

## STATUS OF LEAN MANUFACTURING IMPLEMENTATION ON SECONDARY WOOD INDUSTRIES INCLUDING RESIDENTIAL, CABINET, MILLWORK, AND PANEL MARKETS

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Lean Manufacturing has helped several industries to achieve operational and manufacturing excellence by increasing productivity and enhancing quality, while reducing waste and costs. However, the wood industry has been historically slow in adopting this philosophy and its many tools. In times when overseas competition has taken big portions of the traditional market share for U.S based wood industries, it has become important that companies start to take actions in order to regain competitiveness. In this sense, Lean Manufacturing could provide a competitive advantage. Main findings of this project includes high percentages of Lean Manufacturing implementation among companies from the Wood Component Manufacturing Association, substantial differences in the tools implemented by companies on an early vs. extensive Lean Manufacturing implementation stage, as well as identification of main reasons and advantages derived from its implementation, and how Lean Manufacturing is rated among these companies. Findings lead to the conclusions that many companies are pursuing cost savings strategies without implementing Lean Manufacturing. Training and education on Lean Manufacturing, and well implemented Lean Manufacturing programs would help members of the Wood Component Manufacturing Association to regain competitiveness and achieve substantial cost reductions.

*Keywords:* Lean Manufacturing; Wood Industries

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### INTRODUCTION

#### Challenges in the Wood Industry

The United States wood products industry is threatened by competitors outside the U.S (Roob et al. 2003). Milauskas (2005) explains its concern about the loss of approximately 61,000 jobs in the furniture industry over five years, along with the increased value of wood furniture imports (+86% over 5 years), especially from Asia and other Pacific regions (+149%). Czabke et al. (2008) stated that due to growing global competition, especially in the last decade, the U.S. and German wood and wood-based industries have suffered significant market share losses. According to the North Carolina in the Global Economy report (Bo et al. 2006), the increase in wood products imports from China is due to weaker regulations, the ability to build world-class facilities, and an abundant supply of cheap labor. Overall, manufacturing in the United States will not be able to continue following traditional and previously used manufacturing systems due to globalization changes (LaBissoniere 2006).

The ability of U.S. manufacturers to compete with Asian producers (and other regions) on a pure price basis is limited. Also, U.S. companies must prepare for a shift from the old world of mass production where standardized products, homogeneous markets, and long product life and development cycles were the rule, to the new business world where variety and customization of products and services become the norm. As a result, the wood industries need to change their business model to remain competitive (Schuler and Buehlmann 2003).

An important philosophy that suits these accomplishments, and which could become extremely useful for the secondary wood industry, is Lean Manufacturing. Lean Manufacturing requires far fewer resources - labor, capital, machinery, time and manufacturing space - to make a given amount of products and services and to make them with fewer defects to precise customer desires, compared with traditional manufacturing operations (Lean Enterprise Institute 2007). According to definitions provided by the Lean Enterprise Institute (2007), many of the wood industry issues could be improved by means of a Lean Manufacturing implementation.

### **Literature Review**

Lean Manufacturing proposes a simple, feasible, reliable, cost effective, revolutionary, synergistic, and complete philosophy that can be implemented in wood industries to reduce/eliminate waste. Lean Manufacturing defines waste as anything that adds unnecessary costs to the product without adding value. Therefore, it helps improve the product flow through the process, shortens the manufacturing lead time and supports continuous improvement, and, as a complete philosophy, helps reduce defects of the products (Lean Enterprise Institute 2007).

A principal tenet of Lean Manufacturing is to eliminate waste in all its forms (Ray et al. 2005). According to Earl Kline, cited by Testa (2003), Lean Manufacturing is the most successful method to eliminate waste, based on its record in other industries like automobiles, aerospace, and pharmaceuticals.

In addition, James Womack, who launched the Lean Enterprise Institute (LEI) in 1997, stated on the LEI (2007) report, that the biggest benefit of Lean Manufacturing is that it frees resources by using less human effort, space, capital, and time, turning waste into available capacity. Lean Manufacturing is not only about cutting costs. Dave LaHote, president of LEI's Lean Education advocates on the LEI (2007) reported that although cost savings is a side benefit of reducing waste, organizations that focus on this area usually miss the real opportunity to significantly transform their business. He also established that many organizations get some limited results because they have a sharper focus for their improvement efforts and some new tools to use, but few significantly change the way they make business decisions, develop future management talent, and lead the business. This may explain why while many organizations appreciate the savings they get with a focus on Lean Manufacturing tools and waste reduction, few of them significantly change their competitive position and even fewer break through to lead their industry in quality, value, innovation, growth, and profitability as Toyota has done in the auto business. Moreover, Krassimir Totev, interviewed by Testa (2003), identified another aspect of impatience. "Most companies tend to proclaim themselves "Lean" after the experience of only one project, before Lean company culture, sufficient training, designated Lean champions, and clear improvement strategies are in place. Furthermore, Testa (2003) stated that while Lean Manufacturing definitely costs money to implement, the savings usually outweigh the costs many times over. Typical benefits attributed to

lean production are those cited by Kotelnikov (2001): Reduction of waste and inventory by 80%, decrease in manufacturing cycle times and labor by 50%, increased capacity and product quality in facilities by 50%, higher profits and system flexibility, better cash flow, and just-in-time delivery.

Unfortunately, the wood industry has not adopted Lean Manufacturing approaches as quickly as might have been, compared to other industries. With the powerful tools provided by Lean Manufacturing, it is entirely possible that the mass exodus of wood industry jobs out of the U.S. can be halted. However, some examples of successful applications need to be both completed and publicized for the industry to see the opportunity these tools can afford them in becoming more competitive. Some companies in the wood industry have found a way of improving their competitiveness by reducing costs through Lean Manufacturing, better training, increasing worker productivity, adopting new technology, and improving their supply chain management (Schuler and Buehlmann 2003). Hunter et al. (2004) showed a systematic case study that “proves the flexibility of Lean Manufacturing due to is adaptive and cost effective, improves quality, and is ergonomically correct for workers in the furniture industry”. Many wood products companies have adopted or are considering adopting full or partial Lean Manufacturing components and tools. The most successful wood products company in utilizing lean production techniques may be the Merillat Industries Door and Panel Plant in Atkins, Virginia (Ray et al. 2005). The company, which won the Shingo Prize (for Lean Manufacturing performance) in 2003, achieved 99.7% on time delivery, reduced cycle time from over 5 days to 17 hours, reduced WIP by over 80% and reduced total cost by 7.1% from implementation of lean strategies (Shingo Prize 2003). Furniture Companies such as Hon Company (2007 and 2003), Steelcase Inc. (2006), and Merillat Industries (2003) have achieved this significant award.

Despite successful results attained by these companies, not every industry may realize the same dramatic benefits from lean production as Toyota. Specifically, for hardwood products manufacturers, raw material (lumber) cost accounts for more than 50% of total production cost. Customer-driven inventory practices, that is, restriction of lumber or component production to current order requirements, could result in the disposal of clear wood not required by the customers, which increases the material cost significantly through yield loss. This unique feature of wood products processing can lead to conflicts among wood recovery, inventory, and cost when wood products companies attempt to adopt lean techniques (Kenny and Florida 1993). Despite many efforts of wood manufacturers to remain competitive and to make profitable products, additional work needs to be conducted in order to overcome the inertia and to help the wood industry to become more competitive in the global markets.

## **Objective**

The objective of this project is to provide insight regarding the status of Lean Manufacturing implementation in secondary wood manufacturers by conducting a survey, as well as to determine main barriers for its implementation, triggers, and tools, that may lead companies to pursue a full implementation of the Lean Manufacturing philosophy. This research should provide insightful information about actual trends, and what needs to be done in companies from the secondary wood industry in order to attain competitiveness through the use of Lean Manufacturing.

For this project, several wood industry associations were invited to collaborate with the survey distribution through their member's list. The Wood Component Manufacturing Association (WCMA) agreed to share their members' list of wood companies located throughout the United States and Canada. For that reason, the companies included in this analysis belong to the Wood Component Manufacturing Association (WCMA). Since the objective of associations such as the WCMA is the promotion and interchange of ideas and cooperation among its members, the results of this survey should provide valuable information regarding how the Lean Manufacturing philosophy is disseminated and implemented among members that share information through this association, providing a snapshot of typical tools, level of implementation, and common issues faced by these companies when implementing Lean Manufacturing.

## **METHODS**

Prior to the survey configuration, an overall study of the number and classification of the secondary wood industry in the U.S. was executed with the help of the North America Industry Classification System (NAICS). Following that, a wood industry classification was structured by selecting the largest products in the market as follows: engineered wood products, furniture residential, furniture office, cabinets, millwork and moulding, doors and windows, pallets and containers, panel boards, dimension stock, flooring, remanufactured products, and others industries.

An investigation concerning previous surveys on Lean Manufacturing was performed in order to identify main questions of interest to be selected and discussed (LEI 2002, 2003, 2004, 2005, 2006, 2007; Strategem 2003; Yusuf and Adeleye 2002; Ray et al. 2005). Several questions of interest were found, selected, and discussed. The survey instrument developed for this study was compiled from applicable questions found in the abovementioned Lean Manufacturing surveys, and questions formulated by the research team. The survey consisted of fifteen questions that included single, multiple choice, and open ended questions. The structure of the questions, as well as the levels employed for measuring each item were developed following guidelines from previous surveys in Lean Manufacturing (Lean Enterprise Institute 2005, 2007), and considering the most common classifications for the secondary wood industry, process improvement activities, and Lean Manufacturing tools. The structure of the survey considered demographic questions for classification purposes, general questions about process improvement, specific questions about Lean Manufacturing and its implementation, and opinions about Lean manufacturing and its findings for the wood industry. Specific questions in the survey were designated for a particular group of companies depending on their awareness of Lean Manufacturing, such as activities for improvement involved, tools used in process improvement, etc. Furthermore, some specific questions on the survey were designated for a particular group of companies, depending on the respondents' awareness of Lean Manufacturing. Several reviews and modifications were performed to the survey prior to the next step of the project based on a pilot sample. The pilot sample was implemented in order to prove the robustness of the measurement instrument. This pilot consisted of sending the survey to people related to the industry in order to verify clearness, ambiguity, time, and effectiveness of the questions. After modifying the measurement instrument according to recommendations obtained from the pilot sample, the survey was finalized and compiled in the software Survey Monkey®.

Parallel to the survey design, the task of obtaining the set of contact information needed of those companies willing to participate was ongoing. Several wood industry associations were contacted and invited to collaborate with the survey distribution through their member's list. After several communications, the Wood Component Manufacturing Association (WCMA) agreed to share their confidential members' list of wood companies located throughout the United States and Canada. However, a majority of companies on the distribution list are located in the United States. The WCMA market sector represents manufacturers of dimension and wood component products who can supply any component needed for cabinetry, furniture, architectural millwork, flooring, staircases, building materials, and a wide variety of decorative/specialty wood products. The WCMA's database provided to the project was composed of 198 companies' contact information. A first contact email was sent as a courtesy to the potential respondents in order to make them aware of the oncoming survey. In addition, the email helped to inform the respondents about a short summary of the results that was going to be sent to them as an incentive for helping filling out the surveys. Also, confidentiality on their responds was assured on this email.

After the instrument was sent by email, two reminders were sent for those specific potential respondents that might not have had the chance to answer the survey, thus, trying to keep the potential respondents aware of the importance of their support and collaboration. From the 198 companies surveyed, 55 responses were returned, with a response rate of approximately 30 percent. This percentage was considered significant in order to drive analysis and conclusions for the behavior of that specific population (WCMA's list of members). However, it is possible that respondents were different from non-respondents, so caution is warranted in generalizing beyond the population of WCMA subscribers. After the closing date, surveys were processed and analyzed based on the answers received, and also the evaluation of the open ended questions was conducted. It was decided to employ the statistical software SPSS® as the instrument for analyzing the responses, supported by the use of Microsoft Excel® for data processing.

### **Survey Design and Analysis**

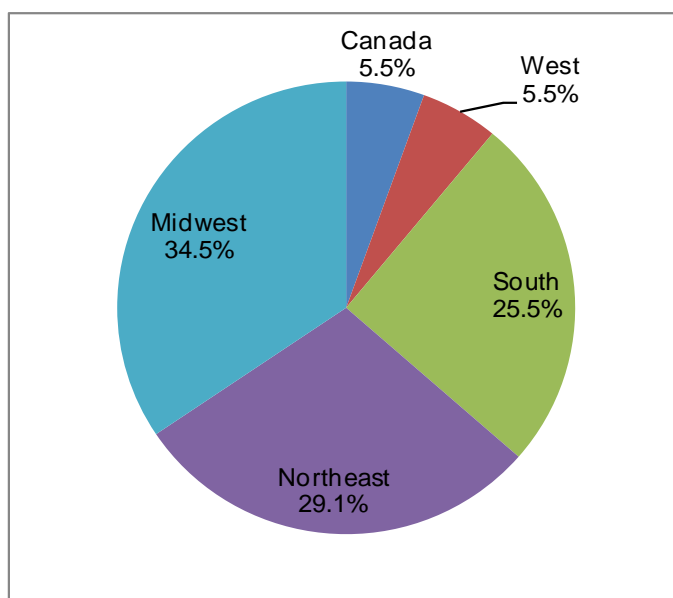
Results from the 55 responded surveys were inserted in SPSS. In order to facilitate the analysis of the responses obtained, the survey was developed following a determined structure. Demographic questions were asked first, regarding name of the company, job title of the respondent, primary product manufactured by the company, location, and number of employees. These questions served for general understanding of the population, as well as for further analysis, when combined with responses from other questions from the survey. Subsequent questions were about process improvement activities in general; at this point, the concept of Lean Manufacturing had not been introduced yet. These questions asked about typical activities for process improvement, and the level of involvement of companies into any of them. More specific questions about Lean Manufacturing were asked afterwards, starting with a question about the awareness of the respondent about Lean Manufacturing. If the respondent was aware of and implementing Lean Manufacturing, more specific questions were asked about the triggers that led them to implement it, their level of implementation, resources used to start their Lean implementation, and Lean Manufacturing ideas, tools and techniques used in their area. Final questions were asked about the benefits of Lean Manufacturing, the barriers perceived for its implementation in the secondary wood industry, and a final

open-ended question regarding the usefulness of Lean Manufacturing in the wood industry.

In the following section, results from each question, as well as discussion and findings are provided, presenting each questions' result in the same order as they were contained in the survey.

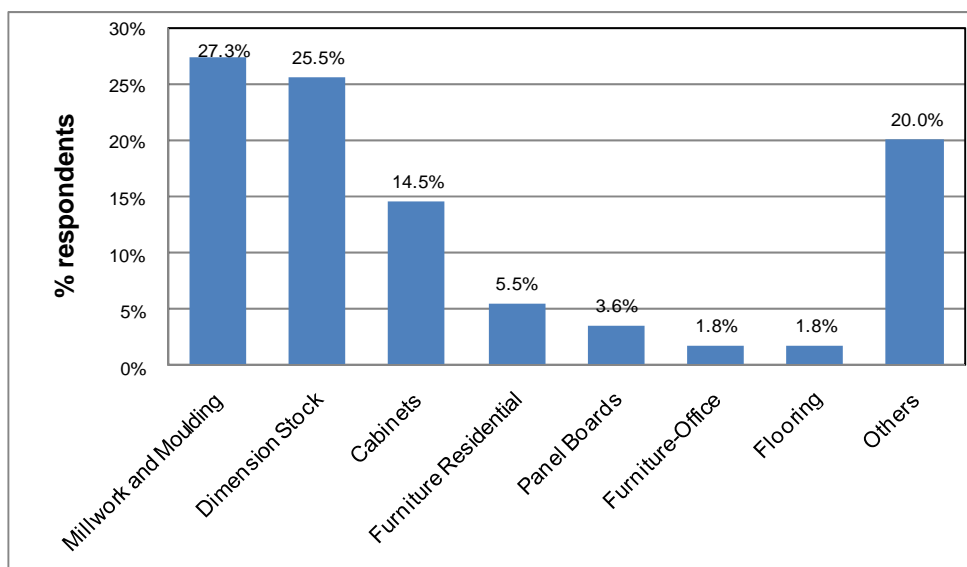
## RESULTS AND DISCUSSION

The categorization for regions was supported by the Census Bureau Regions classification system, which included the Northeast, Midwest, South, and West regions of the U.S. Since the WCMA members' list includes companies from Canada, this classification was also included as a region. Figure 1 show how the majority of responses came from the Midwest region of the U.S. This classification provides insight about the composition of companies that belong to WCMA, finding the majority of them in the Midwest and Northeast region of the U.S.



**Figure 1.** Surveys responses by region

Approximately 68 percent of the respondents were Owners, CEOs, Presidents, Directors, or General Managers. Only around 13 percent of the respondents were Production Managers. The classification of the industries that have responded to the survey is depicted in Fig. 2.



**Figure 2.** Classification of the industries that have responded to the survey

A high percentage of industries were placed in the category defined as “Others”, which encompassed other wood industries such as sawmills, hardwood lumber, special wooden components, as well as others. These results could be directly related to the WCMA member list composition of predominantly wood components companies, and shows that the three major industries belonging to WCMA are Millwork and Moulding (27.3%), Dimension Stock (25.5%), and Cabinets (14.5%) industries.

More than 90 percent of the respondents claimed to be involved with the following activities at this time: cost reduction (98.2%), improvement in product quality (96.4%), improvement in customer satisfaction (90.9%), and improvement in service quality (90.9%)<sup>1</sup>. From these results it would appear that companies are focusing on producing high quality product at the lowest cost, with a main focus on the customer. The status of awareness of Lean Manufacturing and its implementation is depicted in Fig. 3. A high number of companies that responded the survey claimed to be implementing Lean Manufacturing (55%). From this group of companies 64 percent stated that they have an extensive implementation described on the survey as “an *implementation underway with many areas of the business applying lean tools and having a solid progress in these areas*”; 28 percent responded to have an early implementation referred to as “*starting to implement in pilot areas where some progress have been made*” and only 8 percent have a advanced implementation where Lean Manufacturing has become a “*standard of operating, employees, supervisors, and managers understands*”.

Additionally, Fig. 3 shows that 27 percent of surveyed companies are planning to implement Lean Manufacturing. From this group of companies, 60 percent of them are planning on beginning the implementation of Lean Manufacturing within six months, and the other 40 percent after six months respectively. The rest of the companies are either aware of Lean Manufacturing but not implementing it (27%) or not aware of Lean Manufacturing at all (7%).

<sup>1</sup> The number of selections were unrestricted in this question. Therefore, the total number of answer choice selections was greater than the number of respondents to the survey.

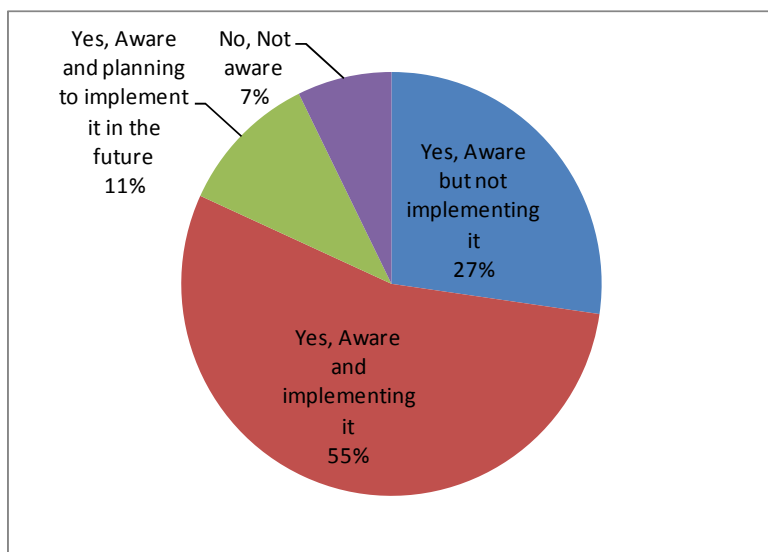


Figure 3. Companies' awareness and implementation of Lean Manufacturing

In 2005, the Lean Enterprise Institute conducted a survey about the Lean Manufacturing status through their member's list. Industries such as automotive, aerospace, chemicals and allied products, furniture and fixtures, petroleum refining and related industries, among others, participated in this research. Figure 4 shows a comparison between the level of Lean Manufacturing implementation in this member list (LEI) and the one utilized for this project (WCMA). This comparison takes into consideration that the levels of implementation used were the same for both surveys, and the respondents for the LEI survey were similar (managers, CEO's, etc. from several companies across different industries). This similarity in the conditions present in the question allows making a comparison between both, and provides insight on how companies from WCMA are compared to other industries in terms of Lean Manufacturing acceptance and implementation.

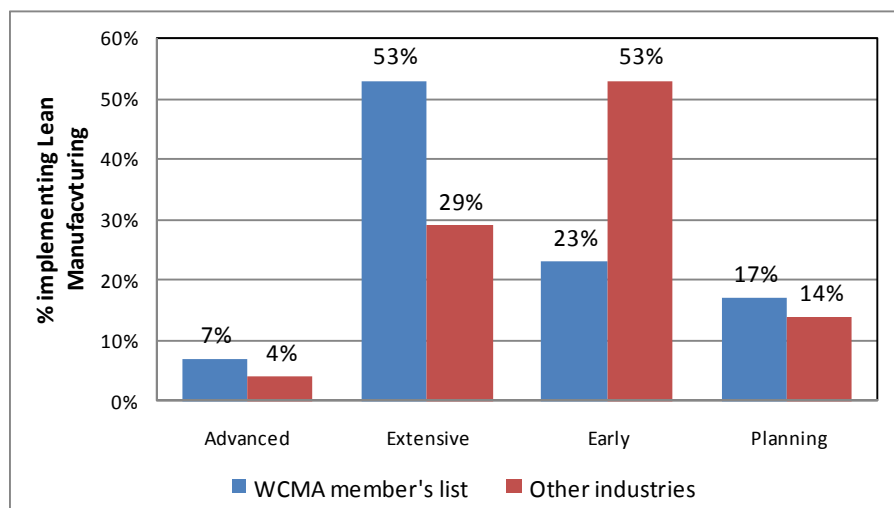
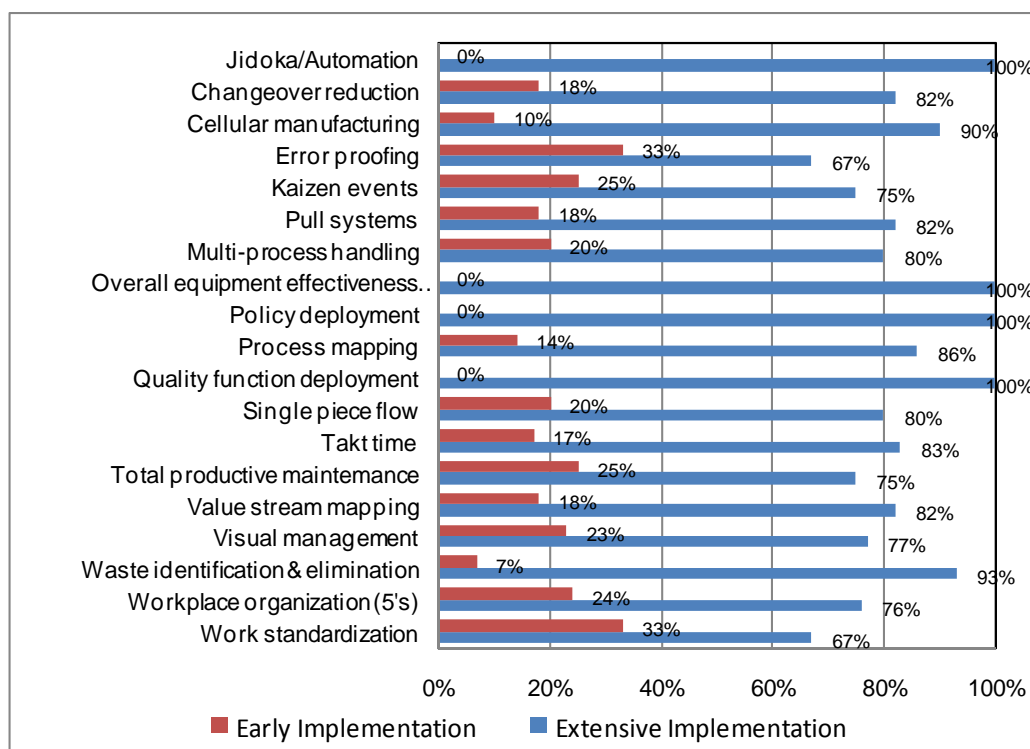


Figure 4. Comparison of Lean Manufacturing implementation of LEI vs. WCMA member's list



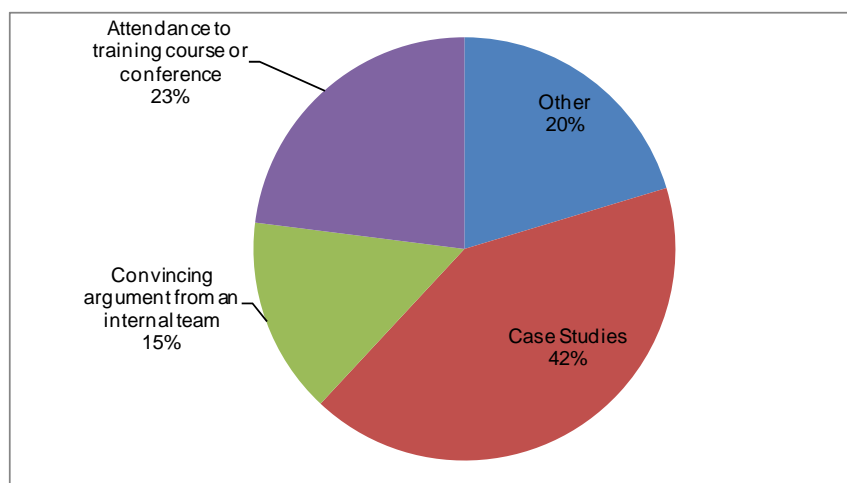
Figure 4 shows that there is a substantial difference from the WCMA member's list having an extensive and early implementation of Lean Manufacturing when compared to other industries considered by the LEI survey. Companies that belong to the WCMA were compared in terms of their level of Lean Manufacturing implementation, in which is interesting to denote that members from the WCMA have a higher percentage of Lean Manufacturing implementation at an extensive level, as compared with companies from the LEI survey (24% difference between them); the opposite case occurs with companies in an early level of Lean Manufacturing implementation, in which companies from the LEI survey are substantially more involved than companies from the WCMA (30% difference between them). Another question about typical tools from Lean Manufacturing was asked to the companies. Figure 5 shows results from this question, when combining it with the level of implementation achieved by the company when the survey was completed. Tools such as Overall equipment effectiveness, Policy deployment, Quality function deployment, and Jidoka/Automation are exclusively used by companies with extensive implementation levels. Another important finding from Fig. 5 is the fact that companies that have an extensive level of Lean Manufacturing implementation keep on having high levels of tools implementation (every tool listed has at least a 67% of implementation among these companies), reinforcing the fact that Lean Manufacturing is a philosophy for continuous improvement, and that these tools are implemented and kept on a regular basis. On the other hand, companies with an early level of Lean Manufacturing implementation tend to implement more Error proofing, Work standardization, Kaisen events, and Total productive maintenance.



**Figure 5.** Tools used by companies having an early and an extensive Lean Manufacturing implementation from the WCMA member's list

When analyzing the geographical distribution of the surveyed companies, it was identified that most of the companies from the WCMA member's list that are implementing Lean Manufacturing are located in the Midwest (35.5%), and South (32.3%) regions, followed by Northeast (25.8%) and West (6.5%). In the case of Canada, none of the companies that have been surveyed are actually implementing Lean Manufacturing at this time, instead 33.3 percent of the companies surveyed in this region are planning to implement it in the future and 66.7 percent are in fact not aware of Lean Manufacturing.

When asked about the trigger(s) that lead companies to implement Lean Manufacturing, the majority of respondents stated that the trigger(s) that led them to embark on Lean Manufacturing was *examples and/or case of studies* on the benefits of Lean Manufacturing (42% respondents), followed by attendance to training courses and/or conferences (26%). These results indicate that a valuable way to learn and convince companies to implement Lean Manufacturing tools or programs is through experiences and programs previously implemented by other companies. In this sense, courses and training that uses case studies, and more publications related to the experiences lived through Lean Manufacturing implementations, could help these industries to implement their own programs and convince key personnel about the benefits of a Lean Manufacturing implementation (Fig. 6). Notice that combining the learning of Lean Manufacturing through Case Studies, Training, and an internal team with Lean Manufacturing knowledge could be a very effective trigger for companies to embark on a Lean Manufacturing project for process improvement; 80% of respondents used at least one of these strategies, while the combination of one or more of them could be more even more successful.



**Figure 6.** Convincing trigger to embark on Lean Manufacturing

In order to analyze and study the relationship between different variables, a bivariate correlation was conducted utilizing Pearson<sup>2</sup> as a correlation coefficient with a level of significance of five percent (two-tailed). The process improvement activities Customer Satisfaction, Awareness of Lean Manufacturing, and Cost Reduction were

<sup>2</sup> Pearson's correlation coefficient is a measure of linear association. Correlation coefficients range in value from -1 (a perfect negative relationship) and +1 (a perfect positive relationship).

considered dependent variables, while the rest of the process improvement activities were considered dependent variables. A significant result from this non-parametric test indicated that there is a relationship between the level of Awareness of Lean Manufacturing [implementing (1), not implementing (2), planning to implement (3), and not aware (4)], and the improvement in product quality, reduction in lead time/cycle time, and improvement in customer satisfaction [currently involved (1), not involved (2), and not involved but planning (3)]. More detailed information about this test is depicted in Table 1. Thus, large companies, from the WCMA members' list, that are implementing Lean Manufacturing are currently involved in improving product quality, customer satisfaction and reducing lead times. From these three categories, improving customer satisfaction seemed to have a higher correlation with those companies that are implementing Lean Manufacturing. The latter could be due to the fact that Lean Manufacturing is focused on all those activities that add value to the customer.

**Table 1.** Bivariate Correlation between the Awareness of Lean Manufacturing and Company Involved Activities at this Time

	Improvement in product quality	Reduction in mgf. lead time/cycle time	Improvement in customer satisfaction	Awareness of Lean Manufacturing
Pearson Correlation	.270(*)	.309(*)	.423(**)	
Sig. (2-tailed)	0.046	0.022	0.001	
N	55	55	55	

\*. Correlation is significant at the 0.05 level (2-tailed), \*\*.Correlation is significant at the 0.01 level (2-tailed)

All companies that have responded to the survey seemed to be conducting cost reduction activities, while having a reduction in manufacturing lead times and improving product development/on-time to market<sup>3</sup>. These results could have their origins in the waste and non-value added activities that must be eliminated in order to reduce manufacturing lead time. In addition, the elimination of waste can be conducted at the product development state. The dependency described by these variables is depicted in Table 2.

**Table 2.** Bivariate Correlation between the Cost Reduction as an Activity Implemented by the Companies from the Sample of Study and the Reduction in Manufacturing Lead Time/Cycle Time and the Improvement in Product Development/on-Time to Market.

	Reduction in manufacturing lead time/cycle time	Improvement in product development/ time to market	Cost Reduction
Pearson Correlation	.281(*)	.295(*)	
Sig. (2-tailed)	0.019	0.014	
N	55	55	

\*. Correlation is significant at the 0.05 level (2-tailed)

<sup>3</sup> Other experiments have to be conducted in order to unequivocally demonstrate a causal relationship

A significant relationship was also obtained while comparing the dependency between companies that are applying cost reduction at this time, and those ones that believe that Lean Manufacturing could drive resource savings (Pearson correlation=-0.218, and sig. (2-tailed)=0.077, N=44). From the total sample that have responded to be applying cost reduction, 7.7 percent are planning to implement Lean Manufacturing and 28.8 percent are aware of Lean Manufacturing but not planning to implement it. Furthermore, companies showed to be improving in customer satisfaction while improving in service quality, on-time delivery, manufacturing flexibility agility, product development and time to market, and by reducing in manufacturing lead time/cycle time see Table 3.

In addition, a significant relationship was found when comparing the companies currently improving in customer satisfaction activities, and those companies that believe that Lean Manufacturing could result in: revenue growth, improvement in market share, customer loyalty, customer satisfaction, the diminishing in rework and duplication work, and a low employee turnover. For these companies, they seem to identify and relate that customer satisfaction with their products is highly dependent on the accomplishment of these activities for improvement. From the total sample that have responded that they are involved with customer satisfaction activities at this time, 6 percent are planning to implement Lean Manufacturing and 28 percent are aware but not planning to implement it.

**Table 3.** Bivariate Correlation between Customer Satisfaction and Improvement in Service Quality, On-Time Delivery, Flexibility, Product Development and Reduction in Manufacturing Lead Time

	Improve ment in service quality	Improve ment in on-time delivery	Improvement in product development and time to market	Improve ment in flexibility agility	Reduction in mfg lead time/cycle time	Custo mer satisfa ction
Pearson Correlation	.475(**)	.210(***)	.266(*)	.418(**)	.284(*)	
Sig. (2- tailed)	0.000125	0.062	0.025	0.001	0.018	
N	55	55	55	55	55	

\*\*\* Correlation is significant at the 0.10 level (2-tailed), \*\* Correlation is significant at the 0.05 level (2-tailed), and \* Correlation is significant at the 0.01 level (2-tailed)

According to these results, 28.8 percent of companies are interested in improving in cost reduction and 27.7 percent in customer satisfaction that are not implementing Lean Manufacturing as a tool to accomplish these objectives. Given the apparent dependency of these two activities with several other competitive advantage activities that were explained above, Lean Manufacturing could offer these companies more returns than only cost reduction and customer satisfaction, such as resource savings, improvement in service quality, on-time delivery, manufacturing flexibility/agility, product development and time to market, and reduction in manufacturing lead time/cycle time.

Furthermore, Fig. 7 reflects a high usage of workplace organization (5S's) technique of 73.3 percent by those companies that are either currently implementing Lean

Manufacturing or planning on doing it. The next most used tools were process mapping (56.67%), waste identification and elimination (53.33%), visual management (50%), and kaizen events (50%). Only 40 percent of the respondents favored the usage of value stream mapping. More companies seemed to be utilizing process mapping. The latter is a simpler tool, since it is not required to indicate valuable data such as the Lean Manufacturing metrics (change over time, lead times, WIP, overall equipment effectiveness, among others) as well as the information flow.

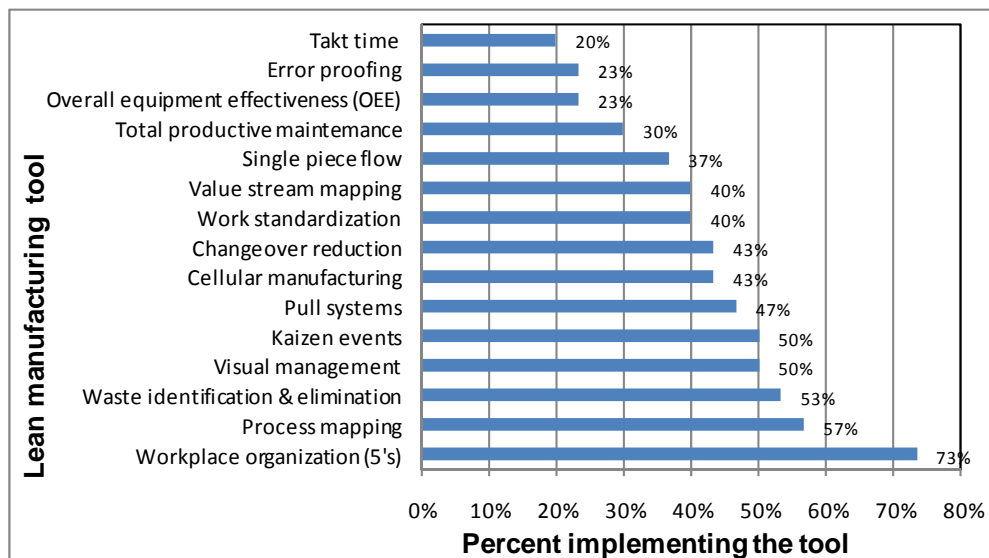


Figure 7. Lean Manufacturing tools usage

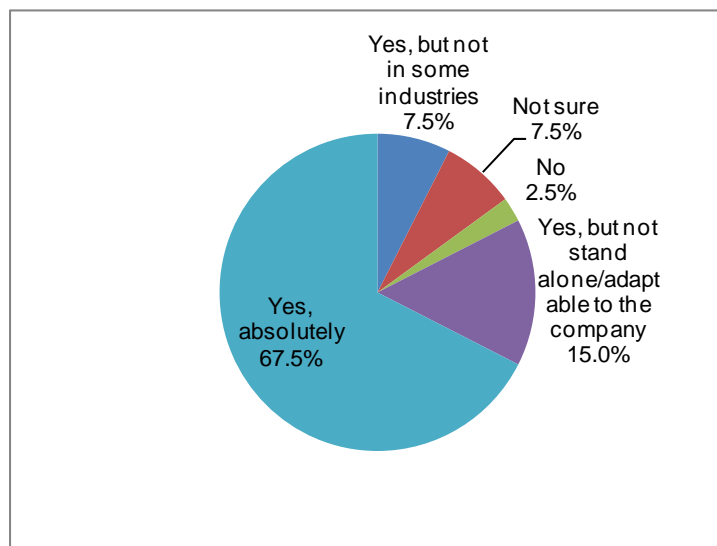
Interesting results were found when considering the size of companies (Table 4). A total of 52.7 percent of companies surveyed were large companies, while 47.3 percent were of small size. By applying a bivariate correlation (10% significance level), it was found that there is a relationship between the size of the company and the improvement in product development/time to market activity. (*Pearson correlation*=-0.244, and *sig. (2-tailed)*=0.06, *N*=55). Thus, large companies are currently pursuing improvements in product development and time to market. This could be due to the fact that large companies tend to have more resources to spend in these activities. Table 4 shows that small companies are more likely to perform these activities in the future. In this sense, smaller companies seem to be reacting and embarking in activities that would made them more competitive.

Table 4. Relation between the Size of Companies and the Level of Improvement in Product Development and Time to Market

	Improvement in product development/time to market		
	Yes, currently (1)	Not Involved (2)	No, but planning (3)
Small Companies (<=80 employees)	40.0%	59.1%	75.0%
Large Companies (>80 employees)	60.0%	40.9%	25.0%
<b>Total</b>	100.0%	100.0%	100.0%

Moreover, large size companies from this sample (5% confidence level) seemed to be using internal staff learning through training programs as a method to initiate/implement Lean Manufacturing (*Pearson correlation*=-0.413, and *sig. (2-tailed)*=0.0023, *N*=30). From the total sample of 55 companies, it could be observed that only 3.3 percent of them have had public agency cooperators as a resource to initiate in Lean Manufacturing. This could be considered as an important opportunity to develop programs to public institutions to support Lean Manufacturing implementation. Additionally, large size companies considered employee training as the starting point for Lean Manufacturing (26.7%), while for small companies it seemed to be in process improvement (23.3%).

All the companies were asked their opinion about Lean Manufacturing helping the wood industry to become more competitive<sup>4</sup>. A high number of them agreed to this (67.5% of participation). Another 15 percent believed that Lean Manufacturing must be combined with other philosophies, and be customized in order to help the wood industry become more competitive. Some comments such as these were found: “Yes, but it is clearly a different implementation than the standard Lean Manufacturing,” “I think any company can improve via Lean Manufacturing. Not all parts are compatible with all companies, but even the analysis has been educational, and our limited implementation to date has had significant impact,” and “Generally, but not Lean Manufacturing alone.” Another 7.5 percent believe that Lean Manufacturing could help some industries to become more competitive, but not the wood industry as a whole. Comments like this were found: “In certain areas Lean Manufacturing could help, but not in the custom shop.” The rest of the respondents are either not sure or are not agreed with what it was asked (Fig. 8).



**Figure 8.** Respondents' opinions about Lean Manufacturing as a competitive advantage for the wood industry

Nearly 89 percent of the respondents claimed that Lean Manufacturing could help them improve in cost savings, 79 percent in enhanced competitiveness, 75 percent in reduction in lead time, and 68 percent in each of these categories: customer satisfaction,

<sup>4</sup> This was an open-ended question

rework reduction and duplication, and smooth operation processes. Figure 9 depicts the responses to a main question, regarding the barriers, as seen by these companies, which prevent or delay a Lean Manufacturing implementation. The two main barriers that were seen as preventing the adoption of Lean Manufacturing principles were the backsliding to old ways of working, lack of implementation know-how, and employee and middle management resistance. Comparing these barriers with the ones found by the LEI's research (2005), it can be observed that these are the same main obstacles encountered by other industries. However, backsliding to old ways of working is considered by the WCMA member's list to be in the first place before the lack of implementation know-how. Thus, it could be inferred from this information that these companies have to work hard in making their people to believe in all the benefits that Lean Manufacturing can bring to them and that there is a better way in which their job can be performed. A new culture has to overcome the old way of thinking.

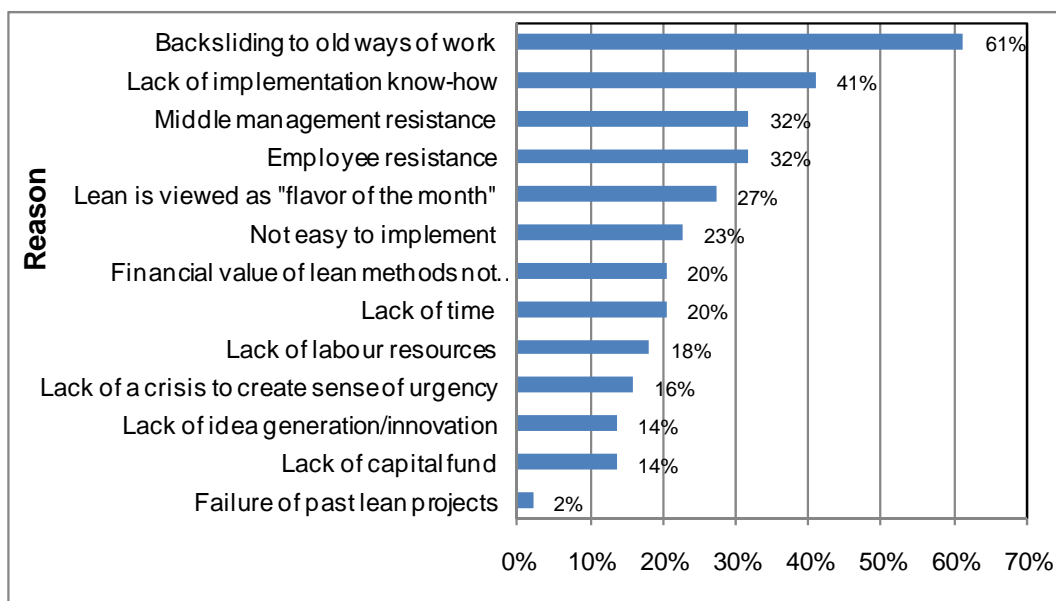


Figure 9. Barriers to Lean Manufacturing implementation

## CONCLUSIONS

A better understanding of the status regarding Lean Manufacturing for companies that belong to the Wood Component Manufacturing Association (WCMA) has been achieved through the results obtained and presented from the survey applied to WCMA members.

1. More than half (55%) of the companies that are part of this association are implementing Lean Manufacturing at this time. In addition, a high percentage of these companies (64% of the implementers) indicated that they have an extensive level of Lean Manufacturing implementation, increasing the competitive level that companies belonging to the WCMA could achieve.
2. It was determined that almost one third of the companies from the WCMA are aware of Lean Manufacturing but do not have a Lean Manufacturing program, and are not

planning to implement it in the near future. These companies may need more training and case studies to convince managers and workers about the benefits of implementing Lean Manufacturing, since among the main barriers for its implementation are the backsliding to old ways of work, as well as resistance from middle-management and employees. This training and case studies could be complemented/implemented by new personnel and internal teams with previous experience in Lean Manufacturing projects, combining the main triggers that may lead a company to embark on a Lean Manufacturing project (case studies with convincing arguments from an internal team) for a more effective and faster implementation of many process improvement activities; thus, enhancing the usage and implementation of Lean Manufacturing as a standard for process improvement among members of WCMA.

3. Those companies that were aware of Lean Manufacturing (but not implementing it yet) could be described as aiming mainly at improvements in cost reduction and customer satisfaction. Many of the activities that these companies are pursuing correspond to a full implementation of Lean Manufacturing. These companies still have room for process improvement by implementing some other Lean Manufacturing tools and activities. For them, a full Lean Manufacturing implementation may seem the next logical step in process improvement and achievement of cost savings.
4. Given the dependency encountered between cost reduction and customer satisfaction activities, with the benefits obtained from Lean Manufacturing implementation such as resource savings, improvement in service quality, on-time delivery, manufacturing flexibility/agility, product development/time to market, and reduction in manufacturing lead time/cycle time; it is likely that Lean Manufacturing could offer these companies several competitive advantages, when having a full Lean Manufacturing implementation. These are similar competitive advantages that Schuler and Buehlmann (2003) report will help the wood industry to become more competitive in the global market. Many companies are already having several process improvement activities in place, in order to increase customer satisfaction and cost reduction. The implementation of some other Lean Manufacturing tools may further enhance the improvements pursued by these companies.
5. In order to encourage the wood industry to implement process improvement tools from Lean Manufacturing, examples and/or case studies should be promoted, since they seemed to be the principal triggers that have supported a Lean Manufacturing implementation. In addition, institutions such as the Lean Enterprise Institute, the Society for Manufacturing Engineers, the institute of Industrial Engineers, as well as universities and research institutes, etc, should be promoted as a resource to initiate Lean Manufacturing, since little information was found showing previous collaboration between institutions and promoters of Lean Manufacturing, and the wood industry (contrary to the case of other industries, such as automotive and aerospace industries).
6. This research also showed that companies from this sample have hard work to do in making their people believe in all the benefits that Lean Manufacturing can bring to them and that there exist better ways in which to perform the manufacturing activities in the secondary wood industry, which will bring a competitive advantage to them. Since the triggers that most Wood Companies from WCMA have followed to embark on Lean Manufacturing were Case Studies, training/course, and convincing argument



from internal teams, a combination of all or some of these triggers may enhance the likelihood of companies to implement Lean Manufacturing or some of its process improvement tools, and increase the potential of a successful implementation of a Lean Manufacturing project.

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