table 3-60. Orthogonal factor analysis for supply chain management performance sub-factors (loadings ≥0.4 in bold)

Code	Supply Chain Management Performance Factor	Rotated Factor Pattern				Variance Explained			
		Sub-Factor 1 Supplier Perform.	Sub-Factor 2 Imported Wood Pallet Materials	Sub-Factor 3 Logistic issues	Sub-Factor 4 Domestic Wood Pallet Materials	Sub-Factor 1	Sub-Factor 2	Sub-Factor 3	Sub-Factor 4
Q242	Our company knows what orders are coming and when they are going to be delivered	***0.477***	-0.160	0.286	0.440	4.574	3.422	1.616	1.616
Q248	Our suppliers deliver on time	***0.891***	0.119	0.120	0.090				
Q2492	Our suppliers are able to respond quickly to our needs	***0.867***	-0.019	-0.231	0.134				
Q247	Our suppliers offer a reliable delivery	***0.828***	0.149	0.174	0.072				
Q249	Our suppliers are consistent in their delivery operations	***0.903***	0.166	0.014	0.018				
Q2491	Our suppliers are flexible when we request different qualities (grades) and quantities of wood pallet materials	***0.811***	-0.061	-0.064	0.157				
Q241	When suppliers are transporting wood pallet materials, our company can check where they are exactly located	0.261	-0.053	-0.126	***0.791***				
Q2494	Our suppliers are able to make fast changes in their production process to accelerate or des-accelerate the wood material supply	0.542	-0.066	-0.083	***0.586***				
Q2496	Domestic wood pallet materials supply is not delivered on time	-0.258	0.258	0.284	***0.422***				
Q2497	Transportation is a problem when acquiring wood pallet materials	0.079	0.307	***0.728***	0.228				
Q2498	Suppliers cannot give us information about where wood pallet materials are located when transported	-0.005	0.028	***0.849***	-0.214				
Q24992	Our company has to buy treated lumber/wood pallet parts when importing wood pallet materials	0.399	***0.617***	0.155	-0.216				
Q24993	Imported wood pallet materials supply is not consistent	0.120	***0.882***	0.106	-0.073				
Q24994	Imported wood pallet materials supply is not delivered on time	-0.141	***0.834***	0.169	0.094				
Q24995	Transportation is a problem when importing wood pallet materials	0.085	***0.825***	0.091	0.202				
Q24996	Suppliers from overseas cannot give us information about where wood pallet materials are located when transported	0.002	***0.788***	-0.049	-0.128				

3.5.1.6 Business Management

The factor business management includes 4 sub-factors: process strategy, process performance, marketing strategy, and innovation. Table 3-61 shows all items and sub-factors that are part of the business management factor. The sub-factors were subject to Cronbach's alpha analysis and exploratory factor analysis; the latter was conducted using principal components as extraction method, and Varimax as rotation method. For simplicity, only loadings around 0.5 and higher were displayed in the resulting tables.

Table 3-61. Business management factor and sub-factors

Code	Business Management Factor	Sub-factor
Q191	Our company forms leader groups from diverse areas for the planning and developing of the strategic business plan	Process strategy
Q192	Our company develops strategic operation plans with suppliers	
Q193	Our company has reduced manufacturing processes cost in the last 3 years	Process performance
Q194	Inventory costs have been reduced in the last 3 years	
Q195	Our company offers competitive wood pallet prices	Marketing strategy
Q196	Our company offers lower prices than our competitors	
Q197	Our company works with a differentiation strategy (produces unique products for different customers)	
Q198	Our company works with a segmentation strategy (categorizes its customers in groups with similar needs, and makes products to satisfy those needs)	
Q199	Our company produces only against firm customer orders or uses the "pull" production system	
Q1991	Our company produces for stock replenishment	
Q1992	Our company makes emphasis on the benefits of our product compared to our competitors'	
Q1993	Our company offers wood pallets directly to the customer	
Q1994	Our marketing team has a lot of experience	
Q1995	Our company invests resources in new processes and products	Innovation
Q1996	Our company usually hires some experts in the pallet field for improving processes and products	

Process Strategy

The items used in this sub-factor and Cronbach's alpha values are shown in Table 3-62. The value for Cronbach's alpha to be acceptable has to be greater or equal to 0.6 (Van-Aken, 2007). According to the raw Cronbach's alpha, 0.71 means that this is good scale reliability and that the items are measuring the same sub-factor.

Table 3-62. Reliability analysis for process strategy sub-factor

Code	Process Strategy	Raw Cronbach Coefficient Alpha (α)	Standardized Cronbach Coefficient Alpha (α)
Q191	Our company forms leader groups from diverse areas for the planning and developing of the strategic business plan	0.712	0.702
Q192	Our company develops strategic operation plans with suppliers		

The individual alpha values could not be calculated for this sub-factor, because it contains only 2 items (see Table 3-63). Therefore, it was retained the raw Cronbach's alpha for all variables of 0.712 showed in Table 3-62.

Table 3-63. Individual Cronbach's alpha for process strategy sub-factor

Cronbach Coefficient Alpha with Deleted Variable					
Raw Variables			Standardized Variables		
Deleted variable	Correlation with total	Alpha	Correlation with total	Alpha	Label
Q191	0.553	---	0.542	---	Q191
Q192	0.553	---	0.542	---	Q192

Once reliability analysis was carried out, an individual factor analysis was performed as can be seen in Table 3-64. This analysis shows that the process strategy items form one factor with an Eigenvalue of 1.54. Results for process strategy sub-factor show the loads for each item which have values of 0.87 each, indicating high correlations and meaning how much every item contribute to the sub-factor. Then this sub-factor retains two items for further analysis.

Table 3-64. Factor analysis for process strategy sub-factor

Code	Process Strategy	Eigenvalue	Sub-Factor	Variance Explained
			Process Strategy	
Q191	Our company offers lower prices than our competitors	1.541	0.878	1.541 (77%)
Q192	Our company works with a segmentation strategy (categorizes its customers in groups with similar needs, and makes products to satisfy those needs)		0.878	

Process Performance

The items used in this sub-factor and Cronbach's alpha values are shown in Table 3-65. According to the results, a raw Cronbach's alpha value of approximately 0.43 was obtained, meaning poor data reliability.

Table 3-65. Reliability analysis for process performance sub-factor

Code	Process Performance	Raw Cronbach Coefficient Alpha (α)	Standardized Cronbach Coefficient Alpha (α)
Q193	Our company has reduced manufacturing processes cost in the last 3 years	0.427	0.437
Q194	Inventory costs have been reduced in the last 3 years		

The individual alpha values could not be calculated for this sub-factor, because it contains only 2 items (see Table 3-66). Thus, this sub-factor process performance and their items were not used in posterior analysis because of the Cronbach's alpha poor reliability.

Table 3-66. Individual Cronbach's alpha for process performance sub-factor

Cronbach Coefficient Alpha with Deleted Variable					
Raw Variables			Standardized Variables		
Deleted variable	Correlation with total	Alpha	Correlation with total	Alpha	Label
Q193	0.275	---	0.279	---	Q193
Q1924	0.275	---	0.279	---	Q194

Marketing Strategy

Table 3-67shows the items used in the marketing strategy sub-factor, also Cronbach's alpha values. The raw and standardized Cronbach's alpha values correspond to 0.48 and 0.53 respectively, indicating poor reliability.

Table 3-67. Reliability analysis of marketing strategy sub-factor

Code	Marketing Strategy	Raw 's Coefficient Alpha (α)	Standardized Cronbach Coefficient Alpha (α)
Q195	Our company offers competitive wood pallet prices	0.481	0.530
Q196	Our company offers lower prices than our competitors		
Q197	Our company works with a differentiation strategy (produces unique products for different customers)		
Q198	Our company works with a segmentation strategy (categorizes its customers in groups with similar needs, and makes products to satisfy those needs)		
Q199	Our company produces only against firm customer orders or uses the "pull" production system		
Q1991	Our company produces for stock replenishment		
Q1992	Our company makes emphasis on the benefits of our product compared to our competitors'		
Q1993	Our company offers wood pallets directly to the customer		
Q1994	Our marketing team has a lot of experience		

The individual alpha values were calculated for marketing strategy sub-factor (see Table 3-68). All alpha values showed poor reliability; even deleting one item would not improve the scale reliability. As a result, this sub-factor was not used for further analysis.

Table 3-68. Individual Cronbach's alpha for marketing strategy sub-factor

Cronbach Coefficient Alpha with Deleted Variable					
Raw Variables			**Standardized Variables**		
Deleted variable	Correlation with total	Alpha	Correlation with total	Alpha	Label
Q195	0.243	0.446	0.257	0.494	Q195
Q196	0.098	0.492	0.115	0.539	Q196
Q197	0.334	0.408	0.355	0.462	Q197
Q198	0.220	0.447	0.220	0.506	Q198
Q199	0.045	0.527	0.063	0.554	Q199
Q1991	0.044	0.515	0.068	0.553	Q1991
Q1992	0.294	0.425	0.276	0.488	Q1992
Q1993	0.431	0.393	0.455	0.427	Q1993
Q1994	0.338	0.402	0.357	0.461	Q1994

Innovation

Raw and standardized Cronbach's alpha values were 0.49 and 0.48 respectively, which are shown in Table 3-69. These values indicated poor reliability for these two items.

Table 3-69. Reliability analysis of innovation sub-factor

Code	Innovation	Raw Cronbach Coefficient Alpha (α)	Standardized Cronbach Coefficient Alpha (α)
Q1995	Our company invests resources in new processes and products	0.486	0.484
Q1996	Our company usually hires some experts in the pallet field for improving processes and products		

The individual alpha values could not be calculated for this sub-factor, because it contains only 2 items (see Table 3-70). As a consequence sub-factor innovation was not considered for further analysis.

Table 3-70. Individual Cronbach's alpha for innovation sub-factor

Cronbach Coefficient Alpha with Deleted Variable					
Raw Variables			**Standardized Variables**		
Deleted variable	Correlation with total	Alpha	Correlation with total	Alpha	Label
Q1995	0.323	---	0.319	---	Q1995
Q1996	0.323	---	0.319	---	Q1996

3.5.1.7 Customer Satisfaction

The factor customer satisfaction considers one sub-factor: customer service. All items and sub-factors present in the customer satisfaction factor are shown in Table 3-71. The sub-factor was subject to Cronbach's alpha analysis, exploratory factor analysis, which was conducted using principal components as extraction method, and Varimax as rotation method. For simplicity, only loadings around 0.5 or higher were displayed in the resulted tables.

Table 3-71. Customer satisfaction factor and sub-factors

Code	Customer Satisfaction Factor	Sub-factor
Q201	Our company keeps track of customer needs and asks their feedback on quality/service	Customer Service
Q202	Our company asks customers about their expectations	
Q203	Our company makes it easier for the customers to look for assistance	
Q204	Our company can deliver the required wood pallet quantities to the customers on time	
Q205	Our customers are happy with the quality of the products that we offer	
Q206	Our products are only focused on the customer's needs	

Customer Service

The sub-factor customer service in Table 3-72 shows the raw and standardized Cronbach's alpha values 0.86 and 0.87 respectively. This indicates that there is high consistency among items, meaning good internal consistency within the scale.

Table 3-72. Reliability analysis for customer service sub-factor

Code	Customer Service	Raw Cronbach Coefficient Alpha (α)	Standardized Cronbach Coefficient Alpha (α)
Q201	Our company keeps track of customer needs and asks their feedback on quality/service	0.861	0.870
Q202	Our company asks customers about their expectations		
Q203	Our company makes it easier for the customers to look for assistance		
Q204	Our company can deliver the required wood pallet quantities to the customers on time		
Q205	Our customers are happy with the quality of the products that we offer		
Q206	Our products are only focused on the customer's needs		

The individual alpha values were calculated for customer service sub-factor (seeTable 3-73). All alpha values showed good reliability, thus there is no need to improve the scale reliability.

Table 3-73. Individual Cronbach's alpha for customer service sub-factor

Cronbach Coefficient Alpha with Deleted Variable					
Raw Variables			Standardized Variables		
Deleted variable	Correlation with total	Alpha	Correlation with total	Alpha	Label
Q201	0.680	0.833	0.671	0.847	Q201
Q202	0.687	0.832	0.680	0.846	Q202
Q203	0.729	0.824	0.734	0.837	Q203
Q204	0.674	0.837	0.692	0.844	Q204
Q205	0.747	0.826	0.759	0.832	Q205
Q206	0.484	0.873	0.487	0.878	Q206

Factor analysis was carried out after Cronbach's alpha analysis, to identify latent factors, which in this case corresponds to one latent factor, as can be seen in Table 3-74. The customer service sub-factor shows an Eigenvalue of 3.6, indicating that 61% of the total variance is explained by customer service sub-factor. Customer service sub-factor has six loading values for each item of 0.78, 0.79, 0.83, 0.80, 0.84, and 0.6, respectively. Meaning that, each item highly contributes to customer service sub-factor. Then, this factor will retain all items for posterior analysis.

Table 3-74. Factor analysis for customer service sub-factor

Code	Customer Service	Eigenvalue	Sub-Factor	Variance Explained
			Customer Service	
Q201	Our company keeps track of customer needs and asks their feedback on quality/service	3.657	0.784	3.657 (61%)
Q202	Our company asks customers about their expectations		0.792	
Q203	Our company makes it easier for the customers to look for assistance		0.833	
Q204	Our company can deliver the required wood pallet quantities to the customers on time		0.805	
Q205	Our customers are happy with the quality of the products that we offer		0.844	
Q206	Our products are only focused on the customer's needs		0.598	

3.5.2 *Summary of Data Purification*

The following paragraphs shows the obtained results in the data purification for each factor:

3.5.2.1 Environmental Uncertainties

According to the responses wood pallet manufacturers identified 3 sub-factors in the environmental uncertainty factor, which were named company environment, suppliers and competition, and uncertainty aspects from overseas, with Eigenvalues of 2.2, 1.9, and 1.5 for each sub-factor, respectively. Similar results were found in the electronic manufacturer sector which indicate that the level of supplier alliances have to be tight when environmental uncertainty is present, in this way the adaptation and evaluation problems from suppliers' part will be lessened (Lee et al., 2009). Also it was mentioned that integration between supplier partners becomes of big significance in environmental uncertainties (Paulraj and Chen, 2007).

3.5.2.2 Information Technology

According to the results obtained from the analysis, two sub-factors, “communication tools” and “planning tools” (Eigenvalues 2.35 and 2.32, respectively) were identified to be part of the information technology factor. The use of internal network, the use of internet, to make easier to the customer to buy or to request information through a webpage appear important for the activities in the wood pallet manufacturing sector, were determined to be significant for improving the competitiveness of the company. For example, research by Aksu and Ebru (2002) indicated that the use of internet as a communication tool provide customers on time information to decrease operation costs, or simply to access to information easily and gaining time. Also using the internet as a marketing tool for their services, demonstrating the need to contemplate them in their budget, because of its critical importance.

3.5.2.3 Supply Chain Relationships

The results have shown that the supply chain relationships factor effectively involved two sub-factors, which were named relationship with suppliers, and relationship with customers with Eigenvalues of 3.6 and 2.6 respectively, and which explains the variance accounted for each sub-factor. The need to build up good relations between customer-suppliers was of big importance for wood pallet manufacturers. Then, working with reliable suppliers, promoting the customer’s loyalty, sharing the company’s plan with suppliers are some tasks that need to be promoted and managed for the success of the supply chain management. It also was mentioned by Byoung-Chun, Yang-Kyu , and Sungbin (2011) that developing strategic relationships will let to improve the competitive advantage and organizational performance of the company. Similar results were found in a research made in the information and communication technology sector where communication is significant for suppliers, allowing achieving better benefits in their relationship performance (Eamonn et al., 2010). Another results from research made in logistics Korean firms indicated that trust and collaboration become the nucleus of the buyer-supplier relationship, where trust has direct relation with collaboration allowing information sharing, and joint decision making (Byoung-Chun et al., 2011).

3.5.2.4 Value-Added Process (Manufacturing)

Results indicated the existence of three sub-factors named flexibility, production system, and quality, as significant part of the value-added process (manufacturing) factor. Their respective Eigenvalues were 3.4 (flexibility), 2.8 (production system), and 2.1 (quality). Then, delivering on time, improving their production processes, or controlling the quality of their products is of great significance to the wood pallet manufacturer's supply chain. Similar results were found in the air conditioning sector, where the company indicated that the redesign of its manufacturing process included the use of new technology, allowing them to get flexibility in their processes and improved their yield (Manufacturing Engineering, 2001). Another achievement was obtained in the manufacturing woven sector, where the use of materials handling made possible to give flexibility not only to the production process but also to product quality to the company (Clyde, 1998).

3.5.2.5 Supply Chain Management Performance

The analysis identified four sub-factors named suppliers' performance, imported wood pallet materials, logistic issues, and domestic wood pallet materials, which are part of the supply chain management performance factor. The Eigenvalues for the four sub-factors were 4.5, 3.4, 1.6, and 1.6, respectively. Then, according to respondents, knowing the specific time-delivery, consistency, reliability, flexibility, transportation, on time information, are all critical when working with suppliers of domestic and or imported wood pallet materials. Research indicated that supply chain management not only entails the coordination and communication of information to the involved firms in the chain, but also see significant to improve these activities with suppliers, then suppliers performance play a critical role in the supply chain management (Kannan et al., 2010). According to Tai, Ho, and Wu (2010) a research made in Taiwan firms, indicated that improvements in the suppliers performance could be achieved by reaching inter-organizational process efficiency which involves the participation of partners in the supply chain through the use of tools such as the e-procurement system. It had also been stated that in the automotive sector more attention has to be given to the logistics

and transportation service suppliers, for the proper execution of the supply chain (Bardi and Pascale, 2011).

3.5.2.6 Business Management

The results of the analysis recognized only one sub-factor, process strategy (Eigenvalue of 1.54), of four proposed sub-factors, being an important part of the business management factor. The development of business plans for the company and strategic operation plans with suppliers have been identified by company respondents as strategies used by wood pallet companies. Similar finding was reported in 2005, a research were the importance of putting into practice new strategies to change its business plan was emphasized by the company. Some of its strategies were the building up of a technological partnership, creating relationships among areas such as control quality and manufacturing technologies (JCN Newswire and Japan Corporate News Network, 2005).

3.5.2.7 Customer Satisfaction

Part of the survey was focused on customer satisfaction, where wood pallet manufacturers rated items within a sub-factor for customer service (Eigenvalue of 3.6) as part of the customer satisfaction factor. Results of the analysis had shown that keeping track of customers' needs, their expectations and perceptions respect to quality and service, also the delivery on time were of big importance to wood pallet manufacturer respondents. Similar finding was reported in a research by Siddiqui and Sharma (2010), where a direct relationship was found between an increase of customer satisfaction and improvements in service quality . Therefore, improving the customer's perception about service quality is critical to achieve customers' loyalty (Siddiqui and Sharma, 2010).

3.5.3 *Hypothesis Testing and Analysis of Results*

Once the items included in the research instrument were analyzed and some of them eliminated through the analysis of each factor and its respective items, similar to previous research (Lee, 2009b; Li, 2002; Li et al., 2005; Quesada and Meneses, 2010), meaning that purification of data was completed, it was possible to perform the hypothesis testing for the following success factors: (1) environmental uncertainties, (2) information technology, (3) supply chain relationships,(4) value-added process (manufacturing), (5) supply chain management performance, (6) business management, and (7) customer satisfaction. It is important to take into consideration that all factors were the same as the proposed ones, and about sub-factors, there were some of them that the analysis could not support, and were eliminated (see data purification and analysis in Section 3.5.1). To carry out the regression, it was considered that each latent factor was built up by one or more sub-factors, as was 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). The Pearson's correlation results among latent factors can be seen in Table 3-75.

Table 3-75. Factors' relationship based on Pearson's correlation

Hypotheses	Independent Variable	Dependent Variable	Pearson Correlation
H1	Environmental Uncertainties (EU)	SCM Performance (SCMP)	0.358
H2	Information Technology (IT)	SCM Performance (SCMP)	-0.038
H3	Supply Chain Relationship (SCR)	SCM Performance (SCMP)	0.392
H4	Value-Added Process (Manufacturing) (VAPM)	SCM Performance (SCMP)	0.152
H5	Supply Chain Management Performance (SCMP)	Business Management (BM)	-0.083
H6	Business Management (BM)	Customer Satisfaction (CS)	0.176

It can be seen that the correlation among latent factors for the proposed model was weak, especially for hypothesis 2, 4, 5, and 6. On the other hand, hypotheses 1, and 3 showed better Pearson correlation between factors.

Continuing with the methodology, testing hypothesis is the next step to follow. Then testing hypotheses 1, 2, 3, and 4: "To high levels of environmental uncertainties,

information technology, supply chain relationship, and value-added process (manufacturing), high levels of supply chain management performance are required".

The following relation among dependent and independent variables proposed initially was:

$$SCMP = b_0 + b_1EU + b_2IT + b_3CSR + b_4VAPM + \xi$$

Where b_0 is the intersection, b_1, b_2 b_3, and b_4 are the regression coefficients, and ξ is the error of the regression. Then, an analysis of variance is performed and the results are presented in Table 3-76.

Table 3-76. Analysis of variance for supply chain management performance regression model

Analysis of Variance

Source	*D.F*	*Sum of Squares*	*Mean Square*	*F Value*	*Pr > F*
Model	4	1.32387	0.33097	1.78	0.1567
Error	33	6.14133	0.18610		
Corrected Total	37	7.46520			

Regression analysis shows that the model is not significant, meaning that the model is inadequate (Ho: Model is inadequate). Then, these lead to look for other high correlations that might allow creating a new model with the same factors. Looking at the Pearson correlations between factors, higher correlations than the initial ones were found (see Table 3-77)

Table 3-77. High value Pearson's correlations

Hypotheses	Independent Variable	Dependent Variable	Pearson Correlation
H1	Business Management (BM)	Value-Added Process (Manufacturing)(VAPM)	0.432
H2	Information Technology (IT)	Value-Added Process (Manufacturing) (VAPM)	0.556
H3	Value-Added Process (Manufacturing) (VAPM)	Supply Chain Relationship (SCR)	0.524
H4	Supply Chain Relationship (SCR)	Customer Satisfaction (CS)	0.607
H5	Environmental Uncertainties (EU)	Supply Chain Relationship (SCR)	0.468
H6	Supply Chain Relationship (SCR)	Supply Chain Management Performance (SCMP)	0.392

These high Pearson correlations can lead to the creation of a new model. Table 3-78 shows the Pearson's correlations between factors and their respective hypotheses for the original and new model.

Table 3-78. Original and new model Pearson's correlations

Hypotheses	Original Model	New Model	Original Model (Pearson Correlation)	New Model (Pearson Correlation)
H1	Environmental Uncertainties (EU) negatively affect SCM Performance (SCMP)	Business Management (BM) positively affects Value-Added Process (Manufacturing) (VAPM)	0.358	0.432
H2	Information Technology (IT) positively affects SCM Performance (SCMP)	Information Technology (IT) positively affects Value-Added Process (Manufacturing) (VAPM)	-0.038	0.556
H3	Supply Chain Relationship (SCR) positively affects SCM Performance (SCMP)	Value-Added Process (Manufacturing) (VAPM) positively affects Supply Chain Relationship (SCR)	0.392	0.524
H4	Value-Added Process (Manufacturing) (VAPM) positively affects SCM Performance (SCMP)	Supply Chain Relationship (SCR) positively affects Customer Satisfaction (CS)	0.152	0.607
H5	Supply Chain Management Performance (SCMP) possitively affects Business Management (BM)	Environmental Uncertainties (EU) positively affects Supply Chain Relationship (SCR)	-0.083	0.468
H6	Business Management (BM) possitively affects Customer Satisfaction (CS)	Supply Chain Relationship (SCR) positively affects SCM Performance (SCMP)	0.176	0.392

Because of the low significance in the original model, a new model was proposed, similarly to the research by Chearskul (2010). Then, the original model has changed, and a new model was proposed where factors remained the same and six hypotheses were suggested. The new proposed model can be seen in Figure 3.5:

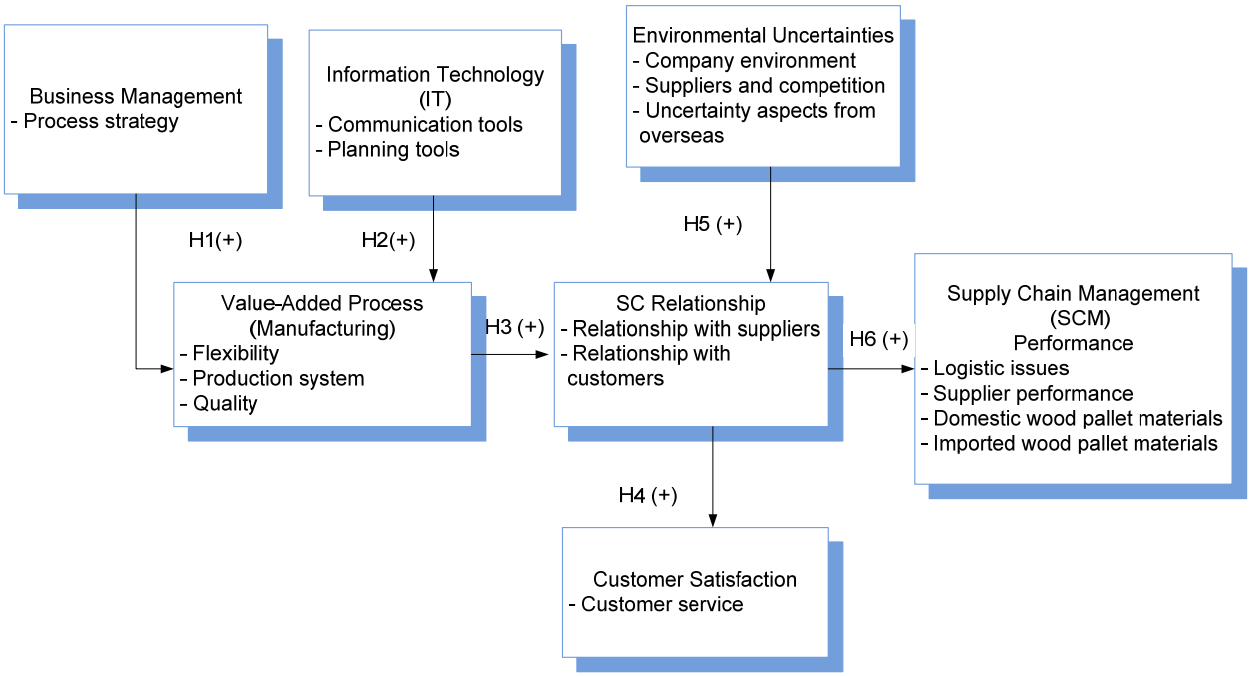


Figure 3.5. New proposed model

As a result the new proposed model was tested. Multiple linear regression was used to test the significance of the six hypotheses. The following section explains the respective procedure in more detail.

3.5.3.1 Regression Model for Dependent Variable Value-Added Process (Manufacturing)

Testing hypothesis 1 and 2: "To high levels of business management (BM) and information technology (IT), high levels of value-added process (manufacturing) (VAPM) are required". The following relationship between dependent and independent variables was:

$$VAPM = b_0 + b_1BM + b_2IT + \xi$$

Then, running the regression analysis for testing the hypothesis (Ho: The model is inadequate, Ha: The model is adequate), can be seen Table 3-79:

Table 3-79. Analysis of variance for value-added process regression model

Analysis of Variance

Source	*D.F*	*Sum of Squares*	*Mean Square*	*F Value*	*Pr > F*
Model	2	10.84740	5.42370	30.35	<.0001
Error	102	18.22543	0.17868		
Corrected Total	104	29.07284			

Root MSE	0.42271	R-Square	0.3731
Dependent Mean	0.03956	Adj R-Sq	0.3608
Coeff Var	1068.43664		

Results of the variance analysis show that the regression model is significant with a p-value <0.05, then Ho is rejected, and Ha: 'The model is adequate'. Also the analysis of variance shows that 37% of the variability is explained with the regression. Then, the regression coefficients were calculated and tested their significance. As can be seen in Table 3-80 the business management (BM) and Information technology (IT) are significant with p-values<0.05.

Table 3-80. Value-added process (manufacturing) regression coefficients

Parameter Estimates

Variable	*D.F*	**Parameter Estimate**	**Standard Error**	*t Value*	**Pr > |t|**
Intercept	1	0.00676	0.04155	0.16	0.8711
BM	1	0.13044	0.04666	2.80	0.0062
IT	1	0.35082	0.06132	5.72	<.0001

In both cases the regression coefficients are positive, meaning that to bigger levels of business management and information technology, bigger the level of value-added process (manufacturing). As a result, the model regression will be:

VAPM = 0.00676 + 0.13044BM + 0.35082IT + ξ

3.5.3.2 Regression Model for Dependent Variable Customer Satisfaction

Testing hypothesis 4: “To high levels of supply chain relationship (SCR), high levels of customer satisfaction (CS) are required”. The following relationship between dependent and independent variables was:

$CS = b_0 + b_1SCR + \xi$

Then, running the regression analysis for testing the hypothesis (Ho: The model is inadequate, Ha: The model is adequate), can be seen Table 3-81:

Table 3-81. Analysis of variance for customer satisfaction regression model

Analysis of Variance

Source	*D.F*	*Sum of Squares*	*Mean Square*	*F Value*	*Pr > F*
Model	1	59.89611	59.89611	91.66	<.0001
Error	157	102.59187	0.65345		
Corrected Total	158	162.48798			

Root MSE	0.80836	R-Square	0.3686
Dependent Mean	-0.05197	Adj R-Sq	0.3646
Coeff Var	-1555.38599		

The regression model is significant with a p-value <0.05, then Ho is rejected, and Ha: ‘The model is adequate’, accepted. Analysis of variance shows that approximately 37% of the variability is explained with the regression. Then, the regression coefficients were calculated and tested their significance. As a result, a p-value< 0.0001 corresponded to the SCR regression coefficient (see Table 3-82).

Table 3-82. Customer satisfaction regression coefficients

Parameter Estimates

Variable	*D.F*	Parameter Estimate	Standard Error	*t Value*	Pr > |t|
Intercept	1	-0.05282	0.06411	-0.82	0.4112
SCR	1	0.87250	0.09113	9.57	<.0001

Regression coefficients are significant, and then the lineal regression model will be:

$CS = -0.05282 + 0.87250SCR + \xi$

3.5.3.3 Regression Model for Dependent Variable Supply Chain Relationship

Testing hypothesis 3, and 5: "To high levels of value-added process (manufacturing) (VAPM) and environmental uncertainties (EU), high levels of supply chain relationship (SCR) are required". The linear model used to relate dependent and independent variables will be:

$SCR = b_0 + b_1VAPM + b_2EU + \xi$

An analysis of variance is run, and results can be seen in Table 3-83.

Table 3-83. Analysis of variance for supply chain relationship regression model

Analysis of Variance

Source	*D.F*	*Sum of Squares*	*Mean Square*	*F Value*	*Pr > F*
Model	2	17.98960	8.99480	35.38	<.0001
Error	103	26.18593	0.25423		
Corrected Total	105	44.17552			

Root MSE	0.50421	R-Square	0.4072
Dependent Mean	0.01337	Adj R-Sq	0.3957
Coeff Var	3771.81846		

According to the analysis of variance the regression model is significant with a p-value <0.0001, where Ho is rejected, and Ha: 'The model is adequate', accepted. Also the analysis of variance shows that 41% of the variability is explained by the regression. And regression coefficient p-values were <.0001, and <.0001 for the independent variables value-added process (manufacturing) and environmental uncertainties, respectively (see Table 3-84).

Table 3-84. Supply chain relationship regression coefficients

Parameter Estimates

Variable	*D.F*	*Parameter Estimate*	*Standard Error*	*t Value*	*Pr > |t|*
Intercept	1	0.04167	0.04925	0.85	0.3994
VAPM	1	0.47745	0.10583	4.51	<.0001
EU	1	0.48230	0.09813	4.91	<.0001

All regression coefficients are positive, and significant, and then the lineal regression model will be:

$$SCR = 0.04167 + 0.47745VAPM + 0.48230EU + \xi$$

3.5.3.4 Regression Model for Dependent Variable Supply Chain Management Performance

The last hypothesis to test is hypothesis 6: "To high levels of supply chain relationship (SCR), high levels of supply chain management performance (SCMP) are required". The relationship between dependent and independent variable is:

$$SCMP = b_0 + b_1SCR + \xi$$

An analysis of variance is carried out in order to identify if the model is significant or not (Ho: The model is inadequate, Ha: The model is adequate). This can be seen in Table 3-85.

Table 3-85. Analysis of variance analysis for supply chain management performance regression model

Analysis of Variance

Source	*D.F*	*Sum of Squares*	*Mean Square*	*F Value*	*Pr > F*
Model	1	1.79789	1.79789	8.19	0.0064
Error	45	9.88009	0.21956		
Corrected Total	46	11.67798			

Root MSE	0.46857	R-Square	0.1540
Dependent Mean	-0.01572	Adj R-Sq	0.1352
Coeff Var	-2980.05105		

A p-value of 0.0064 was the result of the regression model, then Ho is rejected, and Ha: 'The model is adequate', accepted. Also the R-square shows that 15% of the variability is explained with the regression. The regression coefficients were calculated and tested their significance. As can be seen in Table 3-86, the supply chain relationship (SCR) independent variable is significant with p-value of 0.0064.

Table 3-86. Supply chain management performance regression coefficients

Parameter Estimates

Variable	*D.F*	**Parameter Estimate**	**Standard Error**	*t Value*	**Pr > |t|**
Intercept	1	-0.01666	0.06835	-0.24	0.8085
SCR	1	0.30541	0.10673	2.86	0.0064

As a result, the model regression will be:

$SCMP = -0.01666 + 0.30541SCR + \xi$

3.6 Summary and Conclusions

This research is a first step to characterize supply chain success factors in the wood pallet industry. A model was developed based on preliminary studies and applied to a national level, obtaining perceptions of wood pallet manufacturer's regarding to business management, information technology, value-added process (manufacturing), customer satisfaction, environmental uncertainties, supply chain relationship, and supply chain management performance factors. A nationwide survey of wood pallet manufacturers was carried out, with a sample size of 1,500 and a response rate of 14%.

To better understand the wood pallet supply chain, a model was proposed, which was validated through the use of statistic tools, such as Cronbach's alpha, factor analysis, and regression analysis. Correlations among factors were calculated, and those with high correlation (around 0.4 or higher) were subject to hypothesis testing through the use of analysis of variance to test their significance. The results of the statistical analysis were used to rectify the initial model and a new model was proposed. The latter showed significance after running hypothesis testing.

3.6.1 *Conclusions*

The objective of this Chapter was to identify and to understand success factors and their relationships in the wood pallet supply chain. A model was proposed and seven factors were identified:

- business management,
- customer satisfaction,
- value-added process (manufacturing),
- information technology,
- supply chain relationships,
- supply chain management performance,
- environmental uncertainties.

The relationship between the factors as initially proposed changed after the analysis. The results did not support the direct relationship between environmental uncertainties and supply chain management performance, instead it was found that environmental uncertainties affect directly supply chain relationships, and as a consequence indirectly supply chain management performance. Results show that there are relatively strong associations between the following:

- Supply chain relationships and customer satisfaction (Pearson coefficient of 0.61). 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 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 customers (e.g. pallet manufacturer) actively participating in improving the supplier’s (sawmill) internal processes (e.g., sharing improvement methodologies or even sharing costs of improvement programs).

- Information technology and value-added process (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) 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 process and supply chain relationships (Pearson coefficient of 0.52). Research supports that information sharing helps to reduce wasteful activities, specifically improving material flows and reducing inventories (Stiess, 2010). 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.

3.6.2 *Implications for Business*

This research can help U.S. wood pallet manufacturers to have a better understanding of their supply chain management practices. Findings provide a theoretical framework for supply chain management in the wood pallet industry, by identifying 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 affects directly to supply chain relationships, and as a consequence to supply chain management performance.

Wood pallet manufacturers must understand how critical is to communicate, and to plan jointly with suppliers, giving more importance to supply chain relationships, and understanding the significance of this concept, that allow to reach customer satisfaction.

Practitioners must realize that the flow of information in a coordinated manner, access to information and data interchange, improve customer and supplier relationship. This leads to identify information technology as a potential field for improvement.

The methodology used in this research demonstrated to be useful and can be utilized as basis for future research in supply chain studies.

Wood pallet manufacturers must understand that fast changes in customer demand, globalization of markets, and changing technology require companies focus their efforts on improving competitiveness, trying to meet customer's satisfaction, through adding more value to their products. Also to take into account that the implementation of process strategies will improve their manufacturing performance and supply chain management performance.

Chapter 4. CONCLUSIONS AND RECOMMENDATIONS

This study provides an insight into the wood pallet manufacturers supply chain, from a manufacturer's perspective. This research is unique in that it applies supply chain management principles to study the wood pallet industry through an analytical model. The main purpose was to have a profile of the wood pallet industry and to identify supply chain success factors. A model for success factors was developed based on the literature review, which was later refined. In this section, the major results and conclusions are presented, as well as implications for the industry and recommendations for future research.

4.1 Conclusions

The major conclusions from the research are presented in this section. Conclusions are grouped according to the research objectives proposed in Chapter 1.

4.1.1 *Objective 1: Estimate production volumes, major suppliers, and species distribution of wood pallet material imports and domestic production in the U.S.*

- The average use of lumber, cants, pallet parts, and pallet cores was 2.16 MMBF, 1.55 MMBF, 2.12 MMBF, and 110,000 units, respectively.
- The average total annual output of pallet units was 727,229, and median of 200,000.
- Regarding wood species, the most common used were oak, southern pine, and spruce-pine-fir, and mixed hardwoods (15.8%, 15.5%, 12.7%, and 27.3%, respectively). Most of the respondents purchased their raw material from domestic suppliers, except from SPF which mostly came from Canada. Eucalyptus and Radiata Pine were also purchased from Chile, Brazil, and Uruguay in 2009.

4.1.2 *Objective 2: Compare characteristics of imported and domestically produced pallets from a business perspective.*

- Among respondents interested in purchasing imported wood pallet materials, pallet parts, lumber, and pallet kits (31.1%, 25.4%, and 15.5% of respondents, respectively) were the most important types of material of interest.
- Price, logistics, and delivery on time (rated an average of 4.1, 3.9, and 3.8 in a scale from 1 to 5, 5 being the most important, respectively) were perceived by respondents as the most important barriers to importing wood pallet materials. Respondents in general do not consider that imported materials are superior to domestic ones in dimensions like technical specifications, performance, and easier to make business with.

4.1.3 *Objective 3: Increase the understanding of the U.S. wood pallet manufacturing industry, its supply chain management practices, and factors affecting the supply chain management processes.*

- Wood pallet manufacturers indicated that around 73.1% of wood pallets are sold directly to manufacturers without the intervention of intermediaries.
- Availability, cost, supplier reliability, quality, punctuality, strength and workmanship, were identified as the most important factors for purchasing decisions.
- Approximately 49.0% of respondents indicated that their raw material suppliers take 1 to 5 days, from order to shipment and around 33.0% of respondents reported and order-to-shipment lag between 5 to 10 days.
- Regarding business management, on average the items with highest ratings were: “direct sales to customer” and “competitive prices”. On the other hand, “hiring experts for improving processes and products” was the lowest rated item. As a result, wood pallet manufacturers give a lot of importance to marketing strategies, and innovation does not play an important role in business management.

- Results for the customer satisfaction factor showed that manufacturers perceived that “time-delivery” and “product quality”, were the most important items to take into consideration for achieving customer satisfaction.
- For supply chain relationships, “customer loyalty” and “periodic evaluation of the relationship with customers” were recognized by respondents as the most important items.
- Regarding value-added process, respondents reported flexibility as the most important sub-factor. Specifically, flexibility refers to the capability of handling big and small orders, working with cross-trained employees, and answer quickly to fast changes in the market.
- On average, “investments in communication tools” and the “use of internal computer network” were rated highest among information technology. On the other hand, “internet use for business processes”, “personnel training on information technology”, and “Enterprise Resource Planning” received relatively low ratings.
- Results for supply chain management performance indicated that there is high competition for the acquisition of raw materials; this item was reported by wood pallet manufacturers as the most important factor.
- Regarding environmental uncertainties, “high competition in the wood pallet industry” and “working with more than 3 suppliers” were the most important items identified by manufacturers.

4.1.4 *Objective 4: Identify and understand supply chain management success factors and their relationships in the wood pallet industry.*

For this purpose, a model was developed. The original model identified seven factors in the wood pallet manufacturers supply chain:

- business management,
- customer satisfaction,
- value-added process (manufacturing),
- information technology,

- supply chain relationships,
- supply chain management performance, and
- environmental uncertainties.

The relationships among factors initially proposed were:

$$SCMP = b_0 + b_1EU + b_2IT + b_3CSR + b_4VAPM + \xi$$

The results for this multiple linear regression indicated that the model was not significant with a p-value of 0.1567. Consequently, an alternative model was proposed based on Pearson correlations between factors. Higher correlations than the initial ones were found with the alternative model (see Section 3.5.3).

After analysis of Pearson's correlations, the new model consisted on the following relationships among dependent and independent variables:

$$VAPM = b_0 + b_1BM + b_1IT + \xi$$

$$SCR = b_0 + b_1VAPM + b_2EU + \xi$$

$$CS = b_0 + b_1SCR + \xi$$

$$SCMP = b_0 + b_1SCR + \xi$$

The results did not support the direct relationship between value-added process and supply chain management performance, neither the relationship between environmental uncertainties and supply chain management performance. Instead, it was found that environmental uncertainties directly affect supply chain relationships, and as a consequence indirectly affect customer satisfaction and supply chain management performance.

Supply chain relationship and customer satisfaction had a Pearson's correlation of 0.61, showing strong correlation among factors. According to Samaranayake (2011) integration crosswise the supply chain lead to have collaborative partnerships and allow

to obtain efficient operations in the supply chain. Also the research made by Bantham (2010) indicated that the level of partners interaction and the results of this partnership meeting performance expectations is named satisfaction. Wood pallet manufacturers must understand that customer satisfaction can be achieved by solving problems jointly with suppliers, through cooperation, communication, and commitment (e.g., sharing improvement methodologies or even sharing costs of improvement programs with suppliers).

Information technology and value-added process had a Pearson's correlation of 0.56. Information technology can improve supply chain responsiveness through the control of inventory (Barjis and Wamba, 2010). According to Sanders and Premus (2005) the relationship between information technology capability and collaboration and company performance had proven to be positive allowing cost reduction and time performance improvement.

Value-added process and supply chain relationships had a pearson's correlation of 0.52, also showing strong correlation between factors. Whicker et al (2009) research supports that working with key suppliers regarding manufacturing schedules and provision of raw materials allow manufacturers to reduce time and cost related with non-value-added. What's more, Wikner et al. (1991) research demonstrated that demand amplification can be reduced through the use of high levels of information sharing.

4.2 Implications of the Research

The results from this study allow wood pallet manufacturers and their stakeholders access to up-to-date information about important company characteristics in this manufacturing sector. Perceptions about characteristics of domestic and imported wood pallet materials are also presented, as well as respondents, perception of demand for environmentally certified wood pallets. Supply chain factors and important sub-factors were also identified. Organizations that support the industry can benefit of the information presented here by designing more effective assistance programs to improve the industry's competitiveness.

It has been found that availability, cost, reliable supplier, quality, and deliver on time, play an important role when supplying the industry. Domestic or international suppliers should take into consideration these factors in order to promote their offerings more effectively. International suppliers should take into consideration that price, logistics & transportation, on time delivery, tariffs, and quality were the main barriers when importing wood pallet materials.

Results from this research allow manufacturers to understand how critical is to communicate, and to plan jointly, giving more importance to supply chain relationships. Understanding the significance of this concept will help manufacturers and suppliers in improving customer satisfaction.

Findings provide a theoretical framework with seven factors in the wood pallets supply chain: environmental uncertainty, information technology, supply chain relationships, value-added process, supply chain management performance, business management, and customer satisfaction. Manufacturers should focus on the effective management of value-added process, since it was demonstrated that it is associated strongly with supply chain relationships, and as a consequence supply chain management performance.

4.2.1 *Practical Implications*

In this section, major recommendations to take into consideration when planning and implementing supply chain management practices are provided. Practical implications that come from the analysis of the proposed model are described in the following paragraphs:

- **High levels of value-added processes (manufacturing) (VAPM) depend on high levels of business management (BM) and information technology (IT)**.

  This is shown in Section 3.5.3.1. The following relationship between dependent and independent variables was:

  $VAPM = b_0 + b_1BM + b_2IT + \xi$

  Business management should plan carefully and have clear objectives. Internal climate organization becomes significant in order to determine if sharing of information is a practice in the company. The flow of information through the supply chain has to be in both directions (from suppliers to customers, or vice versa); for example, allowing a salesperson to give customers reliable information about lead times. Also important is the use of the internet as a communication tool, which allows customers to place orders more efficiently, avoiding issues such as busy lines or the person in charge not available. Besides, the internet can help manufacturers to promote their products and increase their efforts. Therefore, the internet should be part of the company communication tools. These practices together will allow improving value added-processes (manufacturing).

- **High levels of customer satisfaction (CS) depend on high levels of supply chain relationship (SCR).**

  This is shown in the Section 3.5.3.2. The following relationship between dependent and independent variables was:

  $CS = b_0 + b_1SCR + \xi$

  Closer relationships with strategic suppliers depends on cooperative planning and agreement on objectives for a specified period of time, and how these objectives and aims can be achieved. Cooperative strategic planning should include raw material and inventory management. Then, it is important that both suppliers and

manufacturers understand the meaning of deadlines, including the associated penalties. Also, manufacturers must give total attention to customer needs before and after sales. Therefore, they have to take into account the importance of supplier, wood pallet manufacturer, and wood pallet manufacturer customer relationship management for improving supply chain performance and customer satisfaction.

- **High levels of supply chain relationship (SCR) depend on high levels of value-added process (manufacturing) (VAPM) and environmental uncertainties (EU).**

  This is shown in the Section 3.5.3.3. The linear model used to relate dependent and independent variables was:

  $SCR = b_0 + b_1VAPM + b_2EU + \xi$

  Value-added processes should include a flexible production and tools such as lean manufacturing and six-sigma among others. These practices reduce waste and time, and focus on continuous improvement. These tools can lead to improve customer satisfaction. At the same time, both suppliers and wood pallet manufacturers have to include, in their plans, possible uncertainties that might affect on-time delivery of raw materials, causing delays in the manufacturing processes, and as a result customer dissatisfaction. For example, when making delivery forecasts, wood pallet manufacturers and suppliers might include uncertainties such as transportation schedules issues, raw material delivery delays, and equipment malfunction. Uncertainties can be reduced by mutual sharing of much information as possible. All these practices will affect supply chain relationships.

- **High levels of supply chain management performance (SCMP) depend on high levels of supply chain relationship (SCR)**.

  This is shown in the Section 3.5.3.4. The relationship between dependent and independent variable was:

  $SCMP = b_0 + b_1SCR + \xi$

Supply chain relationships with suppliers and customers are critical for the excellent performance of supply chain management. This research shows that wood pallet manufacturers have to focus on collaboration, partnership, and share of information with customers and suppliers. This can be accomplished by developing a set of strategies to acquire new customers, and maintain the current ones through offering value-added products and services. These can also include offering customers customized products and services at affordable prices (McCormack, 2003). Also, establishing strategic alliances with suppliers, will allow them to achieve their objectives, leading to improve the supply chain management performance.

Among other important tasks to take into account when implementing supply chain management:

- To train the whole company and employees regarding the importance of supply chain management, emphasizing the achievements obtained with its application in other industries.
- To create teams; for example: one for managing relationships with suppliers, another to deal with manufacturing processes, and another team for managing relationships with customers.
- Moreover, it is important to measure the performance of supply chain management through the use of indicators such as: order lead-time, the customer-order path (identifying non-value added activities), evaluation of suppliers (efficiency, integration, and customer satisfaction), strategic level measures (quality level, cost saving initiatives), tactical level measures (cash flow, quality assurance, and capacity flexibility), capacity utilization, on time-delivery, number of faultless notes invoiced, customer query of time, information processing costs, cost associated with assets, and return on investment and post-transaction measures of customer service. These indicators will permit companies to view their performance over time and to identify those opportunities for improvement with the most impact on supply chain performance.

Finally and most important, companies have to realize that all employees and suppliers have to know about the significance of supply chain management, and that companies have to compete in the market as integrated supply chains starting from managing relationship with suppliers, manufacturing processes, and relationship with customers, for achieving a competitive advantage.

4.3 List of Best Practices for the Wood Pallet Industry

As identified in this research, seven factors are affecting the wood pallet supply chain, therefore it is important to compile information regarding best practices, which will allow pallet manufacturers to improve their supply chain management. The following paragraphs show the seven best practices for the wood pallet industry:

1. Environmental Uncertainties

Companies are constantly faced to environmental uncertainties that lead to unexpected changes of customer, supplier, competitor, and technology according to Ettlie and Reza (1992). Therefore, companies should focus on this factor in order to implement strategic supply management plans. Also integration between supplier partners becomes of big significance in environmental uncertainties (Paulraj and Chen, 2007). If companies are considering to import materials from other countries they have to regard standards issues (Snell, 2008).

2. Information Technology

Wood pallet companies must realize that the flow of information in a coordinated manner, access to information and data interchange, improve customer and supplier relationship, and inventory management not only at national level but also internationally (Handfield and Nichols, 1999). The use of communication tools such as the internet for supplying contracts, distributing strategies, outsourcing and procurement can improve the service level (Simchi-Levi et al., 2003). Manufacturers must focus on investing in communication tools such as the creation of webpages and advertisement. In this way companies will create value in their supply chain relationships (Tim, 2007)

and develop planning tools (plans and strategies for IT investments, and training personnel in the use of IT) to improve their time delivery and product quality.

3. Supply Chain Relationship

Manufacturers must realize of the importance to build and manage good relationships with suppliers and customers. According to Fraza (2000), supply chain management is directly related to relationship management which includes suppliers and customers. The wood pallet industry must focus on collaborative relationships with suppliers rather than transactional ones. Working closely with few suppliers, and taking care of each other will allow that both buyer and supplier benefit. Supplier development can be based on customers to improve capabilities of suppliers, and in this way, both parties will be also benefited (Rogers et al., 2007). For example, some companies provide and or support workshops for suppliers or share their information technology. Therefore, a strategic management of suppliers and customers must be performed and sustained in the organization.

4. Value-Added Process (Manufacturing)

Wood pallet manufacturers have to know and understand that value-added are all those added manufacturing or service steps to a commodity product, that are perceived as value increase in the product (Bishop, 1990). Manufacturers must be able 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 required. Therefore, focusing on production processes will contribute to improve value-added (Benetto et al., 2009). The application of tools, such as lean manufacturing allow companies to eliminate manufacturing waste achieving improvements in manufacturing flexibility that give greatest value to customers (Goldsby and Martichenko, 2005; Raisinghani et al., 2005).

5. Supply chain Management Performance

Wood pallet manufacturers must realize the importance of SCM as the operational excellence to deliver leading customer experience (Simchi-Levi et al., 2003), and put it in practice, using key performance metrics to measure the supply chain performance on each part of the chain. Also important is to train key employees to develop better decision-making capabilities to improve the management of issues that can lead to negatively affect customer satisfaction (Elkins et al., 2005). Internal integration will allow the coordinated management of business processes and functions inside the firm through a common set of principles, strategies, policies, and performance metrics" (Barki and Pinsonneault, 2005; Germain and Lyer, 2006). It will also allow sharing information between departments, an integrated database, cross-functional work, management of processes instead of functions, and an integrated production system (Barki and Pinsonneault, 2005; Germain and Lyer, 2006). Supply chain relationship management plays also an important role in the supply chain management, because establishing a strong relationship with suppliers will help the pallet sector to react effectively to variations in demand.

6. Business Management

Pallet manufacturers must take into consideration that the process of managing networking between companies is named business management (Ford and Mouzas, 2010) . Fast changes in customer demand, globalization of markets, and changing technology require companies focus their efforts on improving competitiveness, trying to meet customer's satisfaction, through adding more value to their products (Hung, 2010). Through the implementation of process strategies companies improve their manufacturing performance and as a result business performance (Thomas et al., 2008). Manufacturers should identify objectives, create policies, create strategic plans, and assign resources for the implementation of plans (Sultan, 2006).

7. Customer Satisfaction

Quality products are not only referred to physical attributes, customers also measure quality as product delivery on time, and reliability of service. According to Robinson and Malhotra (Robinson and Malhotra, 2005) who mentioned that for achieving customer satisfaction the whole supply chain has to "commit, integrate, and coordinate to pursue coherent and innovative practices". Therefore, manufacturers must give total attention to customer's needs before and after sales. Also they have to take into account the importance of customer-firm-supplier relation management for improving operational performance and customer satisfaction (Ou et al., 2010).

4.4 Limitations of the Research

Most importantly, the non-response bias assessment showed that very small companies were less likely to answer this survey. Therefore, some of the conclusions and recommendations may apply to medium and large-sized companies. Also, this research did not include customer's perceptions, only wood pallet manufacturers' opinions.

Like 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.

Most of the results from this survey reflect the activity of the companies during 2009, when U.S. manufacturing output was at its lowest during 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 maybe influenced by this fact.

4.5 Future Research

Summarizing and considering the perceptions of the previous sections some recommendations for future research can be made.

- As importers from other countries (except Canada) demonstrated a certain level of participation in the market, it might be valuable to do research in those countries to identify the opportunities to import more quantities and varieties of wood species.
- Future research should focus on the benefits of measuring performance of supply chain management in a typical wood pallet value stream.
- This research was focused on the experience and perceptions from the wood pallet manufacturer's point of view, 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 A: Glossary

Dunnage = Wood packaging material to secure a commodity

Lead time = Elapsed time from order to shipment

Order frequency = How often an item is ordered

Pallet cores = Used pallets

Unit load = assembly of good(s) on a pallet as a unit for handling, moving, storing, and stacking.

APPENDIX B: IRB Approvement

VirginiaTech

Office of Research Compliance
Institutional Review Board
2000 Kraft Drive, Suite 2000 (0497)
Blacksburg, Virginia 24060
540/231-4606 Fax 540/231-0959
e-mail irb@vt.edu
Website: www.irb.vt.edu

MEMORANDUM

DATE: August 12, 2010

TO: Henry Quesada Pineda, Leslie Sanchez

FROM: Virginia Tech Institutional Review Board (FWA00000572, expires June 13, 2011)

PROTOCOL TITLE: Identifying Success Factors in the Wood Pallet Supply Chain

IRB NUMBER: 10-625

Effective August 12, 2010, the Virginia Tech IRB Chair, Dr. David M. Moore, approved the new protocol for the above-mentioned research protocol.

This approval provides permission to begin the human subject activities outlined in the IRB-approved protocol and supporting documents.

Plans to deviate from the approved protocol and/or supporting documents must be submitted to the IRB as an amendment request and approved by the IRB prior to the implementation of any changes, regardless of how minor, except where necessary to eliminate apparent immediate hazards to the subjects. Report promptly to the IRB any injuries or other unanticipated or adverse events involving risks or harms to human research subjects or others.

All investigators (listed above) are required to comply with the researcher requirements outlined at http://www.irb.vt.edu/pages/responsibilities.htm (please review before the commencement of your research).

PROTOCOL INFORMATION:
Approved as: **Exempt, under 45 CFR 46.101(b) category(ies) 2**
Protocol Approval Date: **8/12/2010**
Protocol Expiration Date: **NA**
Continuing Review Due Date*: **NA**
*Date a Continuing Review application is due to the IRB office if human subject activities covered under this protocol, including data analysis, are to continue beyond the Protocol Expiration Date.

FEDERALLY FUNDED RESEARCH REQUIREMENTS:
Per federally regulations, 45 CFR 46.103(f), the IRB is required to compare all federally funded grant proposals / work statements to the IRB protocol(s) which cover the human research activities included in the proposal / work statement before funds are released. Note that this requirement does not apply to Exempt and Interim IRB protocols, or grants for which VT is not the primary awardee.

The table on the following page indicates whether grant proposals are related to this IRB protocol, and which of the listed proposals, if any, have been compared to this IRB protocol, if required.

APPENDIX C: Case Study Questionnaire Applied To Wood Pallet Manufacturers

CASE STUDY QUESTIONNAIRE

Company:	Date:
Interviewee:	Position:

1. What is the main business of your company?

Manufacture new wood pallets	
Recycle or repair	
Broker Lumber	
Broker pallet	
Lumber manufacturer	
Other ()	

2. What are your major products?

New wood pallets	
Recycled or repaired wood pallets	
Lumber	
Other ()	

3. Is your company a member of an association? Which one?
4. Do you import lumber/wood pallets/pallet parts (all of them)? Why?
5. Approximately what percentage of your business consists of imported wood pallet material (percent of total sales or percent of volume)?
6. How long has your company been working with imported material?
7. Do you purchase your materials directly from a supplier overseas or through an intermediary? Why?

8. What imported wood species are you using? What are the countries of origin?

Species	Country of origin

9. How does the system works for importing. For example some company asked you to bring some type of lumber/pallet/pallet parts and gives you the name of the company of overseas to deal with. Can you explain, please?
10. According to your experience, rank from 1 to 7, the importance of the following factors on your purchase decision of lumber/wood pallets/pallet parts (1 is the most important and 7 the least important).

Description	Lumber	Wood Pallets	Wood Pallet Parts
Volume			
Quality grade			
Price			
Strength			
Stiffness			
Wood density			
Workmanship			

11. What is the price of your product?

12. What is the price per cubic meter (m3) or thousand board feet (Mbft) paid for the different imported wood product materials (lumber, wood pallet/pallet parts)?
13. During importing what trade barriers such as regulations, procedures, reliable delivery, part of entry, or other occur?
14. Do you expect/plan to increase the volume of imported lumber/wood pallet/pallet parts in the next 6, 12, or 24 months? Why?
15. What is your opinion about working with lumber/wood pallet/pallet parts from overseas?
16. Do you purchase lumber/wood pallet/pallet parts with environmental certification? Which certification scheme is more common (FSC, SFI, ATFS, other)?
17. What regulation compliance is necessary for importing lumber/wood pallet/pallet parts?
18. For ISPM compliance what treatment is commonly used Heat treatment or Methyl Bromide fumigation? Why?
19. Could you give a customer contact in order to ask them their perceptions about imported wood pallet materials? And the name of the company who exports wood pallet materials?
20. Do you have any additional comments about the future of the pallet and container industry in general and of imports in particular?

APPENDIX D: Cover Letter Survey Questionnaire

VirginiaTech
College of Natural Resources and Environment

Wood Science and Forest Products
Brooks Center (0503), 1650 Ramble Road
Blacksburg, Virginia 24061
540-231-4525 Fax: 540-231-8868
E-mail: sanchez8@vt.edu
www.woodscience.vt.edu

August 27, 2010

Dear Manager,

The significant growth of international trade during the last decades created the need to improve not only transportation infrastructure and technology, but also the elements used for handling, loading, unloading, and warehousing. Probably the most important element in the transportation of goods is the pallet. Manufacturing pallets requires working with suppliers, domestic and/or from overseas. Thus, the understanding of the supply chain and how its components manage their businesses processes is very important for wood pallet manufacturers. The purpose of this study is to identify significant factors in the process of supplying wood pallet manufacturers. This information could help in reducing costs and increasing business profitability by understanding how management performance of all members involved in supplying wood pallet materials are related to customer satisfaction.

We are asking your help in this project by completing and returning the enclosed questionnaire. Your response is vital for the success of this project. The postage is prepaid. We would like to thank you for your assistance in advance. Please be assured that your response will be treated with **complete confidentiality**. Only aggregated results will be reported. As a participant, you can receive a summary of the results.

Thank you very much for your time and assistance. Should you have any questions, please contact me by phone at 540-231-4525, fax 540-231-8868, or email sanchez8@vt.edu

Sincerely,

Leslie Scarlett Sanchez
Graduate Research Assistant

APPENDIX E: Survey Questionnaire Applied To Wood Pallet Manufacturers

Identifying Success Factors in the Wood Pallet Supply Chain

The purpose of this study is to identify supply chain management success factors for wood pallet manufacturers providing information that could help in reducing costs, and increasing business profitability, by understanding how their supply chain management performance is related to business management and customer satisfaction.

All the information obtained will be treated in a confidential manner; no specific company information will be disclosed. Completing this questionnaire will take approximately 20-30 minutes. Your assistance is very important and as a participant of the study you can receive a summary of the results. Thank you for your willingness to participate. If you have any questions please contact me at the phone number or email address listed below.

Department of Wood Science and Forest Products
Virginia Tech
Blacksburg, VA 24061

Leslie Scarlett Sanchez
Graduate Research Assistant
Phone: 540-231-7107
Fax: 540-231-8868
Email: sanchez8@vt.edu

GENERAL INFORMATION

1. What type of business best describes your company? Please check all that apply.

- ☐ Manufacturer of new wood pallets
- ☐ Pallet material importer
- ☐ Pallet recycler or repairer
- ☐ Lumber broker
- ☐ Pallet broker
- ☐ Other

(Please specify): _____

2. Please rank in order of volume importance the major products in your company. Rank from 1-7, being 1 the least important and 7 the most important.

Product	Rank
New wood pallets	_____
Wood pallet parts	_____
Recycle/repaired wood pallets	_____
Lumber	_____
Railroad ties	_____
Wood containers	_____
Others (please specify): _____	_____

3. If you recycle/repair wood pallets, how much of your end product consist of recycled and new wood pallet material:

(Board Foot Basis)

New wood material	_____	%
Recycled	_____	%
Total	100	%

4. The number of full-time employees in your company is:

- ☐ 1 to 4
- ☐ 5 to 9
- ☐ 10 to 19
- ☐ 20 to 99
- ☐ 100 to 499
- ☐ More than 500

5. On average, how many pallets do you produce per year?

_____ pallets per year

6. Approximately how much was the annual average gross sales for 2009 (in million dollars)

- ☐ Less than 1 million dollars
- ☐ From 1 to 5 million dollars
- ☐ From 5.1 to 10 million dollars
- ☐ From 10.1 to 20 million dollars
- ☐ From 20.1 to 30 million dollars
- ☐ From 30.1 to 40 million dollars
- ☐ From 40.1 to 50 million dollars
- ☐ More than 50 million dollars

DOMESTIC AND IMPORTED WOOD PALLET MATERIALS

Use the following scale to answer questions

1	2	3	4	5	NA
Strongly disagree	Disagree	Undecided	Agree	Strongly agree	Not applicable

7. Please rate the following factors regarding domestic wood pallet materials. Circle your answer.

Domestic wood pallet materials supply is not consistent	1	2	3	4	5	N/A
Domestic wood pallet materials supply is not delivered on time	1	2	3	4	5	N/A
Transportation is a problem when acquiring wood pallet materials	1	2	3	4	5	N/A
Suppliers cannot give us information about where wood pallet materials are located when transported	1	2	3	4	5	N/A
Domestic wood pallet materials are of high quality	1	2	3	4	5	N/A

8. Please rate the following factors regarding what you think is important when purchasing raw materials.

Machinability	1	2	3	4	5	N/A
Mechanical properties	1	2	3	4	5	N/A
Durability	1	2	3	4	5	N/A
Strength	1	2	3	4	5	N/A
Stiffness	1	2	3	4	5	N/A
Density (specific gravity)	1	2	3	4	5	N/A
Environmentally certified	1	2	3	4	5	N/A
Cost	1	2	3	4	5	N/A
Availability	1	2	3	4	5	N/A
Quality	1	2	3	4	5	N/A
Reliable Supplier	1	2	3	4	5	N/A
Delivery on time	1	2	3	4	5	N/A
Logistics & transportation	1	2	3	4	5	N/A
Workmanship	1	2	3	4	5	N/A
Species	1	2	3	4	5	N/A

9. What is your monthly raw material input (aprox.)?

Cants: _____ thousand board feet

Lumber: _____ thousand board feet

Pallet parts: _____ thousand board feet

Pallet cores: _____ units

10. On average, how long do your suppliers take to ship orders to you, from order to shipment?

_____ days

11. On average, how frequently do you order wood pallet materials (example, every two weeks)?

_____

12. Please check and estimate the percentage of your pallet sales that goes to the following customers:

Customer	Share on total sales	
☐ Distributor	_____	%
☐ Retailer		%
☐ Pallet Broker		%
☐ Government (GSA, DOD)		%
☐ Manufacturer (Pallet user)	_____	%
☐ Other (please specify):		%
_____	_____	%
		%
Total	**100**	**%**

13. Please check all that apply, regarding which wood pallet materials would you like to try from other countries outside the U.S. in the future.

☐ Assembled wood pallets ☐ Wood pallet parts
☐ Lumber ☐ Cants
☐ Pallet Kit ☐ None

☐ Other (please specify): _____

14. Do you think your customers would pay more for environmentally certified wood pallets?

☐ Yes ☐ No Why? _____

If your company does not have experience working with imported wood pallet materials, please skip questions 15 to 17.

Use the following scale to answer questions

1	2	3	4	5	N/A
Strongly disagree	Disagree	Undecided	Agree	**Strongly agree**	Not applicable

15. Please rate the following factors regarding the barriers to buying lumber/cants/wood pallet parts from other countries outside of the US?

Price	1	2	3	4	5	N/A
Tariffs	1	2	3	4	5	N/A
Paperwork	1	2	3	4	5	N/A
Quality	1	2	3	4	5	N/A
Language	1	2	3	4	5	N/A
Delivery on time	1	2	3	4	5	N/A
Logistics & transportation	1	2	3	4	5	N/A
Production capacity	1	2	3	4	5	N/A
Government policies	1	2	3	4	5	N/A
International treaties	1	2	3	4	5	N/A
Past experiences	1	2	3	4	5	N/A
Phitosanitary requirements	1	2	3	4	5	N/A
Payment methods	1	2	3	4	5	N/A
Other: _____	1	2	3	4	5	N/A

16. Please rate the following factors regarding imported wood pallet materials. Circle your answer.

Our suppliers are able to answer quickly to our necessities	1	2	3	4	5	N/A
Our company has to buy treated lumber/wood pallet parts when importing wood pallet materials	1	2	3	4	5	N/A
Imported wood pallet materials supply is not consistent	1	2	3	4	5	N/A
Imported wood pallet materials supply is not delivered on time	1	2	3	4	5	N/A
Transportation is a problem when importing wood pallet materials	1	2	3	4	5	N/A
Suppliers from overseas cannot give us information about where wood pallet materials are located when transported	1	2	3	4	5	N/A
Imported wood pallet materials are of high quality	1	2	3	4	5	N/A
Imported wood pallet materials show good strength performance	1	2	3	4	5	N/A

17. Please rate the following statements. Suppliers from overseas compared to domestic suppliers.

Provide better technical performance (strength, stiffness, durability) for the same price	1	2	3	4	5	N/A
Provide lower price with the same quality	1	2	3	4	5	N/A
Provide superior customer service for less or equal price	1	2	3	4	5	N/A
Are better at meeting technical specifications	1	2	3	4	5	N/A
Are easier to make business with	1	2	3	4	5	N/A

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

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

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	

Thank you for your help! This information will be kept confidential. Please fold, tape, and return the questionnaire. The postage is prepaid. Also, please indicate below if you would like to receive an electronic version of the results of the study. If you would like a printed version, please indicate your mailing address.

☐ No thanks, don't send results.
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Thank you!