Development of a Tool to Measure the Effectiveness of Kaizen Events within the Wood Products Industry

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Thesis submitted to the faculty of the Virginia Polytechnic Institute and State University in partial fulfillment of the requirements for the degree of

Master of Science

In

Forest Products

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August 12, 2015

Blacksburg, VA

Keywords: Kaizen, Continuous Improvement, Wood Products Industry, Survey Research

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ABSTRACT

Kaizen implementation and other continuous improvement practices can be used by companies to lower manufacturing costs and increase product value. Kaizen activities are one way that wood products companies can increase their competitiveness. Being able to measure the effectiveness of Kaizen events is important to factors that contribute to Kaizen's effectiveness as well as identifying the success of Kaizen implementation. However, little research has focused on the implementation of Kaizen and other continuous improvement methods within the wood products industry or on the perceptions of employees within this industry regarding either the motivators for, barriers to, and effectiveness of perceptions of Kaizen, or the drivers affecting Kaizen implementation. The goal of this research is to develop a tool to measure the effectiveness of Kaizen and to apply this tool to companies within the wood products industry.

To accomplish this research goal, a case study approach was used in examining how two U.S. wood products companies implemented Kaizen and other continuous improvement initiatives and how employees at these companies viewed such implementation. As part of this case study, interviews were conducted with staff in each company and surveys were administered to production and non-production employees at each company. A tool was developed to measure the perceived effectiveness of Kaizen events, and this tool was tested using the survey data were collected from each company.

The results from these analyses show statistically significant differences in how production employees across companies viewed the following: motivators related to cost and quality

outcomes, as well as the success of other companies, as motivators for Kaizen; and barriers related to middle management, time, money, technology, and poor past experiences. Poor past experience with Kaizen were also viewed significantly differently by production and non-production employees in one of the companies studied. The results also show that perceptions of productivity improvements were the most significant predictor of the perceived effectiveness of Kaizen implementation. These results and the development of a tool to measure Kaizen will help guide and improve future Kaizen and other continuous improvement efforts within the wood products industry and provide insights for future research.

ACKNOWLEGEMETS

I would like to thank my advisors, Dr. Henry Quesada and Dr. Brian Bond, for all of their continued guidance, support, and assistance both in relation to and beyond my academic work. I would also like to thank Dr. Earl Kline for his helpful advice and support as my committee member. Finally, I would like to thank those wood products industry employees who graciously offered their time for me to interview and survey them.

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Introduction

I. Research motivation

Kaizen implementation as a tool for sustainable continuous improvement is a challenge, not only for global industries, but also for the wood products industry in the United States. Kaizen is a continuous improvement strategy that requires sustained involvement of both management and production employees working together in order to meet customer needs. Outcomes of Kaizen, and continuous improvement more generally, include improved quality, to manufacturing and product costs, and improved product delivery. Such outcomes help companies to increase their competitiveness. To improve company performance it is important to identify motivations for implementing Kaizen, as well as barriers to implementation that may reduce companies' competitiveness. Once Kaizen is implemented (in what is known as a "Kaizen event") it is necessary to be able to measure the effectiveness of the Kaizen event to improve future efforts.

This research was conducted to reveal the recent framework of Kaizen methods in the wood products industry and to develop a tool to measure the effectiveness of Kaizen events. Even though many different industries have adopted Kaizen practices, in addition to other sustainable improvement initiatives, there is a lack of research on the application of Kaizen methods within the wood products industry. In this research, a case study approach was used to show how and why Kaizen has been implemented by wood products companies and to develop and apply a research tool to measure the effectiveness of Kaizen events.

II. Thesis structure

This thesis is ordered as follows: Chapter 1 (Literature Review) provides the literature review and theoretical framework that informs the continuous improvement themes discussed and the

research objectives developed for this study. It also identifies gaps in the available literature related to the use of Kaizen in the wood products industry. Chapter 2 (Research Goal and Objectives) discusses the main research purpose of this research study as well as the three objectives and hypotheses developed and proposed for this research. Chapter 3 (Methodology) outlines the methodology and statistical analyses used to test the research objectives that were developed for this research. Chapter 4 (Results and Discussion) describes the results of the statistical analyses and other research methods used on the information gathered from the surveys and interviews conducted. This chapter also relates the results to the research objectives and hypotheses proposed for this study and includes a discussion of how the results from this research provide original contributions to the existing scholarship on Kaizen and other continuous improvement initiatives within the wood products industry. This chapter also draws from the available literature to help inform the results obtained as part of this study. Chapter 5 (Limitations and Suggestions for Future Research) outlines ways in which this study is limited and provides suggestions for researchers to overcome these limitations in future studies. Finally, Chapter 6 (Conclusions and Guidance for Practitioners and Industry) concludes the body of this thesis by reviewing the main findings of this research and their implications for the study of Kaizen and other continuous improvement initiatives within the wood products industry. It also provides a tool for practitioners and those within the wood products industry to build from these findings and apply the research tool developed.

Chapter 1: Literature Review

1.1.Introduction and Definition of Kaizen Continuous Improvement

Manufacturing practices have been adapted into new principles to maintain the competitiveness within global industry. These new principles include Kaizen, just-in-time, lean thinking, six sigma, total quality management, and process improvement. The main target for using these new techniques is better meet customer needs by eliminating practices that do not add product value. Kaizen is the Japanese term ("Kai" meaning "change" and "Zen" meaning "good") used to define continuous improvement (Palmer, 2001). According to Terziovski and Sohal (2000, p. 540), "Kaizen means ongoing improvement involving everyone, including both managers and workers" with the underlying principle of serving customer needs. The authors cite improvements in product quality, cost, and delivery as main outcomes of Kaizen implementation. Palmer (2001) cites Kaizen implementation as a way to maintain low cost and less inventory, as well as a practice to reduce waste in processes and obtain continuous change in systems when compared to lean implementation. Unlike other traditional methods, Kaizen is a determined technique to achieve quality, functionality, and prices to sustain product competitiveness (Modarress, Ansari, and Lockwood, 2005). Kaizen also distinguishes itself from other continuous improvement practices by allowing for team members to implement changes and see the effects of their efforts (Farris et al., 2008), as well as encouraging active participation of company workers in industrial engineering and job design (Wood, 1989). The implementation of Kaizen metods and activities is sometimes referred to as a "Kaizen event" (Doolen et al., 2007). Figure 1 provides an illustration of some of the key features of Kaizen.

Figure 1

Key Features of Kaizen

Source: 5S today (2015)

Taiichi Ohno (1988) describes Kaizen as one of the pillars of the Lean Management System, as it follows the Plan-Do-Study-Act (PDSA). In the 1970s, Toyota was the first company to fully develop and implement Kaizen (Sheridan, 1997). As a result, Toyota increased production and competiveness by using small teams of members with different functional skill sets who worked together to meet project goals (Doolen et al., 2007). This was done under an accelerated timeframe and with the aim of improving a targeted work area. The main strategy when implementing Kaizen is working together within the company to achieve improvements with less capital investment. The goal for this principle can only be achieved if people are involved constantly, including their assistance in the organizational improvement (Soltero and Waldrip, 2002). The need for ongoing and active engagement of all members within an organization highlights Kaizen's commitment to continuous improvement principles.

1.2.Drivers of Kaizen

1.2.1. Teamwork and Cross-functional Teams

Using cross-functional teams of employees is a large driver of Kaizen initiatives. Cross-functional teams refer to the inclusion of employees with different job functions within the same small project team. Bessant, Caffyn, and Gallagher (2001), as well as Doolen et al. (2007), identify the importance of cross-functional problem solving teams in improving employee cooperation and goal-setting. Kaye and Anderson (1998) found that companies under-used cross-functional teams as a tool for Kaizen and continuous improvement. The use of such cross-functional teams was also included in the survey administered by Czabke (2007) as a measure of Kaizen implementation.

More generally, the topic of teamwork is discussed in the available literature on its own and in relation to other continuous improvement factors and Kaizen activities. For example, Devlin (2005) connects the factor played by effective teamwork with that of employee training by suggesting that initial training efforts for continuous implementation should include education aimed at increasing teamwork. When teamwork is lacking, it will limit continuous improvement (Kaye and Anderson, 1998). Kaye and Anderson (1998) cite the important role that managers can play in developing teamwork and addressing barriers to teamwork, such as personality conflicts. Similarly, Imai (1986) identified the importance of training supervisors in ways to effectively communicate with employees. Graban and Swartz (2012, p. 113) recommended that supervisors coach employees in Kaizen teams by questioning them “in order to think through the Kaizen [event] enough to implement it successfully.” In this way, team members are able to learn firsthand how to implement Kaizen so they can coach themselves and their teammates in the future (ibid.).

1.2.2. Quality Planning and Control

Effective implementation of Kaizen also requires quality planning and control strategies. Bessant et al. (2001) identify cause and effect diagrams, scatter diagrams, and Pareto analyses as tools to supplement continuous improvement initiatives. Meanwhile, Atkins (1994) notes the importance of "quality circles," and Das, Paul, and Swierczek (2008) identify the importance of collecting quality-related data on processes and costs.

Related to the Kaizen principle of involving employees from all levels of a company, the work of Das et al. (2008) highlights that quality planning and control efforts are best done when involving both management and lower-level employees. Das et al. (2008) concluded that it is important for top management to communicate quality plans to employees and involve employees in developing quality assurance plans.

1.2.3. Employee Awareness and Training

Within the consulted literature, Atkinson (1994) cites the importance of employee awareness of company goals and strategies for the successful implementation of continuous improvement. Meanwhile, case study research by Bessant et al. (2001) as well as Atkinson (1994) identified the distinction between the training of production employees versus managers. The findings of Yusof and Aspinwall (2000) show that trainings conducted on a small scale and on an as needed basis can hurt implementation and improvement efforts. This suggests the importance of conducting training on a regular basis. Van Aken et al. (2010) further detailed the importance of having an internal facilitator or another individual coach small Kaizen team members in the PDSA problem solving cycle, including how to effectively gather data needed to make informed decisions.

1.2.4. Productivity Improvement

One of the main aims of Kaizen is to improve business and worker productivity. Productivity can be measured in several ways. For example, Czabke (2007) identified cost savings as a measurement of productivity improvement when surveying wood products companies. Czabke's (2007) research also relates productivity improvement to a company's competitiveness, lead time, and labor productivity. In addition, Liker (1997) highlighted the importance of using the performance improvement measurements of percentage cut time and branding time when measuring productivity improvements. Improving on-time delivery of products is another measure of performance that can be used to evaluate the implementation of Kaizen (Gunasekaran, Patel, and McGaughey, 2004).

1.3.Continuous Improvement Initiatives Related to Kaizen

1.3.1. Lean Thinking

Lean thinking refers the overall production and management method that focuses on reducing waste in the timeline beginning when a customer places and order and ending when a product is sold (Schmitt, 2012). Dickson et al. (2009) similarly describe lean thinking as a philosophy and set of principles that can re-shape an organization and add value to an organization by reducing the irrelevant segments in production and other processes. Lean Production is relatively new among the other general manufacturing systems, such as agile manufacturing and flexible manufacturing, and generally refers to using less of everything, including labor, manufacturing space, tooling investment, and lead time. As a result, the system is designed to look for high quality, best timing, minimum cost, and constancy (Hunter, Bullard, and Steele, 2004).

The idea of lean thinking is based on eliminating or minimizing any kind of waste as much as possible in systems. However, for lean thinking to be effectively implemented all of an organization's members must work toward the idea of banishing waste using a variety of practices (Wood, 2004). In particular, lean thinking aims to reduce the following common types of waste that occur during the production process (Quesada and Buehlmann, 2011):

- **Overproduction:** producing more or a product than is needed, which must be addressed to avoid excess inventory and holding costs;
- **Waiting:** equipment or operators taking too much time and delaying progress;
- **Unnecessary transportation:** using more than an optimized rate of transportation might cause waste and also increase transportation costs;
- **Overprocessing or incorrect processing:** project orders should be well defined and accurate to implement in order to avoid wrong outputs. As a result of accumulated costs customers would be unsatisfied with the service;
- **Excess inventories:** excess inventories will cause most of other shortages, such as long waiting times, damaged products, and unnecessary transportation, which adds to holding and production costs;
- **Unnecessary movement:** employee-related movements that are not urgent or necessary for the process;
- **Defective products:** since it is a customer-oriented project, the products that are not improved towards customer demand will lead costs; and
- **Unused employee creativity:** not listening to employees will decrease the knowledge shared between people within the company.

Of the production issues discussed, the amount of inventory needed for the production process is an especially sensitive measurement. Lean inventory management is one possible solution

for the accumulation of inventory in the product line. Even though it looks like inventory waste could only cause more cost to the company, it is also an issue for the production lead times (Quesada, 2010).

Schmitt (2012) notes that while the term "lean" was first used in 1987 to describe the philosophy and principles aimed at reducing waste from the moment a product is demanded to the sale of the product, aspects of lean thinking have been used in various places for hundreds of years. However, the lean manufacturing as it is known today was developed into a comprehensive organizational philosophy by Toyota Manufacturing in the 1960s and 1970s (ibid.). Schmitt (2012) notes that by the 1960s Toyota began to use statistical process controls and the Plan-Do-Check-Act cycle for continuous improvement. Liker and Meier (2006) as well as Kocakülâh, Austill, and Schenk (2011) also note that lean thinking is derived from the philosophies, principles, and techniques underlying the Toyota Production Process. For example, Toyota popularized the term Muda, which is used to describe waste (Ohno, 1988). Toyota's executive, Taiichi Ohno, identified seven basic types of waste (Ohno, 1988), which were outlined by Quesada and Buehlmann (2011) and to which unused employee creativity was included as an eighth type of waste. Womack, Jones, and Roos (1991) differentiate Toyota's concept of lean from craft and mass forms of production by lean's streamlined approach.

After the visible success of Toyota's use of lean thinking, other companies put the principal of either "lean manufacturing" or "lean production" as lean thinking into their management process to become competitive among the global industries (Ray et al., 2005). Within U.S. industry, the General Motors (GM)-Freemont in California is known as the first attempt at implementing lean production. In 1983 "Toyota started a joint-venture with General Motors (GM) and formed the New United Motors Manufacturing (NUMMI) subsidiary to share the

Toyota Production System knowledge with competitors abroad" (Schmitt, 2012, p. 22). The plant obtained serious improvements in absenteeism and productivity by implementing lean production and team concepts (Howison, 2009; Schmitt, 2012). Moreover, it was envisioned in the 1990s that lean production would be standard manufacturing of the twenty first century (Rinehart, 1997).

Academic discussions of the Lean Production experience within the U.S. dates back to 1991 in the book *The Machine that Changed the World* by James Womack, Daniel Jones and Daniel Roos and in 1996 in *Lean Thinking* by Womack and Jones. In *Lean Thinking* the authors specified five principles important to the lean process of production or delivery:

- specify value,
- identify the value stream,
- organize the conditions for value to flow better through the stream,
- have the customer pull value from the stream, and
- pursue perfection.

Other authors, such as Holweg (2007), have stated that lean production has led to a rethinking of not only manufacturing operations but also service operations. Ahlstrom (2004) went further by claiming lean production as the key point to service companies since Ahlstrom suggested that lean thinking is more useful for service operations than for manufacturing. In addition, a research called "production-line approach to service" was conducted to find out how companies as diverse as Taco Bell, Southwest Airlines, and Shouldice Hospital can achieve reindustrialization by applying lean thinking (Bowen and Youngdahl, 1998). By adopting lean thinking, a variety of industries have benefited from lean production's principle of maintaining the demands of customers with high quality, low cost, and short delivery times (Liker 1997).

1.3.2. Lean Product Lifecycle Management (PLM)

Industries can have competitive advantage by producing new products faster than others in the market. This is the strategy that the Japanese auto industry maintains to be competitive among western auto industries, since the Japanese industry is capable of producing new products faster and with less effort (Clark et al., 1987). Hines, Francis, and Found (2006) have conducted a study to contribute to the concept of lean Product Lifecycle Management (PLM). The six distinct stages that should be accomplished in order to develop product lifecycle management are:

- understanding customer needs,
- value stream mapping,
- improved end to end technical process,
- improved end to end people process,
- develop the single project standard, and
- develop the complete process standard.

1.3.3. 5S

Often used in conjunction with Kaizen and lean thinking, the 5S system was developed in Japan after World War II as part of a country-wide push to improve quality efficiency (Becker, 2001). 5S is based on five Japanese terms that convey principles of industrial housekeeping. These Japanese terms and their English translations are: seiri (“sort”), seiton (“set in order” or “systematize or simplify”), seiso (“shine” or “sweep”), seikestu (“standardize or sanitize”), and shitsue (“sustain” or “self-discipline”) (Avari et al. 2011; Becker 2001; Chapman 2005).

The first stage of 5S, “sort”, focuses on getting rid of unneeded items to reduce confusion and clear space. This can be done by “red-flagging” items that are not in use and then deciding whether to move or discard these items, and by “green-flagging” items that are in-use (Gombrii and Solhkonan 2010, p. 14). The second stage of 5S, “set in order”, refers to the layout of a company’s production floor, which can be changed and labeled using tape (ibid.). The location of files, equipment, tools, and inventory should be clearly identifiable (Chapman 2005). The “shine” stage of 5S involves cleaning the production floor and providing instructions to clean machines (Avari et al. 2011; Becker 2001). The “standardize” stage of 5S includes setting up centralized stations with supplies and color coding tape and materials, creating a checklist of responsibilities and schedules (Chapman 2005), and drafting manuals for how to operate each machine (Avari et al. 2011). Finally, in the “sustain” stage of 5S management should actively follow up with the prior steps in the 5S system and make sure that workers throughout the company are informed and involved (Avarti et al. 2011). To sustain 5S, Chapman (2005, p. 31) recommends that management staff conduct regular audits of 5S principles and “post check sheets that clearly communicate what to clean and inspect, how to clean and inspect, who is responsible and the frequency of checks.”

Following these five principles creates a clean and well-ordered workplace in which supervisors are able to quickly identify when production is behind or if something is out of order (Chapman, 2005). Thoroughly implementing 5S principles is important because a “lack of a robust 5S system makes other lean tools ineffective” (Chapman, 2005, p. 27). As 5S is often used with Kaizen, having a strong and active 5S program also will increase the effectiveness of other continuous improvement initiatives. The application of TQM within the wood products industry has also been studied to a limited extent (Wagner and Hansen, 2005).

Some initial research has been conducted on 5S within the wood products industry. Czabake's (2007) case studies of two wood products companies showed that both companies used 5S strategies to improve safety and quality. One of these companies used 5S to create a "very transparent and visual facility" by posting information boards that were regularly updated to show performance measures and production data (ibid., p. 24). This communicated to all workers whether production was on schedule. In their case study of a Bolivian wood products company, Avarti et al. (2011) concluded that a company with a messy and unorganized production floor could best be improved by implementing 5S principles. Choosing to conduct a survey instead of case study for his research, Fricke (2010) found that wood products companies in Virginia had low levels of implementation of 5S and other continuous improvement practices.

1.3.4. Total Quality Management (TQM)

There has been disagreement over the definition of what Total Quality Management (TQM) really is, since there are other similar methods such as total quality control, total quality improvement, and strategic quality management. TQM can be described as the management philosophy that combines the following goals: customer focus, continuous improvement, process orientation, everybody's commitment, fast response, and result orientation (Hellsten and Klefsjö, 2000). The main idea in TQM rises from the need for quality in every single item during the manufacturing process. Therefore, customer expectations are an important motivation to determine targeted quality. This is a principle that must be entirely adopted by the whole organization, so that employees are dedicated to achieve excellence (Beaver, 1994).

Companies had already been assessing the quality of their products in some way, but quality assessment started to become a serious concern in the mid-1980s. Before then, statistical quality

control measures were used to predict product shortages. TQM has been implemented in fields other than production industries, such as service industries, government, and business schools (Waldman, 1995). Hansen and Smith (1997) included questions on TQM in their survey administered to Oregon and Virginia wood products companies, and Prajogo (2005) included companies within the wood products industry when comparing the use of TQM in various manufacturing versus service sector industries. Czabke, Hansen, and Doolen's (2008) case study of U.S. and German wood products companies also questioned the companies about their use of TQM.

1.3.5. Six Sigma and Pareto Analysis

Six Sigma is the business process that allows companies to maximize customer satisfaction and minimize waste, especially with inventory, by redesigning their system. Motorola Corporation founded Six Sigma in the 1980s to improve quality assurance when handling complex products that have different components (Arnheiter and Maleyeff, 2005). The goal is to get rid of mistakes when possible without categorizing them into small or big problems. The optimum solution for reducing mistakes is possible by enabling the whole process to not allow errors or defects at the first place (Harry and Schroeder, 2005).

The name Six Sigma refers to a process that produces a product that has a variability of six sample standard deviations within the customer's specification limits. These six standard deviations result in a manufacture defective product rate of 3.4 parts-per-million (Ingle and Roe, 2001). Lowering defect rates supports Six Sigma's ultimate goal of eliminating waste in areas that do not improve value for consumers (Pyzdek, 2003). Figure 2 shows how Six Sigma uses the limit of six standard deviations to determine this defective rate limit.

Figure 2

Six Sigma's Calculation of Defective Product Rates

Source: Incito Consulting Group (2014)

The process of Six Sigma has been described by researchers using the acronym DMAIC (Ranawat et al., 2007), which stands for Define-Measure-Analyze-Improve-Control. These terms refer to a company's ability to define the goals for improvement, measure the current system, analyze the current system, improve system operations, and control the new and improved system. These processes are then repeated in an ongoing cycle to eliminate waste and improve product quality. It is this ongoing nature of Six Sigma that has led to Six Sigma's inclusion in discussions of other continuous improvement strategies.

Currently the wood products industry lags behind nearly all other industries in its use of Six Sigma (Zhang et al., 2012). Hubbard (2008) attributes the lag in the wood product industry's use of Six Sigma to the raw material inputs required of Six Sigma, as well as barriers related to lack of awareness and a fear of investment. However, Kucerova and Paulova (2011) note that Six Sigma can help wood products companies become more competitive in the global marketplace by focusing on customer needs, production processes, and staff.

Statistical Process Control (SPC) is a tool used by the Six Sigma process to incorporate continuous statistical analyses during production in order to improve quality. Young and Winistorfer (1999, p. 11) define SPC as using statistics "to achieve and maintain control of process and production within a repetitive manufacturing process." In addition, Srinivasu, Reddy, and Rikkula, (2009, p. 15) note that SPC aims to "control quality characteristics on the methods, machine, products, [and] equipment both for the company and operators." Wood products companies began to use SPC practices in the 1980s as a way to address quality concerns after a renewed focus on quality by American consumers (Young and Winistorfer, 1999).

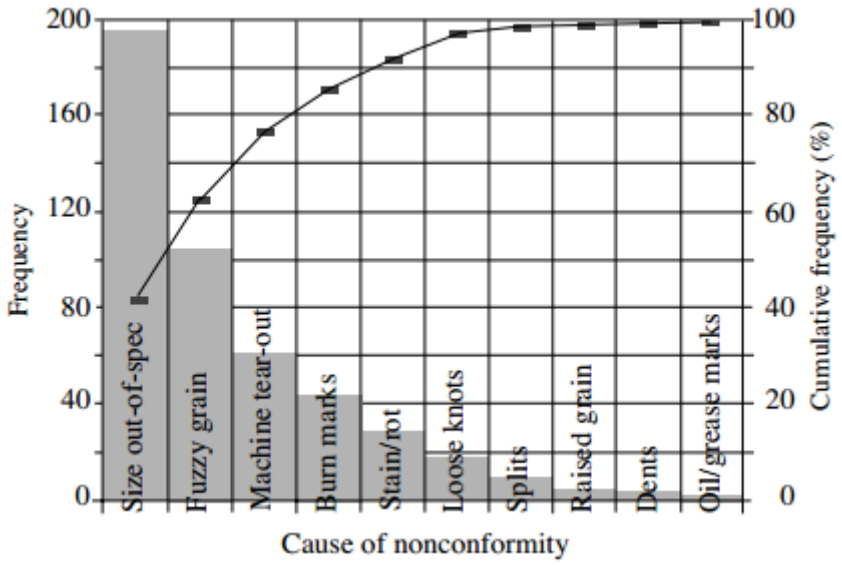
Quality control charts are used as part of SPC in order to identify and minimize variation during production. When the production process is out of control, the sources of variation need to be identified and eliminated. These systematic issues could arise from issues with raw materials, equipment, or operating procedures (Srinivasu et al., 2009; Young and Winistorfer, 1999). Only random variations are allowed as a result of the natural variation of the process.

Another tool frequently used by the Six Sigma process to minimize product variability, although it can be used with any continuous improvement initiative, is Pareto analysis (Leavengood and Reeb, 2002; Young and Winistorfer, 1999). Pareto analyses are based on the principle that approximately 80 percent of problems are caused by 20 percent of the possible causes (ibid.). Therefore, SPC and Pareto analyses can help prioritize quality problems for a company to address and to focus on the "vital few" problems instead of the "trivial many" (Leavengood and Reeb, 2002, p. 2). In order to adopt Pareto analysis companies should develop a standardized and defined list of criteria to identify what can be identified as a "nonconformity" (Leavengood

and Reeb, 2002). Once company staff have collected data on a number of nonconformity issues, Pareto analysis requires that the frequency of these issues is charted for each category of nonconformity after sorting nonconformities from highest to lowest frequency and determining the relative frequency for each category (Leavengood and Reeb, 2002). Figure 3 provides an example of what one of these charts may look like.

Figure 3

Sample Pareto Analysis Chart Identifying Wood Products Nonconformities



Leavengood and Reeb (2002)

1.3.6. The Toyota Production System (TPS) and Just-in-Time (JIT)

What has been considered a traditional or cultural Japanese concept of work was adapted to the Toyota Production System, which is different from what was in place at the time in European and American countries. The Japanese trends behind the Toyota Production System include (Sugimori et al., 1977):

- Group adaptation,
- Sense of equality,
- Desire to improve,

- High degree of ability resulting from higher education,
- Centering their daily living around work,
- Life time employment system,
- Labor unions by companies,
- Little discrimination between blue and white-collar staff, and
- Chances available to workers for promotion.

Even though the Toyota Production System is involved in manufacturing companies such as GM, Ford, and Chrysler, there is a gap between the manufacturers' attempts to use Toyota Production practices and the of Toyota Production System itself. The problem is that application of the Toyota Production System requires specific principles to be able to maintain flexibility and creativity (Spear and Bowen, 1999).

One of the pillars supporting the Toyota Production System is the use of Just-in-Time (JIT) philosophy and practices (Schmitt, 2012). JIT can be summarized as "the production of only what is needed, when it is needed, and at the exact quantity demanded" (ibid., p. 25). While JIT was first used extensively in Japan by Toyota, the JIT approach to manufacturing is spreading throughout western industries, although it is more likely a philosophy rather than a technique, which aims to reduce the costs among all processes by as much as possible until the last moment (Sohal, Keller, and Fouad, 1989). Application of JIT manufacturing into organizations requires different supplies and factors, such as company-wide commitment, proper materials at the right time, supplier relationships, quality, and personnel. Although the JIT system tends to be used with fewer risks, it is hard to predict the fluctuations in inventory costs and also with a company's reorganization with JIT (Swanson and Lankford, 1998).

Researchers Sakakibara et al. (1997) point out the importance of JIT as a principle of overall organization by supporting the model that contributes JIT concept with infrastructure. According to their study, the findings are: (a) in contrast to the idea that there is not an inevitable relationship between the use of JIT practices and manufacturing performance, there is a certain relationship between JIT practices and infrastructure, (b) the combined usage of JIT practices and infrastructure is more related with manufacturing performance, and (c) manufacturing performance is the key to gain competitive advantage.

1.3.7. Agile Manufacturing

Goldman, Nagel, and Preiss (1995) state that agility allows manufacturing to deliver value to the customer, maintain needed change, develop human knowledge and skills, and, as opposed to lean manufacturing, have virtual partnerships. On the other hand, Jin-Hai, Anderson, and Harrison (2003) define the four fundamentals for agile manufacturing as benefit for each partner (manufacturers, suppliers, customers), success in incorporation (recourses, methods, technologies, departments or organizations), better information technology (IT) motivation, and core competence.

1.4.Application within the Wood Products Industry

1.4.1. Problem

There has been a decrease in U.S. exports to China, Canada, Taiwan, and Indonesia in the wood household furniture industry during the past decade (Schuler and Buehlmann, 2003). This has reduced the market share and earnings of U.S. companies. The main issue behind the decrease in exports is the variability of industry items such as kitchen cabinets, upholstered furniture, and wood office furniture. Therefore, benchmarking activities are practiced to have the basis for comparing the United States wood furniture industry with more successful industries (ibid.).

Another issue applies to rough mill, which takes part in the manufacturing of secondary wood products such as wood furniture, cabinets, flooring, turnings, mouldings, and millwork. Thus, manufacturing flexibility in the rough mill is affected by uncertainty on order-to-delivery lead times, which depends on customer demand (Cumbo, Kline, and Bumgardner, 2006).

Key issues in the wood products industry that are forcing companies to apply continuous improvement practices, which include lean thinking and Kaizen methods, are (Brashaw and McCoy, 2007):

- **Speed in the practices of new technology:** Manufacturing systems such as mass production and agile manufacturing have been implemented over years. On the other hand, Kaizen is relatively new and even less implemented within the wood products industry. Therefore, it takes time to adopt the new technology into organizations and to improve employees' performance.

- **Imported manufactured products:** Continuous improvement practices, including Kaizen, are targeted on considering costumer demand to provide specific products. Thus, imported products cause the problem that they cannot fulfill the customer needs and demand becomes hard to predict.

- **Elimination of resources:** Reducing waste is the key point to have better Kaizen implementation results. If there are too many items to minimize, it will be difficult to disregard unnecessary items since every department can affect each other. For instance, even though stocking products might help to provide enough supply for the demand, there will be higher holding costs.

- **High fuel costs:** As mentioned previously, avoiding the transportation of unnecessary goods and parts can prevent higher costs. However, companies still need to reach their suppliers and need to export products. As a result, transportation will be expensive with high fuel costs.

- **Lack of innovation:** Competitive advantage is strongly related to the progress in innovation for companies. Constant innovation is better than any other practice to meet customers' rapid change in demand. Specifically for the wood products industry, there are three different types of innovative levels: product, process, and business systems, which make it difficult to pursue innovation gradually (Wagner and Hansen, 2005).

- **Environmental related issues:** For U.S. wood products companies, it is becoming necessary to change their environmental image because of environmental group activities that increase the environmental awareness of customers. Therefore, environmental certification attempts would be very helpful in addressing customers' environmental concerns (Vlosky et al., 1999).

- **Raw material costs:** Other than government regulations, U.S. Manufacturers have been experiencing difficulties in raw material supplies, which is mainly because of grade degradation and increasing prices. It is reported that Washington State's secondary wood products industry is most concerned about raw material supply and high raw material costs (Hoff et al., 1997).

One of the valid strategies to address these problems is to implement Kaizen methods as part of a company's continuous improvement initiatives. According to Brashaw and McCoy (2007),

continuous improvement is a business system working with change and maintaining improvement for each step of production. To be able to gain continuous improvement, Kaizen and related strategy methods include:

- improvement of long-term and clear thinking,
- selection of appropriate process which is ending with accurate results,
- an increase of value in the organization by developing people and suppliers, and
- the finding of solutions to help provide corporate learning.

As a result of these activities a company can achieve more employee involvement with the ultimate goal of increasing profits and competitiveness (Brashaw and McCoy, 2007). A case study conducted of the Australian Organizations shows the improved outputs, which are related to the importance of integrated lean organization (Sohal and Egglestone, 1994). According to the study, employee involvement—a key factor of Kaizen—is one of the most important drivers of continuous improvement and business improvements.

1.4.2. Studies on the Implementation of Kaizen and Other Continuous Improvement Practices

As part of this research a review of recent scholarship was conducted to investigate the questions and approaches of Kaizen and other continuous improvement practices. One particular study by Velarde et al. (2011) asked industry and support organizations 15 questions related to location, type of industry, company size, job position of the respondent, awareness of continuous improvement strategies and the level of implementation of such strategies. Survey respondents were from industry, consultants, and faculty members. According to pre-test results, reviewed questions were sent through emails. Of the total 2,295 surveys sent out, 179 respondents (for a 7.8% response rate) submitted answers from across the U.S. South Atlantic

Region. A total of 66% of the respondents were presidents, CEOs, owners, vice presidents, directors or GMs, and 60% of the respondents indicated their industry was in the cabinets, residential furniture, or mill working and moulding business. The results of the survey administered by Veralde et al. (2011) indicated that secondary wood products companies in view lean manufacturing as an excellent philosophy to improve competitiveness. While Veralde et al. (2011) found low levels of lean implementation at time of their study, their survey results showed that there is great implementation potential for lean thinking and other continuous improvement practices within the U.S. wood products industry.

Shah and Ward (2003) used survey data from *IndustryWeek*'s Census of Manufacturers to analyze the three organizational patterns of unionization, plant age, and plant size, which might affect the implementation of lean manufacturing. The authors provide evidence of the influence that differences among these patterns can cause. For instance, U.S. manufacturers practiced JIT more often than small manufacturers. Similarly, a survey among Virginia's wood products and furniture manufacturing industries found that lean awareness and implementation status were lower with small companies compared to larger companies (Fricke, 2010).

A company's suppliers is another important factor that contributes to the success of Kaizen and other continuous improvement initiatives. A study conducted on small- and medium-sized Indian companies gave results regarding four types of supplier issues: supplier management strategy, information sharing with supplier, supplier integration, and capability to deal with uncertainty (Sharma et al., 2011).

To have a better understanding of the awareness and implementation of the Kaizen process, a research study was conducted on less successful Kaizen events to examine both the

effectiveness and sustainability of Kaizen (Farris et al., 2008). Farris et al. (2008) highlighted management's unclear communication of Kaizen event goals, lack of communicating the motivations behind these goals, and a top-down communication style as factors that limited the implementation of Kaizen.

In addition, TQM implementation was considered a solid success for many companies. However, there is a gap between how TQM has functioned in practice and its research standing, meaning there is not yet enough adequate research study on this topic. Forza and Filippini, (1998) conducted a case study to find out the reliability of using TQM practices from the aspect of quality conformity and customer satisfaction. Unlike the knowledge gathered from a literature review, the study found out that it is better to reduce human resources towards the process of quality improvement and make the process more system-oriented (Forza and Filippini, 1998).

1.4.3. Outcomes of Continuous Improvement Implementation Studies

Many studies of the implementation of Kaizen and other continuous improvement practices, including lean thinking and TQM, cite improvements for companies. However, the literature remains divided regarding outcomes of such implementation.

The U.S. secondary wood industry has been competing in a more global marketplace resulting in a decreasing market share. It is believed that U.S. secondary wood products companies will continue to lose money and customers through 2010-2011 (Velarde et al., 2011). The challenges this market is facing have developed over the last two decades. Therefore, secondary wood products companies have had to reorganize in order to regain market share and continue to stay in business (ibid.). Implementation of continuous improvement practices could be a method for

increasing the secondary wood industry's competitiveness, as supported by the study of Velarde et al. (2011) regarding secondary wood products companies in the U.S. South Atlantic Region.

Northway Industries is a good example of a successful implementation of continuous improvement practices. Northway's Middleburg, PA plant has arranged manufacturing services using precision-machined components and finished goods to the residential furniture, office furniture, health care and kitchen cabinet industries (Koenig, 2008). Within their 93,000-square-foot manufacturing area, Northway Industries has used the following methods to improve performance:

- being an adopter of lean manufacturing and investing in new technology. Since the company improves equipment, they are able to make fast and better service for customers;
- using sustainable initiatives to save resources and decrease costs, with the installation of a biomass system; and
- tailoring services for customers ordering commercial casework. For example, a customer can order standard cabinet and closet configurations with options for hardware, color, door and drawer fronts, light rails, and kicks.

It is also relevant to know that U.S. and German wood and wood-based industries needed new management approaches to upgrade their competitiveness in the global marketplace. The results of the study conducted by Czabke et al. (2008) on two companies within the U.S. and German industries showed that a Kaizen mindset coupled with lean thinking manufacturing practices and principles made current operations more essential and cost-effective. Moreover, the authors found that lean thinking is also a tool for better customer service, new product development

processes, and customer satisfaction. However, companies' problems with communication seemed to be the main limitations to their lean implementation efforts.

While the previously discussed studies highlight the benefits of Kaizen and continuous improvement, according to the survey applied to Wood Component Manufacturing Association (WCMA) members, almost one third of the organization's companies are aware of continuous improvement practices but have not implemented them. A large number of these companies are mainly interesting in making improvements in cost reduction (Pirraglia, Saloni, and Van Dyk, 2009). In addition, research studies show that large organizational factors may enable or inhibit the implementation of lean practices (Shah and Ward, 2003). For example, Farris et al. (2008) found that an organization's communication strategy can inhibit implementation of continuous improvement practices. White, Pearson, and Wilson (1999) reviewed the available literature on the implementation of lean production and concluded that there are not enough published sources on this topic to draw a strong conclusion on implementation outcomes.

1.5.Implementation Issues

1.5.1. Barriers to Kaizen and Continuous Improvement

Pirraglia et al. (2009) surveyed wood products companies and identified several barriers to implementing continuous improvement initiatives. These barriers include employee and/or middle management resistance, lack of implementation expertise, lack of time, lack of labor resources, lack of capital funds, no sense of urgency, and failure of past continuous improvement projects. Kaye and Anderson (1998) similarly cite employee and managerial resistance as obstacles to implementation. As noted collaboration between employees and management is an important part of Kaizen.

Madrigal-Sanchez and Quesada Pineda's (2012, p. 910) case study of innovation across wood, energy, and medical companies noted that the wood products company studied had no "standardized steps to follow up and start the innovation process" after ideas are received from customers or employees. As a result, the authors concluded that innovation was "more the result of random situation instead of a planned strategy embedded in business growth" (ibid.). Employees may view this lack of planning and the lack of a formal ability to include employees' ideas as barriers to implementing and sustaining continuous initiatives.

In their longitudinal study of continuous improvement implementation, Quesada-Pineda and Madrigal (2013) found that wood products company employees negatively perceived interruptions of continuous improvement activities. Perceiving these interruptions as barriers to continuous improvement implementation may hurt efforts to sustain continuous improvement efforts if management does not effectively communicate changes to production level employees and if production level employees do not embrace such changes.

Additional barriers to implementing Kaizen are outlined by Liker and Meier (2006) in *The Toyota Way Fieldbook*. The authors note that some industry professionals perceive Kaizen events too fast-paced and narrow in focus, which they view as taking away from a company's broader vision. If there is no ownership of the Kaizen event process and tasks, then follow up tasks are less likely to be done. This could create perceived barriers to future Kaizen events. The authors cite other barriers to Kaizen events related to being able to sustain Kaizen, including the barriers of not affecting cultural change and going back to traditional work practices. These findings suggest that if Kaizen events are not incorporated into a larger vision and culture of continuous improvement, and if company officials do not follow up on and

sustain Kaizen, then managers and production employees will be more likely to perceive barriers to implementing Kaizen,

Within the wood products industry, a nationwide mail survey of secondary wood products manufacturers was conducted by Smith et al. (2004). In this study, 83% of respondents indicated that their rough mill had not successfully implemented continuous improvement practices. The main causes cited were:

- inflexible machinery,
- forecasting paradigm,
- too much focus on yield and not enough on demand,
- performance measurement constraints,
- long changeover times,
- inability to control production "off fall" or residues, and
- variability of demand.

1.5.2. Motivators for Kaizen and Continuous Improvement

Several studies in the reviewed literature identify factors that contribute to companies' desires to implement Kaizen methods and other continuous improvement practices. For example, Schuler and Buehlmann (2003) studied how companies look to successful competitor companies and may wish to attempt similar continuous improvement processes. Czabke (2007) and Pirraglia et al. (2009 also highlight the importance of training sessions and trade conferences in affecting companies' decisions to implement Kaizen activities.

Kaye and Anderson (1998) identify leadership from company management an essential motivating factor for the implementation of continuous improvement initiatives. As company

management are also often in control over their company's business goals, a critical part of the implementation process of lean projects is the alignment of the continuous improvement project with the company's strategic goals (Bernett and Nentl, 2010). Having clear company goals in support of the themes promoted by Kaizen and other continuous improvement practices may therefore motivate companies to adopt such practices.

In the analysis of survey data conducted by Smith et al. (2004), "cost reduction" was shown to be a main motivator lean continuous improvement practices. Other important motivators identified by Smith et al. (2004) include a desire to remain competitive, changes in customer demand, desire for reduced lead times, and desire for increased flexibility. In addition, respondents were asked to determine the key achievements of implementing continuous improvement practices. Even though the answers varied, most of them stated "100% buy-in throughout the organization". While this study focused on lean thinking, this focus on agreement throughout the organization is very much a Kaizen concept.

Desires to improve quality (Farris et al., 2008) and sales (Czbake, 2007), as well as the ability to better meet customer demands (Smith et al., 2004) have also been cited as motivating factors for companies when implementing continuous improvement initiatives such as Kaizen. Additional improvements cited as resulting from incorporating a Kaizen-oriented mindset and implementing lean practices include (Cumbo et al., 2006):

- decreased inventory levels,
- shortened lead times and minimized set-up/changeover times,
- the ability to produce what is needed when it is needed,
- 100% on time shipments,
- continuous flow,

- use of lean-based performance measurements, and
- culture change.

In their analysis of Toyota's manufacturing strategies, Liker and Meier (2006) summarize several positive aspect of Kaizen events that can act as motivators to future Kaizen implementation. These potential motivators include Kaizen's ability to be used "as a great tool for implementing aspects of an overall value stream vision", freeing resources to get results in faster time than usual, and teaching employees knew skills (Liker and Meier, 2006, p. 397).

1.6.Review of applicable survey and statistical research methods

1.6.1. Interviews and case studies

Often when studying a topic in their discipline, researchers will conduct case studies of companies or other organizations and conduct in-person interviews with individuals in those organizations. There are several examples of case studies of wood products companies in which researchers interviewed employees to get a deeper understanding of a company's practices and culture. Examples include the research of Farris et al. (2008), Espinoza, Bond, and Kline (2008), Czabke (2007), and Czabke et al. (2008). There are several benefits to conducting interviews as a way to gather information. In-person interviews require less effort for respondents than questionnaires that require written answers, and in-person interviews allow more flexibility in gathering information (Synodinos, 2003).

However, there are also some disadvantages to in-person interviews. One possible issue with interviews is that the presence of an in-person interviewer increases the likelihood that respondents feel pressured to respond to questions in the way they believe the interviewer wants (Synodinos, 2003; Williams, 2003). Williams (2003) also notes that conducting in-person

interviews is more time consuming and expensive than other research methods. This limits the number of people that can be interviewed and the number of organizations that can be examined.

1.6.2. Survey development

Surveys are another very common tool used to collect data from individuals and have been used across disciplines and topic areas, including the study of including continuous improvement in the wood products industry. There are several factors that researchers must consider when planning to administer a survey.

a) Survey and question design

First, it is vital to decide the design and method of the questionnaire since this will affect the response rate and how effective the survey results can be (Williams, 2003). By searching other questionnaires that have been done on the same topic, ideas for survey design will become clearer and save time when deciding upon the questions that will best gather the information for the purpose of the survey (Kitchenham and Pfleeger, 2002). For example, survey research on continuous improvement practices has been conducted within the wood products industry by Cumbo et al. (2006), Fricke (2010), Kozak and Maness (2003), Pirraglia et al. (2009), Ray et al. (2005), Smith et al. (2004), and Velarde et al. (2011).

When designing a survey questionnaire, the order in which questions are asked is important. Both Williams (2003) and Synodinos (2003) state that surveys are most effective if they begin with general questions and move to more specific questions. Similarly, Williams (2003) notes that beginning surveys with non-personal questions could relax respondents so that they are more open to answering later questions.

Researchers also must decide whether and when to ask open-ended versus closed questions. Open-ended questions are useful for identifying a wider range of range responses and are useful when no previous data exist (Williams, 2003). However, it takes respondents longer to complete open-ended responses, and it is also more difficult and takes longer for researchers to code responses to open-ended questions for additional analysis (ibid.). In contrast, in closed questions a respondent must select from the possible answers provided to them. Closed questions are easier for researchers to code and analyze but provide less detailed information than open-ended questions.

Likert scale questions are one type of closed question frequently used in survey research. Likert's (1932) method for questionnaires provides a wider range of response options to survey participants. In this method there are four types of questions: yes-no, multiple choice, statements answered by degrees of approval, and a series of short narratives to be approved or disapproved in various degrees. Allowing this range of responses often results in more accurate survey data that can still be easily coded and analyzed. In recent research Likert questions often make respondents select from listed choices ranked in a numeric six-point scale (five-point if excluding the option of "not applicable") that corresponds to responses of "strongly agree" to "strongly disagree" (Santos, 1999). If there are several Likert-scale questions that ask about a related topic, the ordinal responses can be combined into an "index" that relates to a specific construct or idea (Brayfield and Rothe, 1951; John and Reve, 1982; Santos, 1999).

Each of the many types of questionnaires has its advantages and disadvantages, but researchers should consider these against the available resources they have and the quality of data they are likely to gather from each type of questionnaire (Meadows, 2003). However, for every type of

questionnaire it is important to word a question effectively in order to get high quality survey data. Williamson (2003) outlines several techniques for improving the effectiveness of surveys in order for questions to be easily understood by respondents. These include using simple language, not using jargon (overly technical language), not using unclear questions, not asking two different things in the same question (also known as "double-barreled" questions). Following these techniques in wording questions will help ensure that the responses gathered are accurate and useful for the researcher.

b) Sample size

Both before administering a survey and after survey data are gathered researchers should consider the effects that the survey sample size has on the quality of their results. In order for survey results to be generalized, researchers need to obtain a large enough number of responses to ensure that they can accurately apply their results beyond the survey sample population (Green and Stutzman, 1986). In addition, larger sample sizes allow for more accuracy in generating p-values for various statistical tests, such as the chi-square test (Berkson, 1938). This is another reason why researchers must consider what sample size they will need to conduct their analyses.

1.6.3. Analyzing survey response data

a) Distribution and variance of responses

For a better interpretation of the data it is important to examine the distribution of survey responses, which highlights the need for accurately estimating sampling variances. Some of the techniques for analyzing variances are jackknife (which methodically leaves out each observation from the dataset, calculates the estimate, and then averages these estimates), balance repeated replication (balanced half-samples), and bootstrap (Rust and Rao, 1996).

Likert scales fall within the ordinal level of measurements. In analyzing the Likert scales, distributions of ordinal data (ranked in with numbers that have no significance beyond establishing a ranking order for preferences) can be shown with bar charts, point plots of assessments, and box and whisker plots. For ordinal data, some researchers suggest that the median or mode values should be analyzed as the measure of central tendency (Jamieson, 2004).

b) Correlation and reliability

After examining the distribution of survey data, researchers will often examine how correlated different responses or respondent characteristics are. For example, Morgan and Sonquist (1963) note that when trying to examine a dependent variable such as income, it is important to understand the correlations between a person's age and education. Correlation is also important because it relates to the survey data's reliability. If survey data are not reliable, it means that if respondents were asked the same questions again they may answer differently than before.

To examine correlation between responses and reliability, researchers can use the Cronbach's alpha test statistic. Cronbach's alpha is a measure of internal consistency for survey data (Perry, 1996; Santos, 1999), and it is especially useful when index variables are created from summated scales, such as Likert scales (Santos, 1999). Reliability and consistency are important with index variables because for the index variable to be a meaningful measure of the same idea, also known as a construct, then the questions that make up the index variable should have little variation. Cronbach's alpha coefficients range in value from 0 to 1 to describe the reliability of factors taken from multi-point formatted questionnaires or scales, with higher values indicating a more reliable index variable (ibid.).

In addition, when survey responses are combined to create an index variable it is important not

only important to check that the responses are correlated with each other, it is also important to consider whether correlated responses within an index variable affect the dependent variable in opposite directions (Morgan and Sonquist, 1963). If questions within the index variable are correlated but work in opposite ways, then the effects may cancel each other out so that the index variable as a whole is not correlated with the dependent variable.

c) Comparing responses from independent groups

When it comes to comparing independent groups of items, researchers use a variety of tests to analyze survey data. These tests include the Wilcoxon–Mann–Whitney test, U-test, and the chi-square test (Svensson, 2001). The goal for these tests is to determine whether responses between groups of items can be said to be different with a high degree of statistical confidence. The results from such tests indicate the probability that variation between the independent groups of items is due to random chance.

The chi-square test is perhaps the most common of these tests. For the chi-square test to be effective, the survey data must come from a randomly sampled, normally distributed population (Berkson, 1938). The test generates a p-value that represents the probability of observing a sample value as the true value of the test statistic (Stat Trek, n.d.). If the p-value meets the level of significance set by the researcher, then it can be said that the responses between two groups, such as male versus female respondents, are not independent (ibid.).

d) Regression analyses

As stated by Williams (2003), multiple linear regression analysis is a complex statistical technique that researchers can use to test the effect of one variable on an outcome (i.e., dependent variable), while controlling for other effects (independent variables). Linear

regression requires a continuous, numeric variable as its dependent variable. Independent variables can be either numeric or categorical, but there must be a linear relationship between the dependent and independent variables (Laerd Statistics, n.d.1). In order for researchers to accurately conduct a regression analysis the following conditions must be met: 1) there are no extreme outliers, 2) observations must be independent, 3) variances remain similar across a linear relationship, and 4) random errors (called residuals) are close to normally distributed (ibid.). Applied to survey research, the notion that observations must be independent can mean that one person's response should not be influenced by another person's response. This is one reason why it is import to have surveys completed and submitted anomalously.

In contrast to linear regression, logistic regression is a type of regression analysis that allows researchers to examine categorical outcomes such as binary, ordinal, and nominal responses. As noted by An (2002, p. 1), "Logistic regression analysis is often used to investigate the relationship between these discrete responses and a set of explanatory variables." Unlike multiple linear regression, logistic regression does not require for the relationship between independent and dependent variables to be linear, variances do not need to remain similar for each level of the independent variable, and the error terms (residuals) do not need to be normally distributed (Statistics Solutions, n.d.).

Chapter 2: Research Goal and Objectives

2.1.Research question and Hypothesis

The main goal of this research is to develop a tool to measure the effectiveness of Kaizen and to apply this tool to companies within the wood products industry.

Companies within the wood products industry are increasingly interested in implementing different continuous improvement methods in order to produce high quality products at a low cost, which then improves their global competiveness (Jabnoun, 2001). Given that low-cost foreign competition is one of the main reasons for the loss of competitiveness within the U.S. wood products industry, the very likely solution would be accomplishing innovation at a very high level (Hansen 2010). While wood products companies of a variety of sizes have innovated by implementing Kaizen methods and other continuous improvement practices, research findings show that the type of innovation (process, product, business systems) implemented varies by companies of different sizes (Wagner and Hansen, 2005). Innovation is very necessary for many wood industry products and processes in order to minimize resource challenges and to increase productivity. Generally, the target of innovation is to search for and apply new information to create higher product and company value (Van et al., 2006). To maximize innovation efforts, companies must sustain continuous improvement (Cole, 2003). While wood products companies have used other continuous improvement practices for decades, Kaizen methods are new to many businesses in the wood products industry and provide an opportunity for industry growth and innovation.

This need for Kaizen comes, in part, because U.S. companies have struggled in recent years due to decreased demand for its products from Asian countries (Ray et al., 2005) and the increased competitiveness of wood products companies within those countries. As mentioned,

Czabke (2007) notes in his case study that this need for global competitiveness has pressured both the U.S. and European wood products companies to adapt continuous improvement practices, including Kaizen methods. However, for companies to best use Kaizen and other continuous improvement initiatives to their benefit they need to be able to measure the effectiveness of Kaizen events.

For these reasons, the goal of this research is to develop a tool to measure the effectiveness of Kaizen. This tool will then be applied to selected U.S. wood products companies sing case study methods.

2.2.Objectives

2.2.1. Objective 1

The first objective is to research motivators for, barriers to, and factors driving Kaizen events.

Knowing what most motivates companies to implement Kaizen will identify for practitioners and others the most effective ways of encouraging companies to adopt Kaizen and other innovative continuous improvement practices. This is particularly important in the wood products industry where there has been only limited implementation of Kaizen and other continuous improvement initiatives. Similarly, it is important to identify possible barriers to implementing Kaizen so that these barriers can be addressed and overcome to improve companies' competitiveness. Finally, to improve the outcomes of Kaizen events it is important to understand which factors contribute to the effectiveness of Kaizen events.

2.2.2. Objective 2

The second objective is to develop a tool to measure the effectiveness of Kaizen events.

The development of such a tool will help practitioners and other interested persons understand and compare the successes of Kaizen events. Such a tool may also help in identifying factors to focus on in order to increase the effectiveness of Kaizen events.

2.2.3. Objective 3

The third objective is to apply the tool to conduct a case study of companies within the U.S. wood products industry.

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As part of this case study, information will be gathered from interviews and surveys to:

1) compare perceived motivators for and barriers to Kaizen implementation for production and non-production employees in the U.S wood products industry,
2) compare the perceived effectiveness of Kaizen activities for production and non-production employees in the U.S wood products industry, and
3) understand the contribution of teamwork, employee awareness and training, productivity improvement, and quality planning and control to perceptions of Kaizen's effectiveness.

As discussed, the available literature suggests that the increased use of Kaizen will contribute to improvements in a variety of ways for companies. However, the available literature is lacking with regards to in-depth analysis of how Kaizen initiatives, and continuous improvement more generally, relates to outcomes for wood products industry companies (Brashaw and McCoy, 2007). Similarly, while the discussed literature identifies the importance of employee and manager collaboration, the perspectives of employees and managers have as of yet not been statistically compared and contrasted in relation to the effectiveness of Kaizen initiatives in the U.S. wood products industry. Applying the tool

developed as part of this research to companies within the wood products industry will help fill this gap in the research and provide helpful information to practitioners.

Chapter 3: Methodology

The methodology follows case study principles, and builds upon the initial case study research of Bessant et al. (2001) and Atkinson (1994) on continuous improvement by determining the specific drivers of Kaizen and their effects on continuous improvement and developing a tool to measure the effectiveness of Kaizen events. Researchers have debated whether a survey or a case study is better to compare and evaluate different measurements. Depending on the available data and the applied field, case studies have often been found to be more efficient when it comes to subjects that cannot be generalized for the records, such as specific industry practices and business development (Barkley, 2006). The intent of this study is to test the research tool developed, and two U.S. wood products companies have been selected for this purpose. Given the goals and scope of this research, the case study approach chosen is considered effective and efficient (Barkley, 2006; Czabke, 2007; Czabke et al., 2008).

The findings generated from the literature review, interviews conducted, and survey data gathered were consulted and used to develop an analytical tool to measure the effectiveness of Kaizen events. This tool was developed by creating index variables based on the effectiveness of Kaizen and factors contributing to the effectiveness of Kaizen and then testing the reliability of these index variables. A multiple linear regression model was developed using these index variables, and this model forms the basis of the tool used to measure the effectiveness of Kaizen. This tool was applied to the survey data gathered from the two wood products companies included in this research's case study to measure the perceived effectiveness of Kaizen events.

3.1. Data analysis for research objectives

3.1.1. Objective 1

The first objective is to research motivators for, barriers to, and factors driving Kaizen events.

A literature review was conducted to research what motivators or prevents companies from implementing Kaizen, as well as what factors contribute to successful Kaizen events. Literature reviews are an essential tool for helping understand the depth and variety of information that has already been gathered about a topic and aid in providing a strong foundation to build a study from (Levy and Ellis, 2006). When done effectively, a literature also identifies gaps in the existing research and identifies topics where additional research is needed (Webster and Watson, 2002.). After such gaps in research are identified, a completed literature review will present information for researchers to draw conclusions from to extend current theories or create new directions for research. Through this process, literature reviews assist researchers in developing new theories and analytical tools (Webster and Watson, 2002).

Levy and Ellis (2006, p. 182) outline three main stages of an effective literature review process. These are:

1) The “input” stage, where literature is gathered;
2) The “processing” stage, where the researcher comes to know, understand, apply, analyze, synthesize, and evaluate the literature; and
3) The “output” stage, where the literature review is formulated and written in a format ready to be shared and/or published.

When gathering information in the first stage of the literature review process, Webster and Watson (2002) recommend identifying research contributions in leading journals and then reviewing the citations for the articles found within the research included in these leading journals. This process was used for the literature review conducted as part of this research. 1

As noted by Webster and Watson (2002, p. xiv) literature reviews can either analyze a large body of research that has been conducted on a well-established topic, or literature reviews can "tackle an emerging issue that would benefit from exposure to potential theoretical foundation." For this study, both the larger body of literature on continuous improvement and Kaizen, as well as the more emerging literature on the application of these philosophies within the wood products industry, were reviewed. In addition, prior surveys related to these research topics that were included in the available literature were closely reviewed to identify questions that could be modified for this research to more closely measure the use of Kaizen and other continuous improvement initiatives as applied to the wood products industry.

3.1.2. Objective 2

The second objective is to develop a tool to measure the effectiveness of Kaizen events.

The tool developed to measure the effectiveness of Kaizen events consists of interview and survey questions as well as analytical models developed from the survey data gathered.

a) Interviews

Interview questions were developed as part of this case study to better understand the history and details of how U.S. wood products companies have implemented Kaizen and other continuous improvement practices. Based on the observations of Williams (2003), these questions were generally open-ended to allow for the widest range of answers and to allow for flexibility. Interview questions were at times modified from the interview questions used by Farris et al. (2008), Espinoza, Bond, and Kline (2008), Czabke (2007), and Czabke et al. (2008) in those authors' studies of continuous improvement initiatives within the wood products industry.

Follow-up questions were also asked as needed, since sometimes additional clarification or context was needed. As part of the interview process, notes were taken on the history and management of each company's continuous improvement initiatives.

b) Surveys

Also as part of the case study, a survey was administered to both production and non-production employees at both of the companies selected for interviews. The small sample size of companies allowed for the interviews and survey data to supplement and complement each other. The survey was ordered so that it began with general and non-personal background questions to make the respondent feel comfortable, which follows the advice of Williams (2003) and Synodinos (2003). The survey also included several open-ended questions to allow for a wider range of answers, which also follows the advice of Williams (2003).

The majority of the survey questions were Likert scale questions. The Likert scale method usually gives the clearest results since it has the relative ratings between objects, but it might also have a disadvantage when it is seeking to find out individual effects, which is easier than other methods like the Guttman scale (Komorita, 1963). There is an order to measuring the survey data collected from different questionnaire methods, such as nominal data, ordinal data, interval data and ratio data (Allen and Seamen, 2007). Applying a Likert questionnaire is more likely to have an inherent order or sequence when comparing responses (Mogey, 1999). Maurer and Pierce (1998) point out the similarity between Likert scales and traditional measures of self-efficacy by using a sample of college students. The authors observed that Likert scales and self-efficacy have similar reliability error variance, which shows that Likert scales could be the alternative form of the efficacy method of measurement.

Within the survey developed as a tool for this research, Likert scale questions were grouped into sections of related questions. These sections were related to the following topics: employees' knowledge of Kaizen; motivators for and barriers to Kaizen implementation; the effectiveness of Kaizen; and factors contributing to effective Kaizen implementation such as teamwork, employee awareness and training, productivity improvement, and quality planning and control. These survey questions are listed within the sample questionnaire included as Appendix B.

3.1.3. Objective 3

The third objective is to apply the tool to conduct a case study of companies within the U.S. wood products industry.

This third research objective was addressed in three parts by applying the information gathered from the prior objectives. To accomplish this objective survey data that were gathered for this research were analyzed with a variety of statistical tests. These statistical tests include chi-square tests, Cronbach's alpha, and multiple linear regression analysis.

a) Motivators for and barriers to Kaizen events

The first application of the research tool developed in objective 2 is to analyze and compare perceived motivators for and barriers to Kaizen implementation for production and non-production employees in the U.S wood products industry. Motivators for and barriers to Kaizen implementation were analyzed overall as well as for production versus non-production employees using average and median values.

Next, chi-square tests compared responses between Company A and Company B production employees to determine whether there were statistically significant differences between how production employees in each of the two companies surveyed answered questions related to motivators for and barriers to Kaizen implementation. However, chi-square tests did not compare the responses of non-production employees across the two companies surveyed because only one non-production employee responded for Company B.

Chi-square tests also compared responses from production and non-production employees within Company A to determine whether any significant differences existed in how different types of employees perceived motivators for and barriers to Kaizen. Such a comparison could not be done within Company B because only one non-production employee responded for Company B. These tests comparing production and non-production employees within the same company were conducted in order to provide insights on how well employees' views align across employment levels after implementation of Kaizen has occurred. Since Kaizen promotes communication and collaboration between production and non-production employees, identifying areas where these groups still do not agree after implementation of Kaizen can signal areas to focus communication and collaboration efforts on when conducting additional Kaizen events.

b) The effectiveness of Kaizen events

The second application of the research tool developed in objective 2 is to analyze and compare the perceived effectiveness of Kaizen activities for production and non-production employees in the U.S wood products industry. Chi-square tests were again used to determine whether statistically significant differences existed between how production employees in the two companies answered questions related to the how they viewed the effectiveness of Kaizen

events. Within Company A, additional chi-square tests compared the responses of production versus non-production employees for each Likert scale question related to the perceived effectiveness of Kaizen.

c) Factors contributing to the effectiveness of Kaizen events

The third application of the research tool developed in objective 2 is to understand how the teamwork, employee awareness and training, productivity improvement, and quality planning and control contribute to Kaizen's effectiveness. Based on the literature review conducted for this study as part of objective 1, it these factors stood out as contributors to the effectiveness of Kaizen events and questions were included in the survey created as part of objective 2 related to each of these factors.

As part of objective 3, the index variables were created for each of the drivers of Kaizen events by summing the Likert scale point values of related questions. In this way the individual items in each construct were aggregated to create a single continuous variable for each construct. This is a common procedure in statistical analysis to transform ordinal variables into continuous variables (Brayfield and Rothe, 1951; John and Reve, 1982; Santos, 1999). These newly created composite variables were created to more easily measure a respondents' overall perceptions of teamwork, employee awareness and training, productivity improvement, quality planning and control, and the effectiveness of Kaizen. Cronbach's alpha tests were then conducted to confirm that these composite variables were reliable measures of the listed constructs related to Kaizen.

After examining the composite index variables created, a multiple regression model was developed to analyze how the drivers of Kaizen contribute to the perceived effectiveness of Kaizen. The composite variables based on the constructs of teamwork, employee awareness

and training, productivity improvement, quality planning and control were included as independent (predictor) variables in the regression model. The composite variable based on the construct of the Kaizen effectiveness (KE) was included in the regression model as the dependent variable. The resulting regression model is outlined as follows:

Effectiveness of Kaizen = Quality planning and control construct + Teamwork construct + Employee awareness and training construct + Productivity improvement construct + Error

Through multivariate linear regression, this model was used as a tool to measure the contributions of the drivers of Kaizen to the effectiveness of Kaizen events.

3.1.4. Limitations

It is important to develop a well-organized questionnaire in order to get enough responses for the data. There would be difficulties with the results if the questionnaire does not apply directly to the seeking factors or targeted respondents that possibly could give the accurate data. Moreover, it would be time-consuming and expensive if the questionnaire was not appropriate for the expected data. The reliability of the questionnaire was another possible limitation since the questionnaire was administered once at a specific date and time, which makes it difficult when trying to measure the change over time.

Green and Stutzman (1986) clarify the effect of respondents on the survey with their work on a job analysis questionnaire. According to this research, it was found that: 1) respondents are not equally correlated and they might not have the same interest in answering questions properly, and 2) there might be a certain number of respondents needed to be questioned in order to gather accurate results that can be generalized. It is important to make sure that gathered

information from the survey is accurate to the expected findings. Therefore, the main goal when administering a survey should be to minimize the error in the data collected (Fowler, 2009).

Even with these data limitations, the case study nature of this research that includes both detailed interviews as well as a more limited survey will allow for a greater depth of information on practices and obstacles within the wood products industry than would be possible through survey alone, even a survey a larger sample size. Through such a case study approach, this research will identify themes and develop tools that can be used by practitioners and who by analyzing this research may be able to overcome the limitations identified in future works.

Chapter 4: Results and Discussion

4.1. Objective 1

4.1.1. Results

The literature review conducted and discussed in detail within Chapter 1 of this study identified several important motivators for Kaizen events. These include:

- Customer feedback and the desire to meet customer needs (Smith et al., 2004),
- Desires to reduce costs and create cost efficiencies (Smith et al., 2004),
- Desires to improve quality outcomes (Farris et al., 2008),
- Desires to reduce lead time during production (Cumbo et al., 2006),
- Desires to reduce inventory (Cumbo et al., 2006),
- Leadership from within the company (Kaye and Anderson, 1998),
- Attending a training session or trade conference (Czbacke, 2007; Pirraglia et al., 2009), and
- Knowledge of another company's successful implementation efforts (Schuler and Buehlmann, 2003).

The literature review conducted also identified many barriers that limit Kaizen events and other continuous improvement efforts. The most common barriers cited in the reviewed literature include:

- Little interest in changing or adopting Kaizen activities (Liker and Meier, 2006; Pirraglia et al., 2009),
- Lack of expertise on how to implement Kaizen (Pirraglia et al., 2009),
- Middle management employees resist implementation (Kaye and Anderson, 1998),
- Production level employees resist implementation (Kaye and Anderson, 1998),
- Challenges from the existing workplace culture (Liker and Meier, 2006),

- Lack of time and/or financial resources (Kaye and Anderson, 1998; Pirraglia et al., 2009),
- There were poor experiences with past implementation attempts (Pirraglia et al., 2009), and
- Limited technological or equipment capability (Smith et al., 2004).

The final aspect of objective 1 was to research the driving factors that contribute to the effectiveness of Kaizen events. The following list summarizes the most prominent drivers of effective Kaizen implementation, previously outlined in Chapter 1:

- Teamwork, including cross-functional teams (Bessant, et al., 2001; Devlin, 2005; Doolen et al., 2007; Kaye and Anderson 1998);
- Quality planning and control tools, such as Pareto analyses, value stream mapping, and communicating quality results and goals (Bessant et al., 2001; Das et al., 2008; Liker and Meier, 2006);
- Employee awareness and training (Atkinson, 1994; Bessant et al., 2001; Yusof and Aspinwall, 2000); and
- Productivity improvement tools (Czbake, 2007; Liker, 1997).

4.1.2. Discussion

The results from the literature review conducted as part of objective 1 of this research identify a variety of important factors that contribute to the initiation and effectiveness of Kaizen events, as well as factors that could prevent the initiation of Kaizen events. These results show that Kaizen events are a complex process and require resources and commitment from across all parts of a company. The variety of important factors that contribute to the implementation of Kaizen and the effectiveness of Kaizen events suggest that a comprehensive approach

should be taken when measuring the effectiveness of Kaizen events. Finally, the results from this objective were used to develop the interview and survey questions used the objective 2 research tool. The results also contribute to the comprehensive model applied to the wood products industry companies surveyed as part of objective 3.

4.2. Objective 2

4.2.1. Interview Questions

Table 1 shows the general themes of the interview questions asked as well as specific topic areas within those themes. These interview questions reflect and build upon the findings of the literature review conducted as part of objective 1 as well as the survey questions developed. Appendix A includes an expanded list of interview questions used as part of this case study research and also includes sample language for how the interviews were introduced and concluded.

Table 1
Selected Interview Questions

Question Category	Selected Questions Included
Background	• How long have you worked in your current position? • How long has your company been using Kaizen? • How long has your company been using lean manufacturing?
Motivators and Barriers	• What were the main motivators for implementing these practices? • What were the challenges during Kaizen implementation in your organization?
Teamwork	• For your project teams, about how many members work on a team? • Can you describe the role of team decision making in your company? • How much are employees allowed to participate and give suggestions in order to meet work goals?
Workplace culture and employee awareness	• Can you try to describe your workplace's culture (main values and attitudes)? • How would you describe your leadership style? • How do you communicate goals and strategies with your employees? • How do you help employees understand and share the goals of management
Employee recognition and rewards	• How do you recognize workers for their performance? • How do you reward workers for their performance?
Quality control	• How would you describe your quality management programs? • What measures of quality do you use? • When is a product identified as being defective based on these measurements?
Effects of implementation	• What are the main positive changes you saw after using Kaizen or other continuous improvement initiatives (such as lean thinking)? • What measures of productivity improved the most from using Kaizen? • What productivity measures did not increase as much as expected after implementing Kaizen? Do you have any ideas as to why this was not as successful?
Future plans	• Can you describe any continuous improvement plans that your company is considering to use in the future? • What are the goals of these plans?

4.2.2. Survey Questions

After initial contacts with the management staff members at each company responsible for continuous improvement, these staff members were provided with an electronic version of the survey and paper copies of the questionnaire. The questionnaire included categorical and open-ended background questions, as well as Likert-scale questions asking respondents to agree or disagree with statements related to Kaizen and other continuous improvement practices. These questions were grouped according to the discussed objectives for this research. The electronic version of the questionnaire was created for respondents who may find it more convenient to complete than a paper form. Table 2 shows a simplified list of themes and topics included in the survey. A sample of the questionnaire with all survey questions administered is included as Appendix B.

Table 2
Selected Survey Questions

Question Category	Selected Questions Included
Background (categorical)	• What best describes your position in your company? • How long has your business been using continuous improvement concepts? • Which continuous improvement initiative has your company been using?
Use and knowledge of Kaizen (Likert scale)	Statements asking respondents to rank their knowledge of: • Continuous improvement • Kaizen Statements asking respondents to rank the strength of: • Their company's progress in Kaizen implementation • Their company's use of value stream mapping
Motivators and Barriers (Likert scale and open-ended)	• Nine statements asking respondents to rank to agree or disagree with whether various events or practices motivated their company to implement Kaizen • Ten statements asking respondents to agree or disagree with whether various events or practices posed barriers to their company's implementation of Kaizen • Open ended questions asking respondents to name the largest motivator for and barrier to Kaizen implementation at their company
Effectiveness of Kaizen (Likert scale)	• Nine questions asking respondents to agree or disagree with whether various outcomes were improved by implementing Kaizen
Drivers of Kaizen (Likert scale, open-ended, and categorical)	• Nine questions asking respondents to agree or disagree with whether their company used various practices to improve employee training and employee awareness • Five questions asking respondents to agree or disagree with whether their company used various practices to improve teamwork, two questions asking respondents to agree or disagree with whether their company has problems with teamwork, and three questions asking respondents to agree or disagree with whether their company uses cross-functional team strategies • Ten questions asking respondents to agree or disagree with whether their company used various practices to improve quality planning and control • Five questions asking respondents to agree or disagree with whether their company used various practices to improve productivity outcomes • An open-ended question asking respondents to identify the most noticeable productivity outcome from implementing Kaizen • Five categorical questions related to the frequency of quality planning and control practices

Both electronic and paper copies of the questionnaire included a cover letter from the researcher explaining the purpose of the survey and emphasized the voluntary and anonymous nature of the survey. The company staff members responsible for continuous improvement initiatives at each company then distributed the questionnaire to employees working at their location. Once all surveys were submitted, electronic responses were transferred into a spreadsheet file, and then survey responses from paper forms were entered into the spreadsheet.

4.3.Objective 3

4.3.1. Interview Results

Information on the implementation of Kaizen was gathered from each of the two U.S. wood products companies selected by interviewing company staff members responsible for continuous improvement initiatives. As mentioned, sample interview questions used are included in Appendix A. Table 3 compares descriptive information and summary findings from these interviews between the two companies, which are referred from this point forward as Company A and Company B.

Table 3
Wood Products Companies Interviewed and Surveyed

	Company A	Company B
Number of employees	Approximately 200	Approximately 150
Employees surveyed	Both production and management staff	Both production and management staff
Products produced	Kitchen cabinetry	Standard dimension lumber, manufactured pallets, and countertops
Types of continuous improvement	Just-in-time Kaizen Lean thinking Six Sigma 5S	Kaizen Lean thinking 5S
Specific practices used	Cross-functional teams; employee training, awareness, and recognition; and value stream mapping	Cross-functional teams (using supervisors only), employee recognitions, Go/no go checklists

a) Company A

Company A is one of several manufacturing facilities across the U.S. owned by a parent corporation. With a daily production capacity of about 800,000 square feet, Company A produces kitchen cabinets using soft maple, hard maple, and cherry lumbers. Recently, green lumber is kiln dried at the facility. There are approximately 200 employees working at the company over two shifts, with an almost equal number of male and female employees.

i. Motivators for and barriers to implementation

Company A started implementing continuous improvement initiatives in 2007, with an emphasis on Kaizen and lean manufacturing. At this time the company hired a Lean Manager to implement and sustain Kaizen and lean manufacturing practices. According to interviewed management staff, the company began these initiatives because it wished to standardize its work processes.

When implementing Kaizen and lean initiatives, Company A encountered several challenges. Management staff stated that it was a challenge to close the gap between the strategic vision of continuous improvement and the facility's situation at the start of implementation efforts.

In addition, the Plant Manager said that getting "buy-in" from all management staff members was very important. Getting management staff members to accept the new strategies involved having them agree to use more than cost indicators as the basis of performance at the beginning of lean operations. The Plant Manager and Lean Manager explained that this was important because it may take some time after implementing the initiatives for cost savings to occur.

The Plant Manager and Lean Manager also said that changing the workplace culture for all employees was something the company needed to achieve early in the implementation process for the continuous improvement initiatives to be successful. For Company A, this change in culture meant placing more value on discipline, creativity, responsibility, and alertness. The Plant Manager and Lean Manager stated that cost and productivity indicators could be used once the workplace culture changed. After management staff determined that there has been a successful change in workplace culture, Company A focused on a Kaizen-influenced "bottom-up" approach to future changes by encouraging employees to think proactively, suggest changes, participate in Kaizen meetings, and in general have the motivation and drive to improve their operations.

ii. Value stream mapping

Kaizen, lean manufacturing, and other continuous improvement initiatives were overseen by a full-time Lean Manager who was at times assisted by one to two other staff members to help

with the daily operations of the lean team. At the start of implementation, Company A's leadership team used value stream mapping techniques for the facility's current situation and included "Kaizen bursts", which identified opportunities to use Kaizen. The value stream mapping process was planned for cycles lasting between 6 and 12 months. Next, Company A's leadership team developed a future value stream map showing what the production process should look like after the "Kaizen bursts" have been addressed.

iii. Kaizen events and cross-functional teams

Company A aims to have Kaizen events at least once a week. The Plant Manager said that Company A uses action plans for each Kaizen event, which should clearly identify project goals and activities, steps to achieve the goal, staff responsible for different duties, and the time required to perform tasks.

When working on Kaizen events, management staff place a sign-up sheet on the production floor to help recruit employees for cross-functional teams. Each project team must include a subject matter-expert, a member of the lean leadership team, the personnel involved with the production line, and at least three members from non-related functional areas. Management staff are actively involved in teams, and Company A and has each production floor employee participate in at least one Kaizen event.

iv. Employee recognition and rewards

To reward and recognize employees during Kaizen events, Company A at times will provide lunch for its employees, as well as certificates and gift cards as incentives. At the end of a Kaizen event, Company A rewards employees by having a celebration of the project's success.

v. Employee awareness and 5S

Each day and at the beginning of each shift, Company A holds meetings to communicate continuous improvement and other company goals to both production and management employees. During these meetings employees are also encouraged to discuss challenges and areas that need to be improved.

The facility's layout was in U-line, and every work station had an information board with a checklist related to its 5S program for lean manufacturing. These checklists raise awareness for a project's progress, goals, and challenges. Company A's Plant Manager stated that all 53 checklists and information boards were updated regularly to show whether production goals were met.

vi. Identifying and addressing problems

Kaizen team members are required to walk along the facility's production process in order to identify problems. In doing this, Kaizen team members carry standardized forms with them to identify opportunities to improve quality and safety and to reduce human error and waste. During a Kaizen event process times are measured at least 10 times, which incorporates the principle of continuous improvement. These times are also recorded on a standardized form so that they can be analyzed. Information and data taken from the standardized forms used to identify problems and to record process times are used as part of a Plan-Do-Check-Act continuous improvement cycle.

Company A also conducts internal lean audits to identify and address problems using continuous improvement initiatives. The Project Manager said that these audits relate to value

stream mapping and the company's goal of addressing every Kaizen burst shown on the value stream map. According to the Lean Manager and Project Manager, internal audits should use a list of safety, quality, and equipment maintenance items that should be inspected. If a problem is identified the lean Employees should immediately report to the company's lean leadership team correct the problems identified. Such internal audits are conducted:

- daily by process owners and process,
- weekly by line supervisors,
- monthly by the lean leadership team, and
- quarterly by managers.

When working to improve processes where problems are identified, employees at Company A are directed to address problems using, in order, the following techniques:

- 5S lean practices to reduce waste, and improve order and consistency using visual cues;
- Standard continuous improvement practices of frequently examining the work sequence, key points in the production process, and asking whether each step in the process is necessary. This includes developing manuals, videos, and visual aids to help train employees;
- Visual controls to more easily illustrate ideas to employees;
- Total Productive Maintenance (TPM), which is important because a broken machine will stop the whole production line. Company A's Project Manager and Lean Manager said that TPM is important because it is better for the company to keep equipment to be in good operation condition than to replace equipment; and
- Other techniques such as quality in the source (poka-yoke), six sigma, just-in-time, and one-piece.

b) Company B

Company B is also one of several manufacturing locations across the U.S. owned by a parent corporation. With a total of approximately 150 employees at its location, Company B produces a range of products including standardized dimension lumber, manufactured wood pallets, and countertops. Company B prides itself on having a safety-oriented workplace culture, and employees are encouraged by management staff to have a safe shop floor. In addition, this workplace culture also places a strong focus on making safe products for its customers so that the company can maintain long-term customer relationships.

In the 1990's Company B began implementing Kaizen, but the Safety and Lean Manager stated that the company became more successful in its Kaizen initiatives in the early 2000's. In addition to Kaizen, Company B also uses Lean and 5S practices.

i. Motivators for and barriers to implementation

The Safety and Lean Manager identified the desire to improve safety as the biggest motivator for implementing Kaizen, Lean, and 5S. Company B also introduced these continuous improvement initiatives because it was motivated to save costs and better manage inventory (not over-buy materials). In particular, the Safety and Lean Manger suggested that 5S was best at keeping the shop floor clean and safe.

However, Company B's continuous improvement efforts were limited because of language barriers between the production workers, who mainly spoke Spanish, and the management staff, who mainly spoke English. According to the Safety and Lean Manager, this language barrier is still a problem, and as a result there has been limited collaboration between

production and management employees. For example, the Safety and Lean Manager said that it was difficult to translate the Japanese terms and principles related to 5S and Kaizen so that they could be understood in Spanish. The Safety and Lean Manager said that currently Company B is not working actively to overcome this language barrier because of the amount of time that this would take away from daily production work.

ii. Kaizen events and cross-functional teams

Company B organizes cross-functional Kaizen teams by using supervisors from different company functions and from different product areas. When asked whether production employees are involved in cross-functional teams, the Safety and Lean Manager stated that they are not because of challenges related to the language barrier between production and management staff. Instead, the cross-functional Kaizen teams made of supervisors direct the production staff during Kaizen events. These Kaizen teams implement Kaizen events once each month at Company B.

At the end of each day, supervisors on the Kaizen teams meet to discuss and monitor problems, and also to work together to identify solutions. As a result of these discussions, supervisors on the Kaizen team will at times try to engage production employees who have needed “know how”, or who have expertise in an area. When this happens the production and management employees can work together to discuss solutions to the identified problems.

iii. Employee recognition and rewards

Company B tries to measure performance annually, and will give raises based on this annual performance evaluation. More frequently, Company B management will give “spot bonuses”

in the form of free lunches to reward a work area's employees when the employees quickly reduce "red marks" identified by the Kaizen team.

iv. Employee awareness and 5S

Like Company A, Company B also includes 5S bulletin boards across the production floor in order to keep a constant focus on safety and cleanliness. The facility has three sawmills, two of which are located next to each other. The facility's layout is segmented by with areas dedicated to custom fabrication, lamination, truss, casting, and specialty tasks.

Management staff communicates goals and quality assurance tasks with production by using 5S checklists that are posted in various areas of the production floor. As the language barrier between production and management staff was cited as a problem, these checklists are used as one way to communicate goals and issues.

v. Identifying and addressing problems

In addition to 5S, the Kaizen teams made of supervisors use a checklist with go/no go, good/not good, and green/red cards (green indicating that production can continue and red indicating that something is broken or not clean) to identify problems that need immediate solution and communicate these problems to production employees. Using these types of cards, the Kaizen teams create a list of action items in the production process that must be continued in order, and employees are directed to not proceed in the production process until an item flagged as a problem is fixed.

Quality management supervisors at Company B also ensure quality by checking batches of products to see if there is a problem. If they identify a problem, the quality management

supervisors will then take the products off the production line and try to fix the problem before advancing the products further down the assembly line.

vi. Future plans for continuous improvement

When asked to discuss Company B's future plans for implementing continuous improvement, the Safety and Lean Manager said that Company B will partially expand 5S over the shop floor and follow up on implementing 5S in each of the facility's work areas. However, the Safety and Lean Manager stated that Company B currently does not currently have long-term plans to expand Kaizen because the facility is still at the "baseline" level of implementing Kaizen. As a result of still being at the "baseline" level of Kaizen implementation, Company B has not been able to estimate cost savings specifically due to its Kaizen initiatives.

c) Discussion

The interviews conducted highlight several Kaizen and other continuous improvement practices used by both wood products companies included in this case study. The use of Kaizen events was identified by the continuous improvement staff interviews as a positive way to create targeted bursts of productivity and change. Both companies also closely associated 5S practices with Kaizen, and used these practices to improve the visual layout, of cleanliness, and safety of the shop floor.

The interviews also identified some noticeable differences between how and why the two companies have implemented Kaizen that may suggest that the two companies are likely to see different levels of success from their implementation efforts. For instance, the main goal of Company A was to use Kaizen as part of an overall strategy to standardize the company's work processes across different functional areas and departments. Similarly, Company A

included Kaizen in longer-term value stream maps to fit Kaizen within a larger vision for the company and to ensure that past improvements from Kaizen are sustained and build upon. These practices follow the suggestions of Liker and Meier (2006).

While Company B staff stated that they hoped to use Kaizen to save costs and better manage inventory, their main focus of using Kaizen was related to creating a safe shop floor. Improved safety can be a positive and important outcome from Kaizen, but the apparently narrow focus on and use of Kaizen by Company may limit the extent to which Kaizen can change workplace culture or improve other aspects of the production process. It also appears that Company B does not currently plan to expand Kaizen in its long-term plans, which may limit the sustainability of improvements Company B has already achieved.
In addition, while Company B identified cost savings as a desired outcome from Kaizen, the staff interviewed indicated that the company had not developed a way to measure cost savings from Kaizen events or to quantify other improvements. If a company is not able to measure the effectiveness of Kaizen events, then it is difficult to identify and address areas in need of improvement. Not being able to measure the effectiveness of Kaizen events may also contribute to resistance from employees within a company, as some employees may desire evidence of positive outcomes before fully committing themselves and company resources to the use of Kaizen. These issues support the aim of this research to develop a tool to measure the effectiveness of Kaizen.

The interviews conducted between the two companies also identify common as well as different barriers to the initial implementation of Kaizen, as well as different responses to these barriers. Insights from these differences suggest what methods work most and least when trying to overcome challenges within one’s organization. Both Company A and

Company B identified skepticism and resistance to adopting Kaizen and other continuous improvement initiatives and moving resources from traditional practices to these new approaches. Company B worked to create a more open culture within the management level staff, but Company B did not actively try to get "buy in" or participation from the production level staff because of language barriers. Having support for and a common vision of Kaizen within only one level a company may limit communication, collaboration, and ultimately the effectiveness of Kaizen implementation throughout a company as a whole. It may also contribute to production employees perceiving barriers to implementing Kaizen (Graban and Swartz, 2012; Losonci, Demeter, and Jenei, 2011; Lee, Nippa, and Klossek (2010).

In contrast, Company A actively worked to include production level employees in getting their support for and participation in Kaizen events. Company A did not cite language barriers between production and non-production staff as existing to a large degree, which may have increased their initial ability to communicate and get "buy in" from production employees compared with Company B. Company A's aggressive focus on first changing the workplace culture to one that supports Kaizen principles, and having a bottom-up instead of top-down approach that allows for production employees to express themselves creatively, has a greater likelihood of creating long-term change and sustainable improvements (Atkinson, 1994; Graban and Swartz, 2012; Liker and Meier, 2006).

4.3.2. Results from survey administration

Survey data for this research were collected through a questionnaire completed by employees at two U.S. wood products companies. A total of 23 survey responses were gathered from Company A and Company B. This sample size might be considered small and the number of responses are not equal between the two companies in part due to Company B not being able

to collect as many responses as it had initially anticipated, and because the total number of survey responses submitted was not known until the batch of surveys arrived by traditional mail after a series of delays. The delays in time it took before it was apparent that Company B would not be able to submit the predicted number of responses made it unfeasible to contact another company to administer the survey to within the time constraints of this research.

As shown in Table 4, of the 23 questionnaires that were completed and submitted, 16 were from Company A respondents and 7 were from Company B respondents. The surveys came from a similar number of production versus non-production workers, with 13 production workers and 10 non-production workers responding to the survey. Of the 10 non-production workers who responded to the survey, 7 were administrative staff, 1 was an assistant manager, 1 was a training assistant within the company's human resources department, and 1 was a plant manager. These survey data were then used to test the hypotheses related to the three previously discussed research objectives.

Table 4
Survey Sample Size and Employment Characteristics

Employee Type	Company A	Company B	Total	Percentage of Total
Production	7	6	13	56.5%
Non-Production				
Administrative	6	1	7	30.4
Assistant manager	1	0	1	4.3
Human Resources-Training Assistant	1	0	1	4.3
Manager	1	0	1	4.3
Subtotal	9	1	10	43.5
Total	16	7	23	100.0%

a) Discussion

The relatively equal number of non-production versus production employees gathered allowed for additional tests to build off these results, such as by comparing responses between these two groups. However, since there was only one non-production employee who responded to the survey from Company B these results are not sufficient for testing for differences between non-production employees across the two companies.

Although the overall sample size obtained was smaller than desired, the sample size obtained still provides valuable information as part of this case study approach by providing a wider range of perspectives from different types of employees within the wood products companies than was possible during the interviews conducted.

4.3.3. Results from general survey questions

Results obtained from the survey tool developed as part of objective 2 included general information on respondents' awareness of Kaizen. Overall, the employees surveyed from Company A and Company B agreed that their company "has knowledge of continuous improvement strategies" and "knowledge of Kaizen activities", with average Likert scale responses of 4.6 and 4.4, respectively, for these question. When asked whether their company "is advanced in its implementation of Kaizen activates", the average Likert score was 3.7 across all employees surveyed. These scores suggest that employees perceived themselves as knowledgeable about the main topics of this research and the research objectives to be examined. Appendix C includes these average values are presented for all respondents and are also broken out by the average values for production versus non-production employees for all Likert survey questions. Appendix D includes the median Likert scale values for each Likert survey question, both for all respondents and also for production versus non-production

employees. This appendix was included because while the average values more clearly identify differences between production and non-production employee responses, as mentioned earlier some scholars suggest that for ordinal data the median value may be most appropriate (Jamieson, 2004).

a) Discussion of general survey questions

The results from these survey questions indicate that respondents have sufficient knowledge of and experience with Kaizen for them to answer the remaining questions in an informed way. This supports the reliability of the survey data as a whole. However, if a respondent did not believe he or she had sufficient knowledge to answer a specific question, each Likert scale question included a "not applicable" option.

4.3.4. Results from categorical quality control survey questions

Five categorical questions related to construct of quality planning and control provided further context to the Likert scale questions related to topic. Appendix E includes graphs representing responses to these categorical questions across all employees surveyed as well as for production versus non-production employees. Findings from each of these five categorical questions illustrated in Appendix E include:

1) When employees were asked how often they underwent training in continuous improvement activities, the most common answer was "monthly". Production employees answered that they underwent trainings more frequently than did non-production employees;
2) When employees were asked how often they participated in Kaizen group activities, the most common answer was monthly as well. The answers to this question did not appear to vary largely between production versus non-production employees;

3) When asked how often quality control goals are communicated with management and employees, most responses were either “daily” or “monthly”. Production employees were more likely to answer “daily”, while non-production employees were more likely to answer “monthly”;
4) When asked how often quality control results are communicated with management and employees, most responses were again either “daily” or “monthly”. Non-production employees were twice as likely to answer “daily” than production employees; and
5) When asked how often quality control data are gathered, most respondents answered “weekly”, “daily”, or “every hour”. Non-production employees were more likely to answer “every hour”, while production employees were more likely to answer “weekly”.

a) Discussion of categorical quality control survey questions

The finding that employees are receiving continuous improvement trainings and participating in Kaizen events on a (most often) monthly basis further supports the idea that respondents have regular experience with Kaizen and other continuous improvement experiences, and therefore are likely able to answer the other survey questions in an informed way.

The findings that non-production employees are focused on gathering and communicating quality data and results at more frequent intervals than production employees may reflect the higher level job duties of the non-production employees. For example, production employees may conduct shop floor tasks within their functional department without knowing the quality data and results based on the overall production process. In contrast, management staff are often responsible overseeing a wider range of production activities and monitoring their overall results. However, the goal of Kaizen is to have frequent communication between production and non-production employees, so the differences in responses cited may suggest that this communication could be improved. Similarly, the finding that production employees

indicated that quality goals are communicated at frequent intervals compared with the intervals indicated by non-production employees may also reflect that production employees receive more micromanagement in their daily activities than do non-production employees. As Kaizen encourages the creative thinking and input of production level workers, it is important for the effectiveness of Kaizen events that when goals are communicated there are also opportunities for production level employees to share and take ownership of their own ideas.

4.3.5. Motivators for and barriers to Kaizen events

a) Results comparing motivators for Kaizen events

For three of the Likert scale survey questions that asked respondents about motivators for Kaizen events, there were statistically significant differences between how Company A and Company B production employees answered the questions. As shown in Table 5, there were statistically significant differences in how Company A and Company B employees viewed cost efficiencies, quality outcomes, and knowledge of another company's implementation of Kaizen as motivators for their own company's implementation of Kaizen. Company A production employees were on average more likely to view cost efficiencies and quality outcomes as motivators for their company's implementation of Kaizen, while Company B production employees were on average more likely to view knowledge of another company's implementation efforts as a motivator for their company implementing Kaizen.

Table 5
Chi-square Test Results on Perceived Motivators for Kaizen:
Company A versus Company B Production Employee Responses

Motivators of Kaizen (Where 1 = Strongly Disagree and 5 = Strongly Agree)	**Avg. Company A Likert Value**	**Avg. Company B Likert Value**	**Chi-square Value**	**P-value**
Cost efficiencies influenced our company's decision to implement Kaizen methods	4.5	3.67	5.14	0.08*
Improved quality outcomes influenced our company's decision to implement Kaizen methods	4.43	3.67	4.95	0.08*
Knowledge of another company's use of Kaizen activities influence our company's decision to implement Kaizen methods	3.5	3.83	5.47	0.07*

* $p \leq 0.1$, ** $p \leq 0.05$, *** $p \leq 0.01$

However, chi-square tests comparing the responses of production versus non-production employees within Company A did not provide sufficient evidence to suggest that that views differed across these groups regarding motivators for Kaizen implementation. As mentioned, such a comparison could not be conducted within Company B because only one non-production employee from Company B is included in the survey sample obtained. Table 6 lists the chi-square test statistics and p-values associated with these tests conducted across Company A's production and non-production employees.

Table 6
Chi-square Test Results on Motivators for Kaizen:
Company A Non-production versus Company A Production Employees

Motivators of Kaizen	Chi-square	P-value
Customer feedback influenced our company's decision to implement Kaizen methods	2.14	0.54
Cost efficiencies influenced our company's decision to implement Kaizen methods	1.42	0.70
Improved quality outcomes influenced our company's decision to implement Kaizen methods	2.68	0.44
Sales growth influenced our company's decision to implement Kaizen methods	1.34	0.51
Lead time reduction influenced our company's decision to implement Kaizen methods	0.94	0.82
Inventory reduction influenced our company's decision to implement Kaizen methods	3.29	0.35
Leadership from within the company influenced our company's decision to implement Kaizen methods	0.05	0.98
Attending a training session or trade conference influenced our company's decision to implement Kaizen methods	0.08	0.96
Knowledge of another company's use of Kaizen activities influence our company's decision to implement Kaizen methods	3.57	0.31

* $p \leq 0.1$, ** $p \leq 0.05$, *** $p \leq 0.01$

In addition to the Likert-scale questions that were administered about motivators to Kaizen, respondents answered the open-ended survey question that asked "What is the largest motivator for Kaizen?" The answers to this question were categorized as follows into the common themes summarized in Table 7. As shown, both production and non-production employees identified leadership from management as the top motivator for implementing Kaizen. One such response cited the largest motivator for Kaizen as management's "leadership and our desire to become a world class organization." Similar to the results from the open-ended question, the respondents ranked leadership from within the company highest amongst the list of Likert survey questions on motivators to Kaizen (see Attachment C).

Table 7
Number of Production and Non-Production Employee Responses Identifying
"The Largest Motivator for Kaizen"

Production		Non-Production	
Theme	Num.	Theme	Num.
Leadership from management	6	Leadership from management	4
Cost reduction	2	Productivity improvements for larger profit	2
Quality improvement	2	To better improve and sustain customer demand	1
Reduced setup time and down time, improve cleanliness, standardizing across the company	1		
Improve job performance	1		

b) Discussion of results comparing motivators to Kaizen

The findings that Company A production employees were statistically more likely than Company B production employees to view cost efficiencies and quality outcomes as motivators for Kaizen are at least in part explained by the interview results previously discussed. The staff with continuous improvement responsibilities from both companies cited desires to improve cost and quality outcomes. However, the interview results suggest that Company A had a more comprehensive vision of using Kaizen to improve and standardize processes across the company, whereas the main motivator for Company B appeared to be safety and cleanliness concerns. For these reasons, it may be that the production employees in Company A were more aware of motivations to use Kaizen to standardize processes related to cost as well as quality. In contrast, it is possible that these motivations may have appeared more secondary in nature to many Company B production employees.

The explanation behind the finding that Company B production employees were statistically more likely to view other companies' implementation of Kaizen as a motivator to their own company's implementation is less obvious. Neither company identified other companies'

practices as motivators during the interviews conducted with Company A and Company B staff. However, it is possible that production level employees' knowledge of regional (or other) competitors varied across the two companies due to differences in the visibility of competitors' successful initiatives or in the level of interactions between production level employees and employees at competitor companies. Other possible explanations come from the work of Elmuti and Kathawala (1997). The authors promote the use of companies comparing, or "benchmarking", their continuous improvement experiences with those of other companies, but note that for this process to bring about innovation there must be interest and support among management staff, a good understanding of the operations of one's own company, an openness to new practices, and being willing to share information with other companies. To the extent that the use of "benchmarking" practices by Company B was greater than for Company A, this may explain why perceptions between production employees across the two companies regarding how large a motivator another company's implementation is for their own company's use of Kaizen.

The finding that there were no significant differences between how Company A's production and non-production employees viewed motivators for Kaizen signals general agreement within Company A regarding what has and has not worked for to initiating Kaizen events. This findings is explained in part by the interview results obtained. The interview results discussed suggest that Company A has implemented Kaizen and other continuous improvement initiatives in a comprehensive and sustained way, and companies such as Company A that have effectively implemented Kaizen typically have more open communication between production and non-production employees and create common goals for their employees.

Finally, the identification of leadership as the largest motivator by both production and non-production employees in both open-ended and Likert scale questions indicates the strong and special role that staff can play within their own companies in affecting change for the better through Kaizen. Companies should therefore encourage motivated staff to take leadership roles within their company to advance continuous improvement, and should provide trainings to develop leadership skills when possible.

c) Results for comparing barriers to Kaizen

For five of the Likert scale survey questions that asked respondents about barriers to Kaizen events, there were statistically significant differences between how Company A and Company B production employees answered the questions. As shown in Table 8, there were statistically significant differences between how Company A and Company B employees viewed the barriers of middle management resistance, limited time, poor past experiences with Kaizen, lack of not technological capacity, and lack of financial resources. With p-values of 0.01, the test statistics related to the barriers of middle management resistance and limited time for implementation showed the most statistically significant differences between production employees across the two companies surveyed.

Table 8
Chi-square Test Results on Barriers to Kaizen:
Company A Non-production versus Company B Production Employees

Barriers to Kaizen (Where 1 = Strongly Disagree and 5 = Strongly Agree)	**Avg. Company A Likert Value**	**Avg. Company B Likert Value**	**Chi-square Value**	**P-value**
Middle management resists implementing Kaizen activities	2.57	3.00	13.00	0.01***
There is not enough time for the company to currently implement Kaizen activities	2.14	4.67	13.00	0.01***
There were poor experiences with past Kaizen projects	2.29	3.20	8.71	0.07*
There is a lack of technological capability to implement Kaizen activities effectively	2.43	3.00	7.97	0.09*
Financial resources that are dedicated for Kaizen projects are limited	2.57	3.67	9.78	0.04**

* $p \leq 0.1$, ** $p \leq 0.05$, *** $p \leq 0.01$

When comparing the responses of production versus non-production employees within Company B, statistically significant differences were found only for the question regarding the barrier of poor past experiences with Kaizen. As shown in Table 9, these differences were statistically significant at the 90% confidence level of $p<0.10$. The average Likert scale value for Company A production employees regarding the barrier of poor past experiences with Kaizen was 2.29, whereas the average Likert scale value for Company A non-production employees was 2.78.

Table 9

Chi-square Test Results on Barriers to Kaizen:
Company A Non-production versus Company A Production Employees

Barriers to Kaizen	Chi-square Value	P-value
There is little interest in changing or adopting Kaizen activities	4.41	0.22
There is not enough expertise on how to implement Kaizen activities	2.46	0.48
There is resistance to generating new measurements of improvement for Kaizen activities	4.83	0.31
Middle management resists implementing Kaizen activities	3.96	0.41
Employee staff resist implementing Kaizen activities	2.66	0.62
Implementing Kaizen would pose a challenge to our workplace culture	3.49	0.32
There is not enough time for the company to currently implement Kaizen activities	4.78	0.19
There were poor experiences with past Kaizen projects	8.08	0.09*
There is a lack of technological capability to implement Kaizen activities effectively	2.26	0.69
Financial resources that are dedicated for Kaizen projects are limited	3.96	0.41

* $p \leq 0.1$, ** $p \leq 0.05$, *** $p \leq 0.01$

As with the questionnaire's section on motivators for Kaizen, the questionnaire's section on barriers to Kaizen included an open-ended question asking respondents to specify "What has been the largest barrier to Kaizen?" Table 10 summarizes and categorizes the responses submitted by Company A and Company B for this question and shows that production and non-production employees both identified cultural resistance or lack of motivation, limited time and money, and difficulty sustaining implementation as the three largest barriers to Kaizen events.

Table 10

Number of Company A and Company B Production and Non-Production Employee Responses Identifying "The Largest Barrier to Kaizen"

Production		Non-Production	
Theme	Num.	Theme	Num.
Cultural resistance or lack of motivation	4	Cultural resistance or lack of motivation	3
Limited time and money	4	Limited time and money	3
Sustaining implementation	2	Sustaining implementation	3
Lack of training and expertise	1	Working around production	1

The following sample responses to the open-ended question identify each of the three most cited barriers to Kaizen:

- "Tribal knowledge. Employees of longevity used to the 'old ways', resistant to learning new methods."
- "Time and resources of employees. Often times we have projects that need to be done, but due to production requirements, we are not able to adequately support having a team at that time."
- "The burden of daily operations not allowing for proper execution and sustainment of kaizen activities and deliverables."

d) Discussion of barriers to Kaizen events

A consultation of the available research literature was conducted in light of the discussed results to identify possible reasons as to why the statistically significant different responses between production and non-production employees existed for certain barriers to Kaizen events. The interview results from both companies were also reviewed for additional insights.

i. Discussion of the barrier of middle management resistance to Kaizen events

Prior research has identified middle management as the main source of resistance to innovative manufacturing practices, including Kaizen (Barnes et al., 2001). Ortiz (2006) also

identified middle management as the level within a company where problems are argued over, but the solutions proposed to these problems are often only short-term fixes. In addition, while Ortiz (2006) recommends that each company should have one staff member devoted full-time to Kaizen, he suggests that this person not be someone from management staff. According to Miller and Cangemi (1993), middle management can also become a barrier for implementing continuous improvement practices if middle management staff do not delegate well to those below them, particularly when delegating tasks related to quality. It is therefore possible that the significant differences identified between how Company A and Company B production employees view middle management resistance to Kaizen could be due to differences in how well or poorly middle management at each of the companies delegates to or communicates and collaborates with production employees.

The interview results discussed suggest that there is a more hierarchy in Company B and less involvement of production employees than in Company A. For example, production employees are not included in Kaizen teams at Company B. These differences highlighted in the interviews conducted may explain the statistical differences across the two companies regarding how production employees perceive middle management as a barrier to Kaizen.

ii. Discussion of the barrier of a lack of time for Kaizen events

As noted, Pirraglia et al. (2009) identified a lack of time as a barrier to continuous improvement efforts. Similarly, Kitson, Harvey, and McCormack (1998, p. 155) identified a lack of time on the part of the "facilitator" of Kaizen events as a reason why Kaizen events are not sustained. In addition, the interview results discussed showed how Company B staff indicated that the company was not actively working to break down barriers, such as language barriers, keeping production employees from participating in Kaizen because of concerns that

the amount of time that these efforts require would take away from daily production work. In contrast, the time required of production employees was not greatly emphasized in interviews with Company A staff. These insights from the interviews conducted, which are supported by the relevant literature cited, may help explain the statistically different views between production employees across the two companies surveyed.

iii. Discussion of the barrier of poor past experiences with Kaizen events

Bednarek and Scibiorek's (2011, p.142) study of the implementation of Kaizen in Polish industrial plants highlighted that some 5S and Kaizen did "not bring expected results, moreover it generate[d] barriers" to future efforts. This suggests that discouragement from past Kaizen projects can hurt the drive for future implementation. Mika (2006, p. 26) suggested that poor past experiences with Kaizen can be perceived as barriers to future efforts if there is "finger pointing or blame if an idea should fail." If production employees blame their company's non-production employees, or if a company's non-production employees blame their production employees, then the perceptions of the barrier of the past experience with Kaizen implementation may vary between these two groups. Differences between how Company A and Company B reacted to (or who within each company was blamed) after past negative experiences with Kaizen may explain why Company A production employees were slightly less likely to perceive past experiences as a barrier than were Company B employees. However, within Company A, whereas Company B production employees were more likely to perceive past experiences as a barrier compared.

In his research on Kaizen implementation, Mika (2006, p. 174) found that production level "team leaders were reluctant to be innovative because [their operation's manager] had said in the past that certain ideas were no good or would not work" (p. 174). Similarly, Mika (2006)

found instances where non-production employees held the belief that their company had tried all possible ideas already and didn't want additional suggestions from production employees. Such differences further explain why perceptions may vary between production and non-production employees regarding how much of a barrier poor past experiences with Kaizen pose to future Kaizen implementation. These findings may help explain why Company A non-production employees were statistically more likely to view poor past experiences as a barrier than Company A production employees.

iv. Discussion of the barrier of lacking technological capability for Kaizen events

In discussing technology innovation, Teece and Pisano (1994) note that employees' technological abilities and competencies deeply embedded in them. As a result, even small technological changes can create great difficulties for both individual employees and for a company's overall ability to adapt and compete in the marketplace. The study conducted by Anand et al. (2009) of five companies' investments in information technology provides additional insight into this barrier to Kaizen. The companies analyzed invested in software to with the ability to track the results of Kaizen events and other continuous improvement projects. However, Anand et al. (2009, p.15) note that manager level respondents became "disappointed and frustrated with their organizations' abilities to utilize such technologies for sharing project learning across their companies" because they found that "several project leaders seem[ed] resistant to the idea of exchanging knowledge with their peers. These project leaders [were] not disciplined about entering information into and accessing information from project report databases." In helping explain the differences between Company A and Company B production employees' views of technological capacity as a barrier to Kaizen, one explanation may be that Company B employees responsible for maintaining and using new technologies became frustrated with it or did not apply the technology to its full extent,

which would make the technology appear as a barrier to Kaizen. Another possibility, although one that the gathered interview evidence cannot comment on, is that Company A's technology had greater capacity for the use of Kaizen and other continuous improvement initiatives than did the technology available to Company B employees.

v. Discussion of the barrier of limited financial resources for Kaizen events

Both Czbake (2007) and Liker and Meier (2006) cite the tension between the desire for immediate short term financial gains from Kaizen events and the need for a more comprehensive long-term vision for the company. The interview results from Company B indicated that there were difficulties being able to estimate cost savings as a result of Kaizen events. One possible explanation for Company B production employees being statistically more likely, on average, than Company A production employees to identify financial resources as a barrier may be that Company B production employees are more sensitive to short-term output and cost goals because these are goals stressed by their superiors to a greater extent than as the case in Company A.

vi. Discussion of ways companies can overcome these barriers to Kaizen.

Much of the literature consulted regarding overcoming the discussed barriers of Kaizen share a common suggestion: increasing communication, cooperation, and openness throughout the company. For instance, Barnes et al. (2001, p. 293) suggest addressing the barrier of middle management resistance by having companies "transition from essentially hierarchical organizational forms characterized by high division of labor and extensive use of bounded autonomy, decision rules and standard procedures to more fluid and flexible forms" of management.

Regarding the barrier of perceived limitations in technological capacity, Anand et al. (2009, p. 15) suggest that the installation of new information technologies for Kaizen include ways to encourage the sharing and communicating of new knowledge created from Kaizen events. This practice may more clearly demonstrate for employees the scope of a technology's capacity, identify the technology's limitations, as well as suggest new ways to improve.

Regarding the barriers of limited time and financial resources, the findings of Liker and Meier (2006) and Czbake (2007) suggest that management within a company purposefully set aside time and financial resources for the use of Kaizen events and the training of production level employees in Kaizen. Opening up these resources will give more opportunities for production employees to build skills that help the company and to use their creativity in suggesting new improvement practices.

Graban and Swartz (2012) also suggest that non-production employees should actively seek input and involvement from production level employees, as well as give production level employees a sense of ownership over the results of a project. However, the authors discourage the use of suggestion boxes as a tool. They state that problems associated with the suggestion box as a tool are that "Ownership of the suggestion is lost, as staff expect managers to make all decisions and take all action, instead of collaborating", "Suggestions often sit in a box for weeks or months before being reviewed", and "The focus is often on items to purchase, instead of processes to improve" (ibid., p. 37).

In addressing differences in how to overcome the perceived barrier of poor past experiences with Kaizen, Mika's (2006) findings suggest that companies should establish a culture in which both production and non-production employees believe that "It is better to try and fail

than to wait for the perfect time to begin", and that "Failures are a sign of learning and trying." Therefore, perceived barriers will lessen by framing initial attempts at implementation as opportunities to identify improvements, and by not blaming different employees or groups of employees within a company.

4.3.6. Effectiveness of Kaizen events

Chi-square tests compared the average responses between Company A and Company production employees regarding how employees across the two companies viewed the effectiveness of Kaizen. However, these tests did not identify any statistically significant differences.

As shown in Table 11, there were also no statistically significant differences in how Company A production and Company A non-production employees responded to the nine questions related to the effectiveness of Kaizen.

Table 11

Chi-square Test Results on the Effectiveness of Kaizen:
Company A Non-Production versus Company A Production Employees

Effectiveness of Kaizen	Chi-square	P-value
Since we introduced Kaizen we have increased our competitiveness	2.14	0.54
After we implemented Kaizen activities we have increased profits	1.42	0.70
Since we applied Kaizen activities we have decreased costs	2.68	0.44
Application of Kaizen helped us improve lead time	1.34	0.51
Since we introduced Kaizen we have increased productivity	0.94	0.82
Adopting Kaizen activities enabled us to improve product quality	3.29	0.35
Since we introduced Kaizen we have improved employee motivation	0.05	0.98
After we started practicing Kaizen we have improved customer satisfaction	0.08	0.96
Since we introduced Kaizen we have improved the time it takes to cut the dimensions of a product (cut time)	3.57	0.31

* $p \leq 0.1$, ** $p \leq 0.05$, *** $p \leq 0.01$

Although not used for chi-square tests, an open-ended question also asked for additional information related to research objective 2. Respondents were asked “What has been the most noticeable change in productivity as a result of Kaizen events?” The responses from production and non-production employees were categorized by their main themes, and Table 12 summarizes the main themes identified from these open-ended responses. Production employees most often cited short productivity improvements that were not sustained, whereas non-production employees most cited improvements in how equipment and tools functioned and were maintained.

Table 12
Number of Production and Non-Production Employee Responses Identifying
"The Most Noticeable Change in Productivity as a Result of Kaizen Events"

Production Employees		Non-Production Employees	
Theme	Num.	Theme	Num.
Short improvements that are not sustained	4	Better maintenance of equipment and tools	3
Better maintenance of equipment and tools	2	Production goals are met so less overtime is needed	2
A better organized workplace	1	Reduced set-up time	2
Increased employee motivation and morale	1	Increased employee motivation and morale	1
Improved product quality	1	Frustration from much time spent without instant results	1

Sample responses that identify these two main themes include the following answers:

- "A short burst of added productivity, followed by stagnation"; and
- "Proper tools, point of use, preventative measures, and broken machines being fixed."

a) Discussion of perceived effectiveness of Kaizen events

In companies that have implemented Kaizen most effectively, both production and non-production employees share goals and communicate outcomes. The lack of evidence of any significant differences between either production employees between the two companies surveyed may signal common achievements of Kaizen within the wood products industry. The lack of significant differences between production versus non-production employees surveyed may mean that within the companies surveyed overall outcomes of Kaizen are communicated and agreed upon within each company. The finding that production employees frequently identified short bursts of productivity followed by stagnation in their open-ended responses highlights a problem suggested by Liker and Meier (2006). The raising of this issue through the survey tool developed highlights the need for companies to follow up on past Kaizen events and to continue making resources and opportunities available so that Kaizen's effectiveness and positive outcomes can be sustained.

4.3.6. Factors contributing to the effectiveness of Kaizen events

a) Creating and testing the reliability and validity of index variables

As discussed, to test this hypothesis composite index variables were created by combining the values of individual five-point Likert questions that were part of the same theme, or construct. New composite variables were created from individual questions based on the following constructs:

- the effectiveness of Kaizen (to be used as the dependent variable in regression),
- teamwork,
- employee awareness and training,
- productivity improvement, and
- quality planning and control.

The number and content of individual questions used to measure each driver, as well as the possible range for each construct, is shown in Table 13. The maximum possible value for the index variable created for each construct is the number of Likert scale questions used to create the variable multiplied by 5, the maximum point value for each Likert scale question. If a respondent answered each question on the 1-5 Likert scale, then the minimum value for each index variable would be the number of Likert scale questions used to create the variable multiplied by 1. However, if a respondent answered "not applicable" to a statement or otherwise did not answer a question, the value for that answer would be missing. As will be discussed in greater detail in the following section, if a respondent either answered "not applicable" or did not answer any of the questions used to create one of the index variables, then that respondent could not be included in the regression analysis. For this reason, the minimum value for the range of values for each index variable that would be allowed for

inclusion in the regression analysis is 1. That is, respondents to be included in the regression analysis they had to answer at least one question related to each of the constructs for drivers of Kaizen.

Table 13

Creation of Index Variables for Divers of Kaizen Constructs for Regression Analysis

Construct measured and possible range of values	**Statements used in Likert Questions for Each Construct**
Effectiveness of Kaizen (Overall: 22-45 Company A: 22-45 Company B: 28-35)	1) Since we introduced Kaizen we have increased our competitiveness 2) After we implemented Kaizen activities we have increased profits 3) Since we applied Kaizen activities we have decreased cost 4) Application of Kaizen helped us improve lead time 5) Since we introduced Kaizen we have increased productivity 6) Adopting Kaizen activities enables us to improve product quality 7) Since we introduced Kaizen we have improved employee motivation 8) After we started practicing Kaizen we have improved customer satisfaction 9) Since we introduced Kaizen we have improved the time it takes to cut the dimensions of a product (cut time)
Quality planning and control (Overall: 9-50 Company A: 28-50 Company B: 9-17)	1) Our company uses cause and effect diagrams for quality planning and control 2) Our company uses scatter diagrams for quality planning and control 3) Our company uses “quality circles” for quality planning and control 4) Our company uses Pareto analyses for quality planning and control 5) Our company monitors employees for quality planning and control 6) Our company has a formal continuous improvement program as part of our quality planning and control process 7) Our company administers statistical process control (SPC) for measuring and controlling quality 8) In our SPC process we can make improvement decisions on the shop floor 9) SPC helped us determine control limits to reduce product variation 10) SPC analysis enables us to make changes in the process before defects occur
Teamwork (Overall: 17-25 Company A: 18-25 Company B: 17-20)	1) Employees are knowledgeable of other teammates’ job duties and functions 2) Managers are knowledgeable of each employee’s job duties and functions within a project team 3) Managers successively clarify and communicate each team member’s job duties and functions 4) Duties and functions are effectively delegated among team members 5) Our company actively identifies and addresses barriers to teamwork

Construct measured and possible range of values	Statements used in Likert Questions for Each Construct
Employee awareness and training (Overall: 30-45 Company A: 31-45 Company B: 30-33)	1) Our company's leadership is committed to Continuous Improvement and Lean Thinking 2) Our company's production workers are committed to Continuous Improvement and Lean Thinking 3) Our company has a clear statement of its dedication to implement continuous improvement initiatives 4) Our company has a clear statement of its goals 5) Our company frequently communicates its business goals and strategies with employees 6) Production workers are encouraged to provide input on company goals and strategies 7) Managers receive regular training in continuous improvement skills and strategies 8) Production workers are regularly trained in continuous improvement skills and strategies 9) Training sessions in continuous improvement have improved worker and company performance
Productivity (Overall: 11-20 Company A: 12-20 Company B: 11-13)	1) Kaizen events can help improve our company's cost savings 2) In the past, implementation of Kaizen events has improved our industry competitiveness 3) In the past, implementation of Kaizen events has reduced our company's lead time 4) In the past, implementation of Kaizen events has increased our company's physical labor productivity

For these new construct-based index variables to be effective in their measurements, the variables must be reliable. This means that the individual questions that make up the composite Likert scale variables must be related to each other and correlated in the same direction to show that the individual questions relate to the same overall theme. Table 14 shows the Cronbach's alpha coefficients measuring the reliability of the index variables created. These tests of reliability shown in Table 14 include responses from both Company A and Company B employees. Overall, the results demonstrate strong construct reliability for the composite measurements. The lowest Cronbach's alpha coefficient, 0.67, was for the composite variable based on five Likert questions related to teamwork strategies. The index variable used to measure this construct excluded the two survey questions related to barriers to teamwork because those two questions asked respondents to agree with a negative

statement, which made the response values trend in the opposite direction of the other teamwork questions. The index variable used to measure the construct of teamwork also excludes the three questions related to cross-functional teams because the inclusion of these questions reduced the construct's Cronbach's alpha score and therefore did not help the reliability of the teamwork construct variable. However, this Cronbach's alpha coefficient is still moderately strong.

Table 14
Reliability of Index Variables for Drivers of Kaizen Constructs

Construct measured	Average inter-item covariance	Number of Likert items in the scale	Cronbach's alpha reliability coefficient
Effectiveness of Kaizen	0.44	9	0.96
Quality planning and control	0.61	10	0.90
Teamwork	0.10	5	0.67
Employee awareness and training	0.27	9	0.88
Productivity	0.34	4	0.82

b) Multiple linear regression model

Based on the prior tests and the creation of the construct variables, the following multiple linear regression model was developed and applied:

Effectiveness of Kaizen = b0(constant term) + b1(Quality planning and control) + b2(Teamwork) + b3(Employee awareness and training) + b4(Productivity improvement) + Error

c) Sample size used to test the regression model

The regression was run with the index variables whose values represent the sum of the point values of the individual Likert scale questions related to the same construct. In order to run a regression on the data observation for a survey respondent, the survey respondent could not

have: 1) left all of the questions that were used to create one of the index variables used in the above regression model unanswered, or 2) marked "N/A" ("not applicable") for all of the questions that were used to create one of the index variables used in regression model. For example, if someone did not answer any of the questions related to productivity improvement but answered all the questions that were used to create the other construct variables, that respondent's observation could still not be used in the regression. Out of the 23 survey responses gathered as part of this research, 15 were able to be analyzed using multiple linear regression. Observations for eight survey respondents could not be used because the respondent either did not answer any of the questions used to create one of the construct variables, or the respondent answered "N/A" for all such questions.

As a result of limiting the number of observations that can be used for regression analysis from 23 to 15, no respondents from Company B were able to have their observations included. This is because six of the Company B respondents did not give a one through five Likert point value for all of the quality planning and control questions, one Company B respondent did not give a one through five Likert point value for any of the effectiveness of Kaizen Questions, and one Company A respondent did not did not give a one through five Likert point value for any of the effectiveness of Kaizen Questions. In summary, only respondents from Company A could be used for the regression analysis as part of objective 3.

Chi-square tests were conducted to determine whether the 15 remaining observations from Company A employees varied for any of the regression model variables based on whether the respondent was a production or non-production employee. The test results did not show any statistically significant relationships between production and non-production employee

responses. Therefore, there was no convincing reason to include a variable in the regression model to identify whether an employee is a production or non-production worker.

d) Regression results

As suggested by recent scholarship (King and Roberts, 2015), robust standard errors were used in testing the regression model to correct standard errors for minor issues related to how the model is specified. As shown in Table 15, all of the index variables had positive coefficients. However, only the variable based on the construct of productivity improvement achieved statistical significance, with a p-value of 0.04 and thus statistically significant beyond the 95% confidence level.

Table 15
Multiple Regression Results
(Likert Scale Variables as Sum of Item Values)

Likert scale construct	Coefficients	T-test statistic	P-value
Productivity improvement	1.52	2.39	0.04**
Teamwork	1.10	1.60	0.14
Employee awareness and training	0.13	0.96	0.36
Quality planning and control	0.11	0.44	0.67
Constant term	(19.77)	(1.28)	0.23
R-squared: 0.71 F-ratio: 6. 61 Prob(F): <0.01			

* p ≤ 0.1, ** p ≤ 0.05, *** p ≤ 0.01

The regression coefficient for the index variable related to the construct of productivity improvement was 1.52. This means that that, everything else held equal, if a respondent more positively answered one of the questions used to create the productivity improvement index variable by 1 Likert scale point, then this would correspond to a predicted increase of 1.52 Likert scale points to the value for the respondent's effectiveness of Kaizen index variable. As the composite independent variable based on the construct of productivity improvement

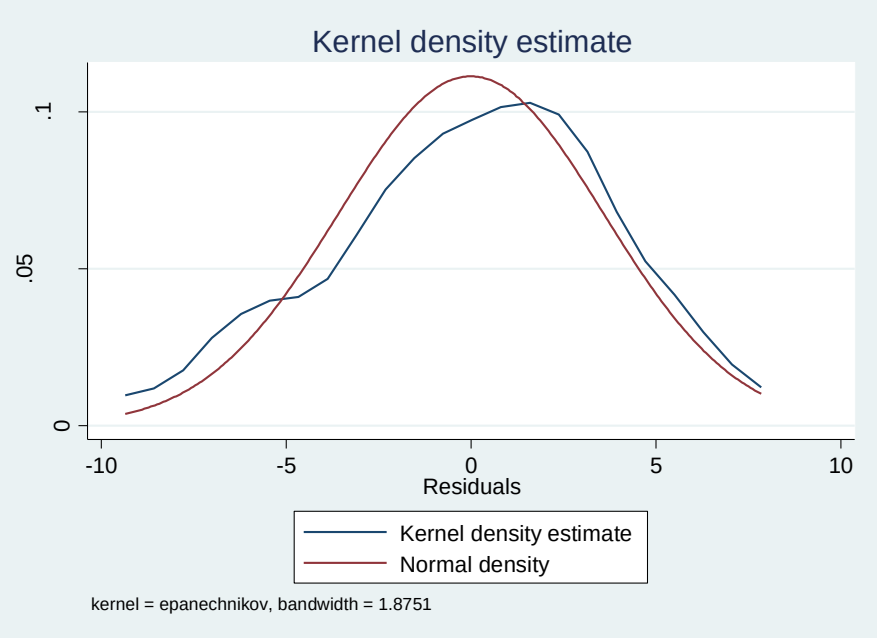
summed the Likert values from four questions, the maximum value any single respondent could have for this variable is 20, and because the composite dependent variable based on the construct of the effectiveness of Kaizen summed the Likert values for nine questions the maximum value any single respondent could have for this variable is 45. If a respondent's value for the index variable based on the construct of productivity improvement increased from answering "strongly disagree" to "to strongly agree" for all four questions (a value increase of 16, from a value of 4 to a value of 20) this would correspond to a predicted increase of 22.8 points for value of the index variable based on the construct of the effectiveness of Kaizen, which represents 50.7% of the total possible value for the effectiveness of Kaizen index variable.

e) Testing the assumptions needed to use multiple linear regression

Testing the assumptions behind the use of multiple linear regression can provide additional evidence to support a regression model's results. UCLA's Institute for Digital Research and Education (n.d.) states that the first assumption of multiple linear regression is that the variances of the modeling measurement errors (also known as "residuals") do not vary with the dependent variable for this regression analysis, the composite Likert variable on the effectiveness of Kaizen). Modeling measurement errors, or residuals, can be thought of as the difference between an observed observation and a predicted value (ibid.). One way of testing the assumption that the residuals do not vary with the regression model's dependent variable is by using and graphing what are known as Kernel density estimates (ibid.). For the assumption to be met, the graph of Kernel density estimates should be as close to normally distributed as possible. Figure 4 shows the Kernel density estimate graph based on the regression model that was used to test the gathered survey data for this research. The Kernel

density estimate appears close to normally distributed, which provides support for the use of the regression model.

Figure 4
Testing the Normality of Regression Model Residuals



The second assumption that must be met for multiple linear regression is that there is no "multicollinearity." According to the UCLA Institute for Digital Research and Education (n.d.), multicollinearity occurs when any of the independent variables in a regression have a close to perfect linear relationship with one another. Multicollinearity is a problem because if the variables are so related that they can be used in change of one other in the regression model then "regression model estimates of the coefficients become unstable and the standard errors for the coefficients can get wildly inflated" (ibid.). The variance inflation factor (vif) test is one way to test for multicollinearity. In general, vif values should be less than 10, and the measure of "tolerance" defined as 1/vif should be less than 0.1 (ibid.). If the vif test value is greater than 10, this may mean that there is too strong of a linear relationship between at

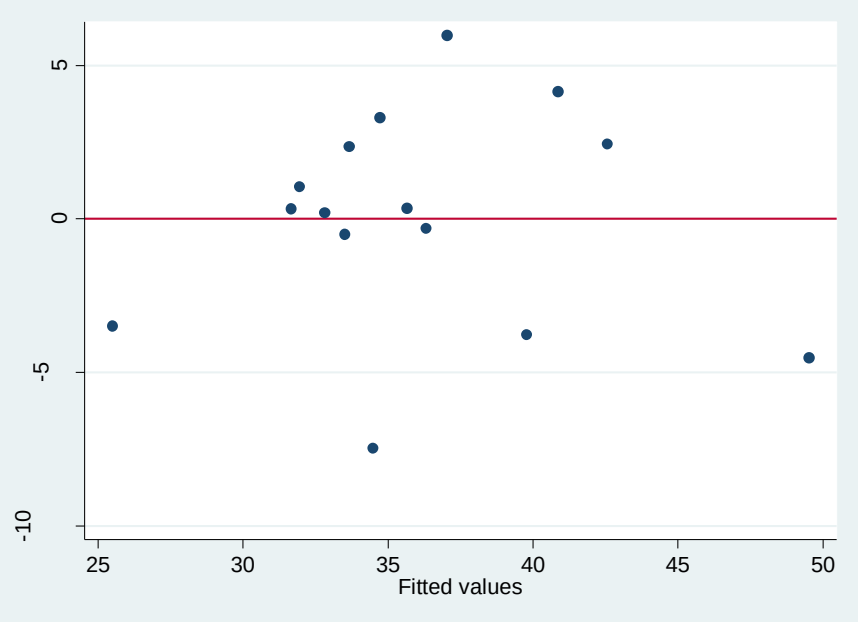
least two of the independent variables used in a regression model. As shown in Table 16, the variance inflation factor values for the regression model are low enough to not raise concerns.

Table 16
Testing Multicollinearity of Regression Model

Likert scale construct	Variance Inflation Factor	1/Variance Inflation Factor
Productivity improvement	2.49	0.40
Employee awareness and training	1.83	0.55
Quality planning and control	1.68	0.59
Teamwork	1.36	0.73
Average	1.84	0.57

The last assumption of multiple linear regression that should be tested is the assumption that there is no pattern in the residuals when these measurement errors are plotted against the values in the regression (UCLA Institute for Digital Research and Education, n.d.). Figure 5 graphs the residuals of the predicted (also known as "fitted") values of the tested regression model, and from the graph there does not appear to be a pattern to the scatterplot.

Figure 5
Distribution of Regression Model Measurement Errors



In addition to creating a scatterplot based on the measurement errors of a regression model, the assumption that there is no pattern to the variance of residuals can be tested statistically using what is known as White's test (Williams, 2015). White's test creates a chi-square value and a p-value to test the assumption that there is no pattern to the variance of residuals, which means that a very low p-value would suggest that this assumption is incorrect and therefore that the regression model is not correct (UCLA Institute for Digital Research and Education, n.d.; Williams, 2015). Conducting White's test on the regression model for this research resulted in a total chi-square value of 18.85 and a p-value of 0.47, which supports the use of the regression model used.

f) Discussion of regression results

The significant and positive association between perceived improvements in productivity and the perceived effectiveness of Kaizen is supported by the research findings of Stainer (1995), as well as of Laraia, Moody, and Hall (1999), who cite Kaizen implementation as a main cause of the increase in productivity for Japanese manufacturing companies after World War II. Singh and Singh's (2009) extensive literature review on Kaizen discusses several other case studies and surveys that highlight productivity gains as a result of effective Kaizen implementation. Within the wood products industry, Radharamanan, Godoy, and Watanabe (1996) found that Kaizen increased productivity and other measurements in custom furniture companies.

While the results of this research identify the significant link between how employees view productivity improvement and the effectiveness of Kaizen, there are several things that those in the wood products industry should consider in order to maximize and sustain productivity improvements related to Kaizen and other continuous improvement activities. Stainer (1995)

cites three principles meant to guide productivity improvement due to Kaizen implementation: 1) productivity improvement should lead to increased long-term employment and hiring; 2) in order to increase productivity, production and management employees must coordinate and cooperate so that there are good labor-management relations; and 3) gains from improved productivity should be fairly distributed between production employees, management employees, and consumers. Laraia et al. (1999) also warn that companies and senior management should have a plan for business growth to ensure that employees are not displaced and laid off after large productivity improvements. The authors caution that production employees will not be motivated to successfully implement Kaizen and improve productivity if the employees believe or witness that an increase in productivity results in layoffs due to reduced need for employees. This lack of motivation may be even worse if production employees believe that management does not care about this issue (ibid.). Therefore, each company should create a plan for expanding business operations and increasing rewards to employees if productivity improvement is achieved, and then this plan should be communicated with the company's employees.

Finally, for productivity improvement to be fully achieved companies need to understand which measurements to use when measuring productivity. As mentioned, Czabke (2007) identified cost savings and lead times as measurements of productivity improvement when surveying wood products companies. Laraia et al. (1999) add that companies must understand the production process that is being measured by using flow diagrams, and must understand how productivity data are gathered, how to interpret the data, and to how to identify other factors that may add context to the gathered productivity data.

Chapter 5: Limitations and Suggestions for Future Research

While the results of this research identify important findings related to the development and application of research tools for measuring the effectiveness of Kaizen, there are several limitations to this study. Future research can build upon the results and initial conclusions from this study by addressing these limitations and examining additional factors that may affect perceptions toward continuous improvement practices.

One of the main limitations in interpreting this study's findings is that the sample size for the number of questionnaires submitted was less than expected. The sample sizes that were used for the chi square tests and regression analysis limit the ability to apply the results and related conclusions more generally within the wood products industry. Future researchers may wish to ensure that they administer the survey to a larger number of employees so that if some fail to submit the survey the overall sample size will still be large enough for the results to be applied more broadly. However, given the case study approach used by this research, interview and survey results were able to helpfully supplement one another to add greater depth and context than possible through either using only interviews or surveys for gathering data.

In addition, future researchers could increase the scope of this study by surveying more companies that produce a wider range of products, which could be divided between primary versus secondary products or which could be categorized by specific product types. This would better allow for conclusions to be applied to the overall wood products industry as well as allow for greater ability to identify any differences in employee perceptions based on the type of product their company produces.

While the questionnaire asked respondents to estimate the number of employees at their company, the limited number of companies surveyed did not easily allow for regression or other tests to control for the effect of company size on employee perceptions. As mentioned, prior research has identified the size of a facility's operations as factor that can affect how successfully continuous improvement practices are implemented (Shah and Ward, 2003). It is possible that perceptions of the effectiveness of Kaizen and other continuous improvement practices also vary by the number of employees in a company and the facility's size. If future studies included greater variety in the sizes of companies employees work for could allow for statistical tests to determine whether perceptions vary by company size.

Another possible limitation of this study is that it did not ask questions about or attempt to control for the effects of a respondent's gender or their length of time at a company on their perceptions of Kaizen and continuous improvement. Company A's staff indicated during the on-site interview process that its employees are approximately half male and half female, but Company B did not estimate the number of male versus female employees at its facility. While the answers to the open-ended survey questions did not identify gender as a factor affecting employee perceptions, some researchers suggest gender may be a meaningful factor. For example, Losonci et al. (2011) found that male employees saw the greatest improvements related to the lean continuous improvement practices implemented. Future survey research could include a question identifying the gender of the respondent if researchers believe that gender is an important predictor of employee perceptions.

The questionnaire and resulting analyses in this study also did not attempt to identify or control for respondents' longevity in the company. While the number of years an employee has worked at their company was not frequently cited as an important factor for employee

perceptions in the reviewed literature, some respondents answered the open-ended surveyed question on barriers to Kaizen by suggesting that employees of longevity within their company were more resistant to using Kaizen methods and to adopting new measurements. Future research could explore this relationship between longevity and employee perceptions further by trying to measure and determine the effect an employee's age has on their perceptions related to Kaizen.

Other limitations to this research are that that the questionnaire administered to employees did not identify "controllable factors such as the pre-event communication process or event design variables (event duration, use of internal versus external facilitator, or the visibility of management support)" that have been found to affect employee perceptions of continuous improvement (Doolen et al., 2008, p. 652). Future researchers may also wish to identify and control for these factors to the best ability possible in regression models. Including these factors in a regression model could also help determine the effect that each of these factors has on employees' perceptions of the effectiveness of Kaizen.

Finally, this study focused mainly on the perceptions of employees related to Kaizen. Many of the questions examining employee perceptions used Likert scale variables asking employees to agree or disagree with various statements. Future research may wish to also more accurately measure how the use of different Kaizen and continuous improvement practices relate to the effectiveness of Kaizen. To measure this, future studies would need to identify and include measurements on a company's productivity, product quality, costs, and revenue in a regression model.

Chapter 6: Conclusions and Guidance for Practitioners and Industry

The results from the data analyses conducted as part of this research highlight areas in which employees differently view motivators and barriers to Kaizen within the wood products industry. These areas include: significant differences in how production employees across companies viewed the motivators of cost efficiencies, quality outcomes, and other companies' successes as a motivator for their own company's implementation of Kaizen; significant differences between how production employees across companies viewed middle management, time, money, technology, and poor past experiences as barriers to Kaizen; and significant differences between how production and non-production employees within one of the companies viewed poor past experiences as a barrier to Kaizen.

These results suggest areas where practitioners should focus their research as well as areas where companies should improve communication and collaboration between production and non-production employees. Similarly, the results from the regression model highlight the significant and positive relationship between Kaizen implementation and productivity improvement. This research also cites useful tools for companies to use in ensuring that they maximize their productivity outcomes from Kaizen events.

Perhaps most importantly, this research established a tool for researchers and companies within the wood products industry who practice Kaizen and other continuous improvement initiatives to measure the effectiveness of their implementation efforts and identify factors that most contribute to positive implementation outcomes.

Figure 6 illustrates the overall process for the development of a research tool to measure the effectiveness of Kaizen events. For practitioners, this process should begin with a thorough

review of the available literature to build upon the literature review conducted as part of this study to identify any new or additional sources that contribute to the understanding of Kaizen and other continuous improvement initiatives. For companies, this information gathering stage may also include gathering background information from trade conferences, training sessions, or by identifying practices used by other companies.

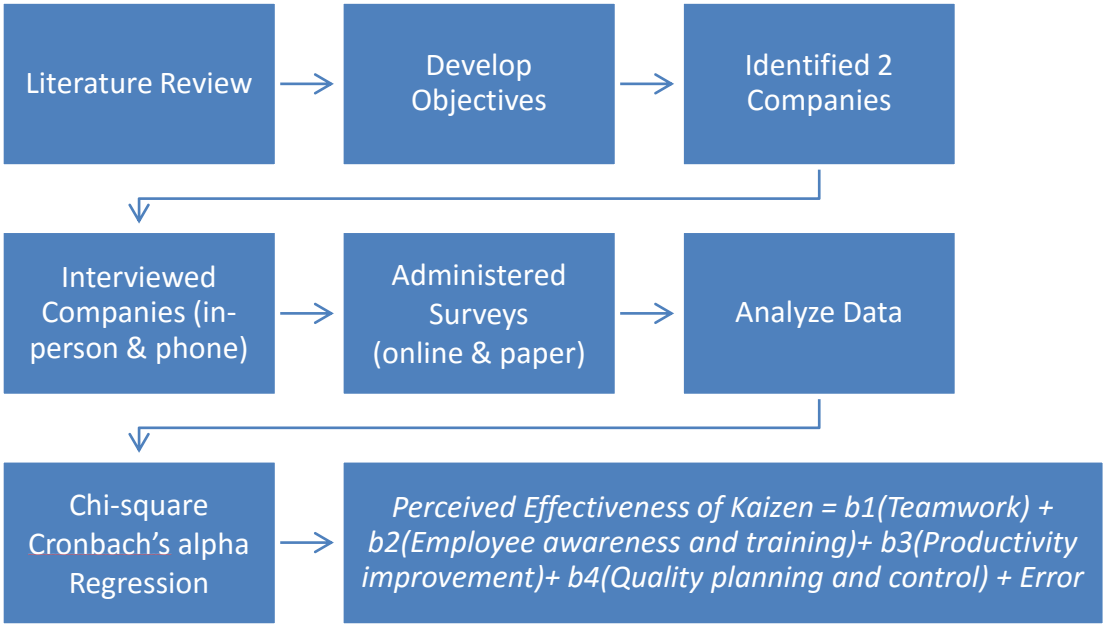
Practitioners and companies should then use the background information gathered, including this study, to modify the objectives developed for this study to best meet their own needs. For companies, this could mean focusing on a specific functional area of their company or on a particular type of desired performance outcome. To replicate this research tools, practitioners will then need to identify companies to interview and survey. Companies could apply this step to their own operations by identifying staff within their own company to interview or survey, but should ensure that these employees come from a variety of levels within their company in order to better understand their business as a whole

Companies can then use the survey questionnaire developed for this research and administer it to their own employees so that they can use this tool themselves measure how much their staff understand Kaizen and other continuous improvement initiatives, and to identify what works best within their company and what most needs improvement. Practitioners can similarly apply and modify this tool as necessary to gather and analyze data for their own research objectives.

The statistical methodology used to test the data gathered from this research, including the unique regression model developed, provide other useful tools for practitioners and companies. These methodology can easily be adapted for analyzing different survey questions

and different research objectives, and variables can be added or subtracted from the regression model shown as part of Figure 6 to accommodate the needs of practitioners or companies. In these ways, this research provides new insights into the use of Kaizen and other continuous improvement events that can be of use to those working within the U.S. wood products industry as well as those in academia and elsewhere.

Figure 6
Research Steps for Practitioners



References

5S today. (2015). Kaizen. Retrieved May 11, 2015, from http://www.5stoday.com/kaizen/

Ahlstrom, P. (2004). Lean service operations: translating lean production principles to service operations. *International Journal of Services Technology and Management*, *5*(5), 545-564.

Allen, I. E., & Seaman, C. A. (2007). Likert scales and data analyses. *Quality Progress*, *40*(7), 64-65.

An, A. B. (2002, April). Performing logistic regression on survey data with the new SURVEYLOGISTIC procedure. In *Proceedings of the twenty-seventh annual SAS® users group international conference* (pp. 258-27). SAS Institute Inc. Cary, NC.

Anand, G., Ward, P. T., Tatikonda, M. V., & Schilling, D. A. (2009). Dynamic capabilities through continuous improvement infrastructure. *Journal of Operations Management*, *27*(6), 444-461.

Anvari, A., Zulkifli, N., & Yusuff, R. M. (2011). Evaluation of approaches to safety in lean manufacturing and safety management systems and clarification of the relationship between them. *World Applied Sciences Journal*, *15*(1), 19-26.

Arnheiter, E. D., & Maleyeff, J. (2005). The integration of lean management and Six Sigma. *The TQM magazine*, *17*(1), 5-18.

Atkinson, C. (1994). Continuous improvement: the ingredients of change. *International Journal of Contemporary Hospitality Management*, *6*(1/2), 06-08.

Barkley, D. L. (2006, October). The value of case study research on rural entrepreneurship: Useful method?. In *presented Joint ERS-RUPRI Conf., Exploring Rural Entrepreneurship: Imperatives Opportunities Res., Washington, DC*.

Barnes, J., Bessant, J., Dunne, N., & Morris, M. (2001). Developing manufacturing competitiveness within South African industry: the role of middle management. *Technovation*, *21*(5), 293-309.

Beaver, W. (1994). Is TQM appropriate for the classroom?. *College Teaching*, *42*(3), 111-114.

Becker, J. E. (2001). Implementing 5S: To promote safety & housekeeping. *Professional Safety*, *46*(8), 29-31.

Bednarek, M., & Scibiorek, J. (2011). The Methodology of Implementation of Kaizen in Selected Polish Industrial Plants. *of Intercultural*, *3*(1), 139-147.

Berkson, J. (1938). Some difficulties of interpretation encountered in the application of the chi-square test. *Journal of the American Statistical Association*, *33*(203), 526-536.

Bernett, R., & Nentl, N. 2010. Opinions and Expectations about Continuous Improvement Programs. *The Journal for Quality and Participation*. *32*(4): 35-38.

Bessant, J., Caffyn, S., & Gallagher, M. (2001). An evolutionary model of continuous improvement behaviour. *Technovation*, *21*(2), 67-77.

Bowen, D. E., & Youngdahl, W. E. (1998). "Lean" service: in defense of a production-line approach. *International Journal of Service Industry Management*, *9*(3), 207-225.

Brashaw B. K., & McCoy J. (2007). Lean Manufacturing Concepts Applied to Logging Businesses. *USDA Forest Service.*

Brayfield, A. H., & Rothe, H. F. (1951). An index of job satisfaction. *Journal of applied psychology*, *35*(5), 307.

Chapman, C. D. (2005). Clean house with lean 5S. *Quality progress*, *38*(6), 27-32.

Clark, K. B., Chew, W. B., Fujimoto, T., Meyer, J., & Scherer, F. M. (1987). Product development in the world auto industry. *Brookings Papers on Economic Activity*, *1987*(3), 729-781.

Cole, R. E. (2003). From continuous improvement to continuous innovation. *Quality into the 21st century: Perspectives on quality and competitiveness for sustained performance*, *26*(8), 119-134.

Cumbo D., Kline D. E., & Bumgardner M. S. 2006. Benchmarking performance measurement and lean manufacturing in the rough mill. *Forest Products Journal, 56*(6), 25-30.

Czabke, J. (2007). *Lean thinking in the secondary wood products industry: challenges and benefits* (Doctoral dissertation, Oregon State University).

Czabke J., Hansen E. N., & Doolen T. L. (2008). A multiside field study of lean thinking in U.S. and German secondary wood products manufacturers. *Forest Products Journal, 58*(9), 77-85.

Das, A., Paul, H., & Swierczek, F. W. (2008). Developing and validating total quality management (TQM) constructs in the context of Thailand's manufacturing industry. *Benchmarking: An International Journal*, *15*(1), 52-72.

Devlin, P. (2005). Effect of continuous improvement training on student interaction and engagement. *Research and Practice for Persons with Severe Disabilities*, *30*(2), 47-59.

Dickson, E. W., Singh, S., Cheung, D. S., Wyatt, C. C., & Nugent, A. S. (2009). Application of lean manufacturing techniques in the emergency department. *The Journal of emergency medicine*, *37*(2), 177-182.

Doolen, T. L., Van Aken, E. M., Farris, J. A., & Worley, J. (2007). Designing Kaizen Events for Success. In *Proceedings of the 2007 IIE Annual Conference and Expo* (pp. 19-23).

Doolen, T. L., Van Aken, E. M., Farris, J. A., Worley, J. M., & Huwe, J. (2008). Kaizen events and organizational performance: a field study. *International Journal of Productivity and Performance Management*, *57*(8), 637-658.

Elmuti, D., & Kathawala, Y. (1997). An overview of benchmarking process: a tool for continuous improvement and competitive advantage. *Benchmarking for Quality Management & Technology*, *4*(4), 229-243.

Espinoza, O. A., Bond, B. H., & Kline, E. (2010). Quality measurement in the wood products supply chain. *Forest products journal*, *60*(3), 249-257.

Farris, J. A., Van Aken, E. M., Doolen, T. L., & Worley, J. (2008). Learning from less successful Kaizen events: a case study. *Engineering Management Journal*, *20*(3), 10-20.

Forza, C., & Filippini, R. (1998). TQM impact on quality conformance and customer satisfaction: a causal model. *International journal of production economics*, *55*(1), 1-20.

Fowler, F. J. (Ed.). (2009). *Survey research methods* (Vol. 1). Sage.

Fricke, C. F. (2010). Lean Management Awareness, Implementation Status, and Need for Implementation Support in Virginia's Wood Industry (Doctoral dissertation, Virginia Tech).

Goldman, S. L., Nagel, R. N., & Preiss, K. (1995). *Agile competitors and virtual organizations: strategies for enriching the customer* (Vol. 8). New York: Van Nostr and Reinhold.

Graban, M., & Swartz, J. E. (2012). Change for health. *Management Services*, *56*(2), 35-39.

Graban, M., & Swartz, J. E. (2012). *Healthcare kaizen: Engaging front-line staff in sustainable continuous improvements*. CRC Press.

Green, S. B., & Stutzman, T. (1986). An evaluation of methods to select respondents to structured job-analysis questionnaires. *Personnel Psychology*, *39*(3), 543-564.

Gunasekaran, A., Patel, C., & McGaughey, R. E. (2004). A framework for supply chain performance measurement. *International journal of production economics*, *87*(3), 333-347.

Hansen, E., & Smith, R. (1997). Assessing educational needs of the forest products industry in Oregon and Virginia. *Forest products journal*, *47*(4), 36-42.

Hansen, E. N. (2010). The role of innovation in the forest products industry. *Journal of Forestry*, *108*(7), 348-353.

Harry, M., & Schroeder, R. (2005). *Six sigma: the breakthrough management strategy revolutionizing the world's top corporations*. Random House LLC.

Hellsten, U., & Klefsjö, B. (2000). TQM as a management system consisting of values, techniques and tools. *The TQM magazine*, *12*(4), 238-244.

Hines, P., Francis, M., & Found, P. (2006). Towards lean product lifecycle management: a framework for new product development. *Journal of Manufacturing Technology Management*, *17*(7), 866-887.

Hoff, K., Fisher, N., Miller, S., & Webb, A. (1997). Sources of competitiveness for secondary wood products companies: A review of literature and research issues. *Forest Products Journal*, *47*(2), 31-37.

Holweg, M. (2007). The Genealogy of Lean Production. *Journal of Operations Management. 25*(2): 420-437.

Howison, J. D. (2009). A Tough 'Cell': Implementing Lean Production at Toledo Jeep. *Critical Sociology*, *35*(5), 689-696.

Hubbard, S. (2008). Challenges and Opportunities: Wisconsin's Forest Industry Today and Tomorrow. Presentation made at a University of Wisconsin-Madison sponsored Forestry Summit. Retrieved April 21, 2015, from http://wisconsinforestry.info/files/summit/SteveHubbardForestryIndustry.pdf

Hunter, S. L., Bullard, S., & Steele, P. H. (2004). Lean Production in the furniture industry: The double D assembly cell. *Forest Products Journal*, *54*(4), 32-38.

Imai, M. (1986). Kaizen: The key to Japan's competitive success. *NY: McGraw-Hill/Irwin*.

Incito Consulting Group. (2014.). Six Sigma, an Essential Tool for all Organizations. Retrieved April 21, 2015, from: http://www.incito.com/insights/six-sigma-an-essential-tool-for-all-organizations/

Ingle, S., & Roe, W. (2001). Six sigma black belt implementation. *The TQM Magazine*, *13*(4), 273-280.

Jabnoun, N. (2001). Values underlying continuous improvement. *The TQM Magazine*, *13*(6), 381-388.

Jamieson, S. (2004). Likert scales: how to (ab) use them. *Medical education*, *38*(12), 1217-1218.

Jin-Hai, L., Anderson, A. R., & Harrison, R. T. (2003). The evolution of agile manufacturing. *Business Process Management Journal*, *9*(2), 170-189.

John, G., & Reve, T. (1982). The reliability and validity of key informant data from dyadic relationships in marketing channels. *Journal of Marketing Research*, 517-524.

Kaye, M., & Anderson, R. (1999). Continuous improvement: the ten essential criteria. *International Journal of Quality & Reliability Management*, *16*(5), 485-509.

King, G., & Roberts, M.E. (2015). How robust standard errors expose methodological problems they do not fix, and what to do about it. *Political Analysis*, 23, 159-179.

Kitchenham, B., & Pfleeger, S. L. (2002). Principles of survey research part 2: designing a survey. *SIGSOFT Softw. Eng. Notes*, *27*(1), 18-20.

Kocakülâh, M. C., Austill, A. D., & Schenk, D. E. (2011, Mar). Lean Production Practices for Efficiency. *Cost Management*, *25*, 20-28.

Koenig, K. (2008, August 13). Northway's Lean, Green Component to Success. Retrieved February 12, 2015, from http://www.woodworkingnetwork.com/articles/northways_lean_green_component_to_success_127742528.html?view=all#sthash.5jui5RmH.dpbs

Komorita, S. S. (1963). Attitude content, intensity, and the neutral point on a Likert scale. *The Journal of social psychology*, *61*(2), 327-334.

Kozak, R. A., & Maness, T. C. (2003). A system for continuous process improvement in wood products manufacturing. *Holz als Roh-und Werkstoff*, *61*(2), 95-102.

Kucerova, M., & Paulova, I. (2011). Six Sigma than method processes improvement of wood companies. *Intercathedra*, *27*(1), 29-32.

Laerd Statistics. (n.d.1). Multiple regression analysis using SSPS statistics. Retrieved May 4, 2015, from https://statistics.laerd.com/spss-tutorials/multiple-regression-using-spss-statistics.php

Laerd Statistics. (n.d.2). Pearson Product-Moment Correlation. Retrieved December 15, 2014, from https://statistics.laerd.com/statistical-guides/pearson-correlation-coefficient-statistical-guide.php

Laraia, A. C., Moody, P. E., & Hall, R. W. (1999). *The kaizen blitz: accelerating breakthroughs in productivity and performance*. John Wiley & Sons.

Leavengood, S. A., & Reeb, J. E. (2002). *Statistical process control part 3: pareto analysis and check sheets.* Corvallis, OR.: Extension Service, Oregon State University.

Lee, R., Nippa, M., & Klossek, A. (2010). Employee Motivation and Employee Differentiation in Continuous Improvement: Evidence from a Multinational Company in China. In *15th Cambridge International Manufacturing Symposium, Cambridge, UK, 23rd-24th September*.

Levy, Y., & Ellis, T. J. (2006). A systems approach to conduct an effective literature review in support of information systems research. *Informing Science: International Journal of an Emerging Transdiscipline*, *9*(1), 181-212.

Liker, J. K. (Ed.). (1997). *Becoming lean: Inside stories of US manufacturers*. Productivity Press.

Liker, J., & Meier, D. (2006). *The Toyota way fieldbook*. New York: McGraw Hill.

Likert, R. (1932). A technique for the measurement of attitudes. *Archives of psychology*.

Linderman, K., Schroeder, R. G., Zaheer, S., & Choo, A. S. (2003). Six Sigma: a goal-theoretic perspective. *Journal of Operations management*, *21*(2), 193-203.

Losonci, D., Demeter, K., & Jenei, I. (2011). Factors influencing employee perceptions in lean transformations. *International Journal of Production Economics*, *131*(1), 30-43.

Maurer, T. J., & Pierce, H. R. (1998). A comparison of Likert scale and traditional measures of self-efficacy. *Journal of applied psychology*, *83*(2), 324.

Meadows, K. A. (2003). So you want to do research? 5: Questionnaire design. *British Journal of Community Nursing, 8*(12), 562-570.

Meredith, J. R., & McTavish, R. (1992). Organized manufacturing for superior market performance. *Long Range Planning, 25*(6), 63-71.

Miller, R. L., & Cangemi, J. P. (1993). Why total quality management fails: Perspective of top management. *Journal of Management Development, 12*(7), 40-50.

Modarress, B., Ansari, A., & Lockwood, D. L. (2005). Kaizen costing for lean manufacturing: a case study. *International Journal of Production Research, 43*(9), 1751-1760.

Mogey, N. (1999). So you want to use a Likert scale. *Learning technology dissemination*

Morgan, J. N., & Sonquist, J. A. (1963). Problems in the analysis of survey data, and a proposal. *Journal of the American statistical association, 58*(302), 415-434.

Ohno, T. (1988). The Toyota Production System: Beyond Large Scale Production. 1988, Portland, OR.

Ortiz, C. A. (2006). *Kaizen assembly: designing, constructing, and managing a lean assembly line*. CRC Press.

Madrigal-Sánchez, J., & Quesada-Pineda, H. (2012). Innovation: case study among wood, energy and medical firms. *Business Process Management Journal*, *18*(6), 898-918.

Mika, G. L. (2006). *Kaizen event implementation manual*. Society of Manufacturing Engineers.

Palmer, V. S. (2001). Inventory management KAIZEN. In *Engineering Management for Applied Technology, 2001. EMAT 2001. Proceedings. 2nd International Workshop on* (pp. 55-56). IEEE.

Perry, J. L. (1996). Measuring public service motivation: An assessment of construct reliability and validity. *Journal of public administration research and theory*, *6*(1), 5-22.

Pirraglia, A., Saloni, D., & Van Dyk, H. (2009). Status of lean manufacturing implementation on secondary wood industries including residential, cabinet, millwork, and panel markets. *BioResources*, *4*(4), 1341-1358.

Prajogo, D. I. (2005). The comparative analysis of TQM practices and quality performance between manufacturing and service firms. *International Journal of Service Industry Management*, *16*(3), 217-228.

Pyzdek, T. (2003). *The Six Sigma Handbook*. New York: McGraw Hill.

Quesada, H. (2010). Lean Inventory Management in the Wood Products Industry: Examples and Applications. *Virginia Cooperative Extension*. Publication 420-148

Quesada, H., & Buehlmann, U. (2011). Lean Thinking: Examples and Applications in the Wood Products Industry. *Virginia Cooperative Extension*. Publication 420-002

Quesada-Pineda, H. J., & Madrigal, J. (2013). Sustaining Continuous Improvement: A Longitudinal and Regional Study. *Leadership (LE)*, *13*, 15.

Radharamanan, R., Godoy, L. P., & Watanabe, K. I. (1996). Quality and productivity improvement in a custom-made furniture industry using Kaizen. *Computers & industrial engineering*, *31*(1), 471-474.

Ranawat, M.B., Arango, A.J.Y, Garcia Lopez, L.G., Bethancourt Perez, J.G., Ruther, C., & Ortiz Sanchez, J. (2007). *Six Sigma in Logistics*. Paper presented at GRIN Management Seminar.

Ray C. D., Zuo X., Michael J. H., & Wiedenbeck J. K. (2005). The Lean Index: Operational 'Lean' Metrics for the Wood Products Industry. *The U.S. Forest Service. p 238*

Rinehart, J. W. (1997). *Just another car factory?: Lean production and its discontents*. Cornell University Press.

Rust, K. F., & Rao, J. N. K. (1996). Variance estimation for complex surveys using replication techniques. *Statistical methods in medical research*, *5*(3), 283-310.

Sakakibara, S., Flynn, B. B., Schroeder, R. G., & Morris, W. T. (1997). The impact of just-in-time manufacturing and its infrastructure on manufacturing performance. *Management Science, 43*(9), 1246-1257.

Santos, J. R. A. (1999). Cronbach's alpha: A tool for assessing the reliability of scales. *Journal of extension, 37*(2), 1-5.

Schuler A., & Buehlmann U. (2003). Identifying Future Competitive Business Strategies for the U.S. Residential Wood Furniture Industry: Benchmarking and Paradigm Shifts. *USDA Forest Service.* p(1)

Schmitt, M. (2012). *Leadership and Healthcare Performance* (Doctoral dissertation, VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY).

Shah, R., & Ward, P. T. (2003). Lean manufacturing: context, practice bundles, and performance. *Journal of Operations Management, 21*(2), 129-149.

Sharma, S. K., Gupta, R. D., Kumar, A., & Singh, B. (2011). Supplier Issues for Lean Implementation. *International Journal of Engineering Science, 3*(5), 3900-3905.

Sheridan, J. H. (1997). Kaizen blitz. *Industry Week, 246*(26), 18-27.

Singh, J., & Singh, H. (2009). Kaizen philosophy: a review of literature. The Icfai University *Journal of Operations Management, 8*(2), 51-72.

Smith, R. L., Pohle, W., Araman, P., & Cumbo, D. (2004). Characterization of low-grade hardwood lumber by the secondary wood processing industry. *Forest products journal*, *54*(12), 15-23.

Sohal, A. S., Keller, A. Z., & Fouad, R. H. (1989). A review of literature relating to JIT. *International Journal of Operations & Production Management*, *9*(3), 15-25.

Sohal, A. S., & Egglestone, A. (1994). Lean production: experience among Australian organizations. *International Journal of Operations & Production Management*, *14*(11), 35-51.

Soltero, C., & Waldrip, G. (2002). Using kaizen to reduce waste and prevent pollution. *Environmental Quality Management*, *11*(3), 23-38.

Spear, S., & Bowen, H. K. (1999). Decoding the DNA of the Toyota production system. *Harvard Business Review*, *77*, 96-108.

Stainer, A. (1995). Productivity management: the Japanese experience. *Management Decision*, *33*(8), 4-12.

Statistics Solutions. (n.d.). Assumptions of logistic regression. Retrieved May 9, 2015, from http://www.statisticssolutions.com/assumptions-of-logistic-regression/

Stat Trek. (n.d.). Chi-square test of independence. Retrieved May 6, 2015, from http://stattrek.com/chi-square-test/independence.aspx

Sugimori, Y., Kusunoki, K., Cho, F., & Uchikawa, S. (1977): Toyota production system and Kanban system Materialization of just-in-time and respect-for-human system, International Journal of Production Research, 15:6, 553-564

Svensson, E. (2001). Guidelines to statistical evaluation of data from rating scales and questionnaires. *Journal of Rehabilitation Medicine*, *33*(1), 47-48.

Swanson, C. A., & Lankford, W. M. (1998) "Just-in-time manufacturing", *Business Process Management Journal*, *4*(4), 333-341.

Synodinos, N. E. (2003). The "art" of questionnaire construction: some important considerations for manufacturing studies. *Integrated manufacturing systems*, *14*(3), 221-237.

Tavakol, M. & Dennick, R. (2011). Making sense of Cronbach's alpha. *International Journal of Medical Education, 2,* 53-55.

Teece, D., & Pisano, G. (1994). The dynamic capabilities of firms: an introduction. *Industrial and corporate change*, *3*(3), 537-556.

Terziovski, M., & Sohal, A. S. (2000). The adoption of continuous improvement and innovation strategies in Australian manufacturing firms. *Technovation*, *20*(10), 539-550.

UCLA Institute for Digital Research and Education. (n.d.). Stata web books regression with Stata chapter 2 – regression diagnostics. Retrieved July 5, 2015, from http://www.ats.ucla.edu/stat/stata/webbooks/reg/chapter2/statareg2.htm

Van Aken, E. M., Farris, J. A., Glover, W. J., & Letens, G. (2010). A framework for designing, managing, and improving Kaizen event programs. *International Journal of Productivity and Performance Management*, *59*(7), 641-667.

Velarde G. J., Pirraglia A., Dyk H. V., & Saloni D. E. (2011). Lean manufacturing in the US South Atlantic Region: an overview of the current state of implementation in the secondary wood industry. *International Wood Products Journal*, 2(1), 30-37.

Vlosky, R. P., Ozanne, L. K., & Fontenot, R. J. (1999). A conceptual model of US consumer willingness-to-pay for environmentally certified wood products. *Journal of Consumer Marketing*, *16*(2), 122-140.

Wagner, E. R., & Hansen, E. N. (2005). Innovation in large versus small companies: insights from the US wood products industry. *Management Decision*, *43*(6), 837-850

Waldman, D. A. (1995). What is TQM Research?. *Canadian Journal of Administrative Sciences/Revue Canadienne des Sciences de l'Administration*, *12*(2), 91-94.

Webster, J., & Watson, R. T. (2002). Analyzing the past to prepare for the future: Writing a literature review. *Management Information Systems Quarterly*, *26*(2), xiii-xxiii.

White, R. E., Pearson, J. N., & Wilson, J. R. (1999). JIT manufacturing: a survey of implementations in small and large US manufacturers. *Management science*, *45*(1), 1-15.

Williams, R. (2015). Heteroskedasticity. University of Notre Dame. Retrieved July 7, 2015, from https://www3.nd.edu/~rwilliam/stats2/l25.pdf

Williams, A. (2003). How to … Write and analyze a questionnaire. *Journal of Orthodontics*, *30*(September), 245-252.

Womack, J. P., Jones, D. T., & Roos, D. (1991). The machine that changed the world: The story of lean production. 1st Harper Perennial Ed. *New York*.

Wood, S. (1989). The Japanese Management Model Tacit Skills in Shop Floor Participation. *Work and Occupations*, *16*(4), 446-460.

Wood, N. (2004). Lean Thinking: What it is and what it isn't. *Management Services*, *48*(2), 8-10.

Young, T. M., & Winistorfer, P. M. (1999). Statistical process control and the forest products industry. *Forest products journal*, *49*(3), 10-17.

Yusof, S. R. M., & Aspinwall, E. (2000). Total quality management implementation frameworks: comparison and review. *Total Quality Management*, *11*(3), 281-294.

Zhang, Q., Irfan, M., Khattak, M. A. O., Zhu, X., & Hassan, M. (2012). Lean Six Sigma: a literature review. *Interdisciplinary Journal of Contemporary research in business*, *3*(10), 599-605.

Appendix A: Sample Interview Questions

Interview Introduction:

Thank you for making the time for this interview. The purpose of the interview is gain a deeper understanding on your company and get your opinion on how continuous improvement is applied at your location.

Questions:

Background

1. How long have you worked in your current position?

2. How long has your company been using Kaizen? How long has your company been using lean manufacturing?

Motivators and challenges

3. What were the main motivators for implementing these continuous improvement practices?

4. What were the challenges during Kaizen implementation in your organization?

- Which of these challenges are your company still facing?
- In hindsight, what might you have done to avoid these?
- How did you solve the problems that occurred?

Teamwork

5. For your project teams, about how many members work on a team?

- What work functions are represented on each team?
- What is a typical timeline for teams to meet their work goals?
- How often do you do team meetings?

6. Can you describe the role of team decision making in your company?

7. How much are employees allowed to participate and give suggestions in order to meet work goals?

Workplace culture and employee awareness

8. Can you try to describe your workplace's culture (main values and attitudes)?

9. How would you describe your leadership style?

10. How do you communicate goals and strategies with your employees?

11. How do you help employees understand and share the goals of management?

Employee recognition and rewards

12. How do you recognize workers for their performance?

13. How do you reward workers for their performance?

- Is there a performance related pay system?

Quality control

14. Can you describe your quality management programs?

15. What measures of quality do you use?

16. When is a product identified as being defective based on these measurements?

Benefits after implementation

17. What are the main positive changes you saw after using Kaizen or other continuous improvement initiatives (such as lean thinking)?

18. What measures of productivity improved the most from using Kaizen?

- By about what percent did these measures increase (and over what time period)?

19. What productivity measures did not increase as much as expected after implementing Kaizen? Do you have any ideas as to why this was not as successful?

20. Did you have any positive change in profits after using Kaizen or lean?

- How large was the change?

21. Can you describe any continuous improvement plans that your company is considering to use in the future? What are the goals of these plans?

Interview Conclusion:

Thank you very much for your time and help. We appreciate you allowing us to visit and meet with you. If you have any other comments or questions that you think of for us please feel free to contact me. Thank you again.

Appendix B: Survey Questions

I. Background Questions

What best describes your position in your company?

☐ production
☐ administrative
☐ other
If other, please list: _____

How long has your business been using continuous improvement concepts?

☐ less than 1 year
☐ 1-3 years
☐ 4-5 years
☐ more than 5 years
☐ I don't know

Which continuous improvement initiative has your company been using?

☐ just-in-time (JIT)
☐ Kaizen
☐ six sigma
☐ total quality management
☐ I don't know
☐ others
If others, please list: _____

In the following part there will be some Likert Scale questions that address the Kaizen continuous improvement initiative in order to measure effectiveness, barriers and drivers of Kaizen activities. Please circle the response that best describes your opinion in the scale. The scale is as follows:

1= Strongly Disagree, 2= Disagree, 3= Undecided, 4= Agree, 5= Strongly Agree, N/A= Not Applicable

Use and knowledge of Kaizen					
1	2	3	4	5	N/A
Strongly disagree	Disagree	Undecided	Agree	Strongly Agree	Not applicable
Our company has knowledge of continuous improvement strategies				1 2 3 4 5	N/A
Our company has knowledge of Kaizen activities				1 2 3 4 5	N/A
Our company is advanced in its implementation of Kaizen activities				1 2 3 4 5	N/A
Our company uses value stream mapping to observe the needs for lean improvement strategies				1 2 3 4 5	N/A

II. Motivators of Kaizen Activities

Motivators of Kaizen Activities					
1	2	3	4	5	N/A
Strongly disagree	Disagree	Undecided	Agree	Strongly Agree	Not applicable
Customer feedback influenced our company's decision to implement Kaizen methods				1 2 3 4 5	N/A
Cost efficiencies influenced our company's decision to implement Kaizen methods				1 2 3 4 5	N/A
Improved quality outcomes influenced our company's decision to implement Kaizen methods				1 2 3 4 5	N/A
Sales growth influenced our company's decision to implement Kaizen methods				1 2 3 4 5	N/A
Lead time reduction influenced our company's decision to implement Kaizen methods				1 2 3 4 5	N/A
Inventory reduction influenced our company's decision to implement Kaizen methods				1 2 3 4 5	N/A
Leadership from within the company influenced our company's decision to implement Kaizen methods				1 2 3 4 5	N/A
Attending a training session or trade conference our company's decision to implement Kaizen methods				1 2 3 4 5	N/A
Knowledge of another company's use of Kaizen activities influence our company's decision to implement Kaizen methods				1 2 3 4 5	N/A

What has been the largest motivator for your company's use of Kaizen methods? Please describe.

_____

_____

_____

III. Barriers to Kaizen Activities

Barriers to Kaizen Activities					
1	2	3	4	5	N/A
Strongly disagree	Disagree	Undecided	Agree	Strongly Agree	Not applicable
There is little interest in changing or adopting Kaizen activities				1 2 3 4 5	N/A
There is not enough expertise on how to implement Kaizen activities				1 2 3 4 5	N/A
There is resistance to generating new measurements of improvement for Kaizen activities				1 2 3 4 5	N/A
Middle management resists implementing Kaizen activities				1 2 3 4 5	N/A
Employee staff resist implementing Kaizen activities				1 2 3 4 5	N/A
Implementing Kaizen would pose a challenge to our workplace culture				1 2 3 4 5	N/A
There is not enough time for the company to currently implement Kaizen activities				1 2 3 4 5	N/A
There were a small amount and only poor experiences with past Kaizen projects				1 2 3 4 5	N/A
There is a lack of technological capability to be able to implement Kaizen activities				1 2 3 4 5	N/A
Financial resources that are dedicated for Kaizen projects are fairly limited into the company				1 2 3 4 5	N/A

What has been the largest barrier to your company's use of Kaizen methods? Please describe.

_____
_____
_____

IV. Effectiveness of Kaizen

Effectiveness of Kaizen					
1	2	3	4	5	N/A
Strongly disagree	Disagree	Undecided	Agree	Strongly Agree	Not applicable
Since we introduced Kaizen we have increased our competitiveness				1 2 3 4 5	N/A
After we implemented Kaizen activities we have increased profits				1 2 3 4 5	N/A
Since we applied Kaizen activities we have decreased cots				1 2 3 4 5	N/A
Application of Kaizen helped us improving lead time				1 2 3 4 5	N/A
Since we introduced Kaizen we have increased productivity				1 2 3 4 5	N/A
Adopting Kaizen activities enabled us to improve product quality				1 2 3 4 5	N/A
Since we introduced Kaizen we have improved employee motivation				1 2 3 4 5	N/A
After we started practicing Kaizen we have improved customer satisfaction				1 2 3 4 5	N/A
Since we introduced Kaizen we have improved the time it takes to cut the dimensions of a product (cut time)				1 2 3 4 5	N/A

V. Drivers of Kaizen Activities

a. Employee awareness and training

Employee awareness and training					
1	2	3	4	5	N/A
Strongly disagree	Disagree	Undecided	Agree	Strongly Agree	Not applicable
Employee Awareness					
Our company's leadership is committed to Continuous Improvement and Lean Thinking				1 2 3 4 5 N/A	
Our company's production workers are committed to Continuous Improvement and Lean Thinking				1 2 3 4 5 N/A	
Our company has a clear statement of its dedication to implement continuous improvement initiative				1 2 3 4 5 N/A	
Our company has a clear statement of its goals				1 2 3 4 5 N/A	
Our company frequently communicates its business goals and strategies with employees.				1 2 3 4 5 N/A	
Production workers are encouraged to provide input on company goals and strategies				1 2 3 4 5 N/A	
Training					
Managers receive regular training in continuous improvement skills and strategies				1 2 3 4 5 N/A	
Production workers are regularly trained in continuous improvement skills and strategies				1 2 3 4 5 N/A	
Training sessions in continuous improvement have improved workers' and company performance				1 2 3 4 5 N/A	

b. Teamwork

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

Employees are knowledgeable of other teammates' job duties and functions	1 2 3 4 5 N/A
Managers are knowledgeable of each employee's job duties and functions within a project team	1 2 3 4 5 N/A
Managers successively clarify and communicate each team member's job duties and functions	1 2 3 4 5 N/A
Duties and functions are effectively delegated among team members	1 2 3 4 5 N/A
Our company actively identifies and addresses barriers to teamwork	1 2 3 4 5 N/A
Our company has difficulties in establishing effective teamwork	1 2 3 4 5 N/A
Lack of understanding of other teammates' roles and responsibilities is a challenge to teamwork in our company	1 2 3 4 5 N/A
Cross-Functional Kaizen Teams	1 2 3 4 5 N/A
Our company creates small project teams with employees with different job functions	1 2 3 4 5 N/A
Our company uses job rotations to create multifunctional workers	1 2 3 4 5 N/A
Our company uses multifunctional product design teams	1 2 3 4 5 N/A

c. Quality planning and control

Quality Planning and Control					
1	2	3	4	5	N/A
Strongly disagree	Disagree	Undecided	Agree	Strongly Agree	Not applicable

Our company uses cause and effect diagrams for quality planning and control	1 2 3 4 5 N/A
Our company uses scatter diagrams for quality planning and control	1 2 3 4 5 N/A
Our company uses "quality circles" for quality planning and control	1 2 3 4 5 N/A
Our company uses Pareto analyses for quality planning and control	1 2 3 4 5 N/A
Our company monitors employees for quality planning and control	1 2 3 4 5 N/A
Our company has a formal continuous improvement program as part of our quality planning and control process	1 2 3 4 5 N/A
Our company administers statistical process control (SPC) for measuring and controlling quality	1 2 3 4 5 N/A
In our SPC process we can make improvement decisions on the shop floor	1 2 3 4 5 N/A
SPC helped us to determine control limits in order to reduce product variation	1 2 3 4 5 N/A
SPC analysis enables us to make changes in the process before defects occur	1 2 3 4 5 N/A

d. Productivity improvement

Productivity improvement					
1	2	3	4	5	N/A
Strongly disagree	Disagree	Undecided	Agree	Strongly Agree	Not applicable
Kaizen events can help improve our company's cost savings				1 2 3 4 5	N/A
In the past implementation of Kaizen events has improved our industry competitiveness				1 2 3 4 5	N/A
In the past implementation of Kaizen events has reduced our company's lead time				1 2 3 4 5	N/A
In the past implementation of Kaizen events has increased our company's physical labor productivity				1 2 3 4 5	N/A
Kaizen events can help improve our company's percentage cut time/branding time				1 2 3 4 5	N/A

What has been the most noticeable change in productivity as result of Kaizen events? Please Describe.

_____
_____
_____

How often the employees have training activities for continuous improvement activities?

☐ never ☐daily ☐weekly ☐ monthly ☐ quarterly ☐ yearly ☐ I don't know

How often do you participate Kaizen group activities?

☐ never ☐daily ☐ weekly ☐ monthly ☐ quarterly ☐ yearly ☐ I don't know

How often are quality control goals communicated with management and employees?

☐ never ☐daily ☐weekly ☐ monthly ☐ quarterly ☐ yearly ☐ I don't know

How often are quality control data results communicated with management and employees?

☐ never ☐daily ☐weekly ☐ monthly ☐ quarterly ☐ yearly ☐ I don't know

How often are quality control data gathered?

☐ never
☐ every hour
☐ daily
☐ weekly
☐ monthly
☐ other

If other, please list: _____

Appendix C: Survey Results for Likert Scale Questions (Mean/Average Values)

Likert Scale Question (Where 1 = Strongly Disagree and 5 = Strongly Agree)	Average Non-Production Employee Likert Score	Average Production Employee Likert Score	Average Overall Likert Score
Use and knowledge of Kaizen			
Our company has knowledge of continuous improvement strategies	4.6	4.6	4.6
Our company has knowledge of Kaizen activities	4.8	4.2	4.4
Our company is advanced in its implementation of Kaizen activities	4.1	3.4	3.7
Our company uses value stream mapping to observe the needs for lean improvement strategies	4.5	2.8	3.6
Motivators of Kaizen			
Customer feedback influenced our company's decision to implement Kaizen methods	3.2	3.3	3.3
Cost efficiencies influenced our company's decision to implement Kaizen methods	4.1	4.1	4.1
Improved quality outcomes influenced our company's decision to implement Kaizen methods	4.2	4.1	4.1
Sales growth influenced our company's decision to implement Kaizen methods	3.1	3.6	3.4
Lead time reduction influenced our company's decision to implement Kaizen methods	4.0	3.9	4.0
Inventory reduction influenced our company's decision to implement Kaizen methods	4.1	3.6	3.8
Leadership from within the company influenced our company's decision to implement Kaizen methods	4.7	4.7	4.7
Attending a training session or trade conference influenced our company's decision to implement Kaizen methods	3.2	3.0	3.1

Likert Scale Question (Where 1 = Strongly Disagree and 5 = Strongly Agree)	Average Non-Production Employee Likert Score	Average Production Employee Likert Score	Average Overall Likert Score
Motivators of Kaizen (continued)			
Knowledge of another company's use of Kaizen activities influence our company's decision to implement Kaizen methods	3.7	3.7	3.6
Barriers to Kaizen			
There is little interest in changing or adopting Kaizen activities	2.5	2.9	2.7
There is not enough expertise on how to implement Kaizen activities	1.6	2.8	2.3
There is resistance to generating new measurements of improvement for Kaizen activities	2.2	3.4	2.9
Middle management resists implementing Kaizen activities	2.1	2.7	2.5
Employee staff resist implementing Kaizen activities	2.4	3.2	2.9
Implementing Kaizen would pose a challenge to our workplace culture	1.4	2.5	2.0
There is not enough time for the company to currently implement Kaizen activities	1.9	2.9	2.5
There were poor experiences with past Kaizen projects	2.7	2.7	2.7
There is a lack of technological capability to implement Kaizen activities effectively	2.3	2.7	2.5
Financial resources that are dedicated for Kaizen projects are limited	2.1	3.1	2.7
Effectiveness of Kaizen			
Since we introduced Kaizen we have increased our competitiveness	3.8	3.8	3.8
After we implemented Kaizen activities we have increased profits	3.7	4.0	3.9
Since we applied Kaizen activities we have decreased costs	3.8	4.0	3.9
Application of Kaizen helped us improve lead time	4.2	3.8	4.0
Since we introduced Kaizen we have increased productivity	3.9	3.9	3.9
Adopting Kaizen activities enabled us to improve product quality	4.2	3.8	4.0
Since we introduced Kaizen we have improved employee motivation	4.1	3.8	4.0
After we started practicing Kaizen we have improved customer satisfaction	3.9	3.8	3.9

Likert Scale Question (Where 1 = Strongly Disagree and 5 = Strongly Agree)	Average Non-Production Employee Likert Score	Average Production Employee Likert Score	Average Overall Likert Score
Effectiveness of Kaizen (continued)			
Since we introduced Kaizen we have improved the time it takes to cut the dimensions of a product (cut time)	3.8	3.8	3.8
Employee awareness			
Our company's leadership is committed to Continuous Improvement and Lean Thinking	4.7	4.3	4.5
Our company's production workers are committed to Continuous Improvement and Lean Thinking	3.6	3.5	3.5
Our company has a clear statement of its dedication to implement continuous improvement initiatives	4.3	4.2	4.2
Our company has a clear statement of its goals	4.6	4.2	4.4
Our company frequently communicates its business goals and strategies with employees.	4.4	4.2	4.3
Production workers are encouraged to provide input on company goals and strategies	4.4	4.0	4.2
Employee training			
Managers receive regular training in continuous improvement skills and strategies	3.5	3.6	3.6
Production workers are regularly trained in continuous improvement skills and strategies	3.5	3.6	3.6
Training sessions in continuous improvement have improved worker and company performance	3.8	3.7	3.7
Teamwork			
Employees are knowledgeable of other teammates' job duties and functions	3.5	3.6	3.6

Likert Scale Question (Where 1 = Strongly Disagree and 5 = Strongly Agree)	Average Non-Production Employee Likert Score	Average Production Employee Likert Score	Average Overall Likert Score
Teamwork (continued)			
Managers are knowledgeable of each employee's job duties and functions within a project team	4.2	4.2	4.2
Managers successively clarify and communicate each team member's job duties and functions	4.0	4.1	4.0
Duties and functions are effectively delegated among team members	4.0	3.8	3.9
Barriers to teamwork			
Our company actively identifies and addresses barriers to teamwork	4.0	3.7	3.9
Our company has difficulties in establishing effective teamwork	1.8	2.8	2.3
Lack of understanding of other teammates' roles and responsibilities is a challenge to teamwork in our company	2.1	2.8	1.5
Use of cross-functional teams			
Our company creates small project teams with employees with different job functions (such as marketing, engineering, production, sales, and human resources)	4.1	4.4	4.2
Our company uses job rotations to create multifunctional workers	3.3	3.6	3.5
Our company uses multifunctional product design teams	3.4	3.4	3.4
Quality planning and control			
Our company uses cause and effect diagrams for quality planning and control	3.2	2.3	2.7
Our company uses scatter diagrams for quality planning and control	3.1	2.1	2.5
Our company uses "quality circles" for quality planning and control	2.8	2.1	2.4
Our company uses Pareto analyses for quality planning and control	3.7	3.5	3.5
Our company monitors employees for quality planning and control	4.1	3.2	3.5
Our company has a formal continuous improvement program as part of our quality planning and control process	4.0	3.5	3.7

Likert Scale Question (Where 1 = Strongly Disagree and 5 = Strongly Agree)	Average Non-Production Employee Likert Score	Average Production Employee Likert Score	Average Overall Likert Score
Quality planning and control (continued)			
Our company administers statistical process control (SPC) for measuring and controlling quality	3.9	3.2	3.5
In our SPC process we can make improvement decisions on the shop floor	3.3	4.1	3.7
SPC helped us determine control limits to reduce product variation	3.4	4.0	3.7
SPC analysis enables us to make changes in the process before defects occur	3.5	3.9	3.7
Productivity improvement			
Kaizen events can help improve our company's cost savings	4.6	4.3	4.4
In the past, implementation of Kaizen events has improved our industry competitiveness	3.7	3.5	3.6
In the past, implementation of Kaizen events has reduced our company's lead time	3.8	3.6	4.7
In the past, implementation of Kaizen events has increased our company's physical labor productivity	3.5	3.5	3.5

Appendix D: Survey Results for Likert Scale Questions (Median Values)

Likert Scale Question (Where 1 = Strongly Disagree and 5 = Strongly Agree)	Average Non-Production Employee Likert Score	Average Production Employee Likert Score	Average Overall Likert Score
Use and knowledge of Kaizen			
Our company has knowledge of continuous improvement strategies	5	5	5
Our company has knowledge of Kaizen activities	5	4	5
Our company is advanced in its implementation of Kaizen activities	4	3	4
Our company uses value stream mapping to observe the needs for lean improvement strategies	5	4	4
Motivators of Kaizen			
Customer feedback influenced our company's decision to implement Kaizen methods	3	3	3
Cost efficiencies influenced our company's decision to implement Kaizen methods	4	4	4
Improved quality outcomes influenced our company's decision to implement Kaizen methods	4	4	4
Sales growth influenced our company's decision to implement Kaizen methods	3	4	3
Lead time reduction influenced our company's decision to implement Kaizen methods	4	4	4
Inventory reduction influenced our company's decision to implement Kaizen methods	4	4	4
Leadership from within the company influenced our company's decision to implement Kaizen methods	5	5	5
Attending a training session or trade conference influenced our company's decision to implement Kaizen methods	3	3	3

Likert Scale Question (Where 1 = Strongly Disagree and 5 = Strongly Agree)	Average Non-Production Employee Likert Score	Average Production Employee Likert Score	Average Overall Likert Score
Motivators of Kaizen (continued)			
Knowledge of another company's use of Kaizen activities influence our company's decision to implement Kaizen methods	3.5	4	4
Barriers to Kaizen			
There is little interest in changing or adopting Kaizen activities	2	2	2
There is not enough expertise on how to implement Kaizen activities	1.5	2	2
There is resistance to generating new measurements of improvement for Kaizen activities	2	4	3
Middle management resists implementing Kaizen activities	2	3	2
Employee staff resist implementing Kaizen activities	2.5	4	3
Implementing Kaizen would pose a challenge to our workplace culture	2	1	2
There is not enough time for the company to currently implement Kaizen activities	2	1.5	2
There were poor experiences with past Kaizen projects	3	3	3
There is a lack of technological capability to implement Kaizen activities effectively	2	3	2
Financial resources that are dedicated for Kaizen projects are limited	2	3	2
Effectiveness of Kaizen			
Since we introduced Kaizen we have increased our competitiveness	4	4	4
After we implemented Kaizen activities we have increased profits	4	4	4
Since we applied Kaizen activities we have decreased costs	4	4	4
Application of Kaizen helped us improve lead time	4	4	4
Since we introduced Kaizen we have increased productivity	4	4	4
Adopting Kaizen activities enabled us to improve product quality	4	4	4
Since we introduced Kaizen we have improved employee motivation	4	4	4
After we started practicing Kaizen we have improved customer satisfaction	4	4	4

Likert Scale Question (Where 1 = Strongly Disagree and 5 = Strongly Agree)	Average Non-Production Employee Likert Score	Average Production Employee Likert Score	Average Overall Likert Score
Effectiveness of Kaizen (continued)			
Since we introduced Kaizen we have improved the time it takes to cut the dimensions of a product (cut time)	4	4	4
Employee awareness			
Our company's leadership is committed to Continuous Improvement and Lean Thinking	5	4	5
Our company's production workers are committed to Continuous Improvement and Lean Thinking	3.5	4	3
Our company has a clear statement of its dedication to implement continuous improvement initiatives	4	4	4
Our company has a clear statement of its goals	5	4	4
Our company frequently communicates its business goals and strategies with employees.	4	4	4
Production workers are encouraged to provide input on company goals and strategies	4.5	4	4
Employee training			
Managers receive regular training in continuous improvement skills and strategies	3.5	4	4
Production workers are regularly trained in continuous improvement skills and strategies	4	4	4
Training sessions in continuous improvement have improved worker and company performance	4	4	4
Teamwork			
Employees are knowledgeable of other teammates' job duties and functions	4	4	4

Likert Scale Question (Where 1 = Strongly Disagree and 5 = Strongly Agree)	Average Non-Production Employee Likert Score	Average Production Employee Likert Score	Average Overall Likert Score
Teamwork (continued)			
Managers are knowledgeable of each employee's job duties and functions within a project team	4	4	4
Managers successively clarify and communicate each team member's job duties and functions	4	4	4
Duties and functions are effectively delegated among team members	4	4	4
Our company actively identifies and addresses barriers to teamwork	4	4	4
Barriers to teamwork			
Our company has difficulties in establishing effective teamwork	4	4	4
Lack of understanding of other teammates' roles and responsibilities is a challenge to teamwork in our company	2	2	2
Use of cross-functional teams			
Our company creates small project teams with employees with different job functions (such as marketing, engineering, production, sales, and human resources)	2	3	2
Our company uses job rotations to create multifunctional workers	4	4	4
Our company uses multifunctional product design teams	3.5	4	4
	4	3	3
Quality planning and control			
Our company uses cause and effect diagrams for quality planning and control	3	1	3
Our company uses scatter diagrams for quality planning and control	3	1	3
Our company uses "quality circles" for quality planning and control	3	1	3
Our company uses Pareto analyses for quality planning and control	3	3	3
Our company monitors employees for quality planning and control	4	4	4
Our company has a formal continuous improvement program as part of our quality planning and control process	4	4	4

Likert Scale Question (Where 1 = Strongly Disagree and 5 = Strongly Agree)	Average Non-Production Employee Likert Score	Average Production Employee Likert Score	Average Overall Likert Score
Quality planning and control (continued)			
Our company administers statistical process control (SPC) for measuring and controlling quality	4	4	4
In our SPC process we can make improvement decisions on the shop floor	3	4	3.5
SPC helped us determine control limits to reduce product variation	3	4	3.5
SPC analysis enables us to make changes in the process before defects occur	3	4	3.5
Productivity improvement			
Kaizen events can help improve our company's cost savings	5	4	4
In the past, implementation of Kaizen events has improved our industry competitiveness	4	3	4
In the past, implementation of Kaizen events has reduced our company's lead time	4	3	4
In the past, implementation of Kaizen events has increased our company's physical labor productivity	4	3	4

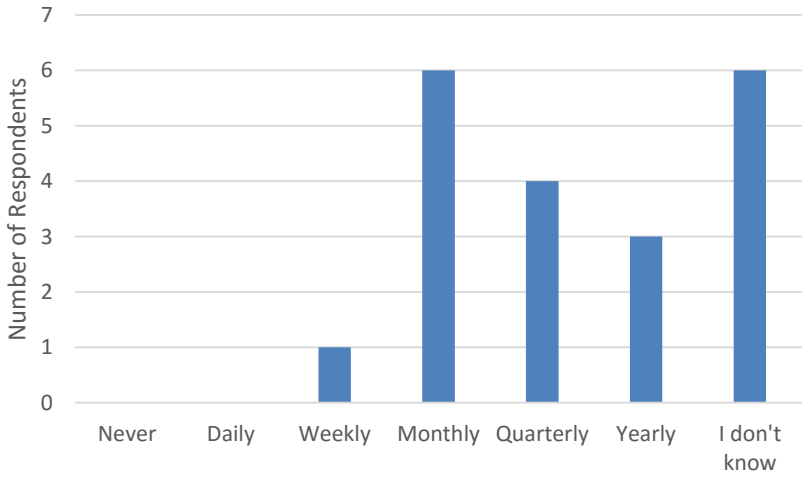
Appendix E: Categorical Questions

Figures E.1 through E.14 graph the responses for survey questions that had categorical questions in in the questionnaire administered. These questions provide additional context and information that supplement the information gained from the Likert scale questions that were used to test the research objectives and hypotheses.

As shown in Figure E.1, when employees were asked how often they underwent training in continuous improvement activities, the most common answers were “monthly” and “I don’t know.” Only one respondent indicated that employees were trained for continuous improvement activities on a weekly basis.

Figure E.1

How Often Do Employees Have Training Activities for Continuous Improvement Activities?



Of those respondents that gave an answer other than “I don’t know” for the question of how often employees have training activities for continuous improvement activities, 43% indicated that they have monthly trainings, which was followed by 29% who indicated that they have quarterly trainings (see Figure E.2).

Figure E.2
How Often Do Employees Have Training Activities for Continuous Improvement Activities?
(Percentage of Responses)

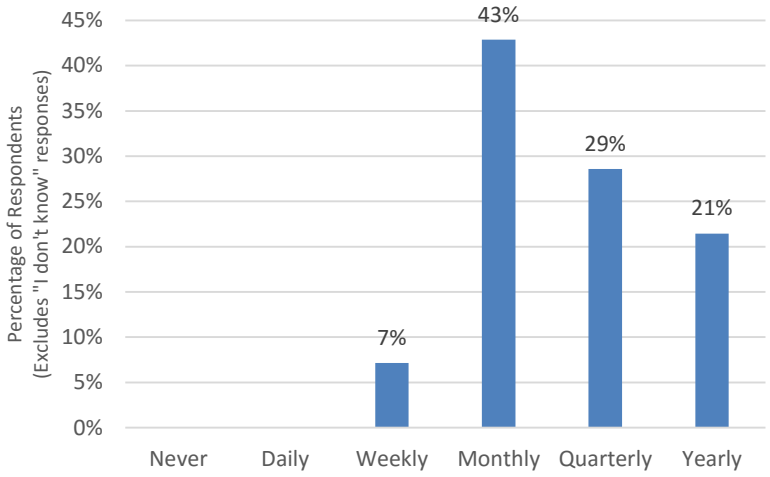
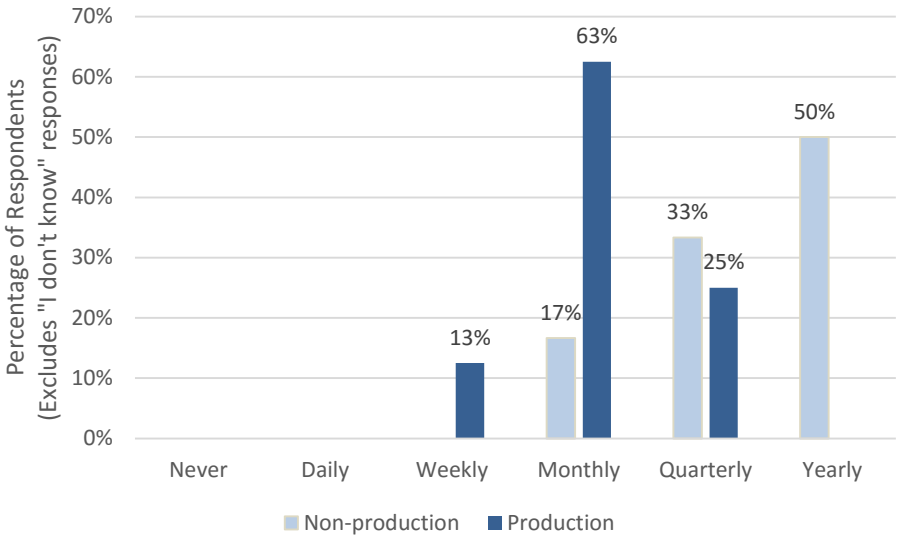


Figure E.3 shows the percentage of responses that answered this question by separating out responses from production versus non-production workers. Overall, it appears that production employees have training activities for continuous improvement activities more frequently than non-production employees. For example, 63% of production employees indicated that they have trainings each month, compared with 17% of non-production employees. While 50% of non-production employees indicated that they have trainings once a year, production employees that were able to answer this question indicated that they had trainings weekly, monthly, or quarterly.

Figure E.3
How Often Do Employees Have Training Activities for Continuous Improvement Activities?
(Percentage of Responses for Production versus Non-production Employees)



The number of responses to the categorical question of "How long do you participate in Kaizen group activities?" is shown in Figure E.4. The most common answer by far was "monthly", with 10 responses, compared with the next most common answers of "never", "quarterly", and "yearly", each with 3 responses.

Figure E.4
How Often Do You Participate in Kaizen Group Activities?

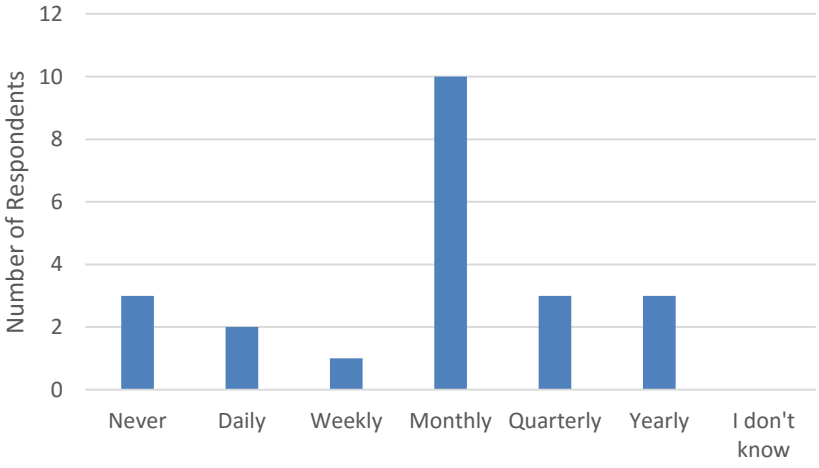
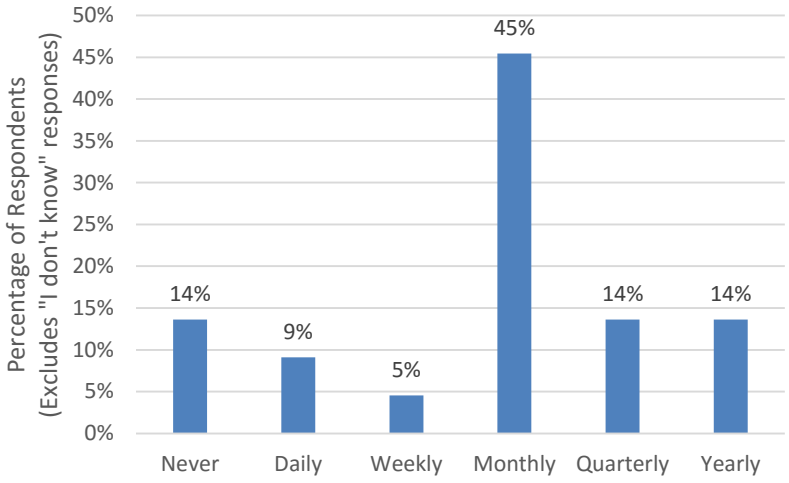


Figure E.5 shows the percentage of respondents for each category of response to how often they participated in Kaizen group activities. The 10 responses that indicated they participate in such activities monthly represent 45% of all responses to the question.

Figure E.5
How Often Do You Participate in Kaizen Group Activities?
(Percentage of Responses)



As shown in Figure E.6, production and non-production employees similarly answered the question of "How often do you participate in Kaizen group activities?" The largest difference between the two groups of employees is that 22% of non-production employees indicated that they participate in Kaizen group activities on a yearly basis, compared with 8% of production employees.

Figure E.6
How Often Do You Participate in Kaizen Group Activities?
(Percentage of Responses for Production versus Non-production Employees)

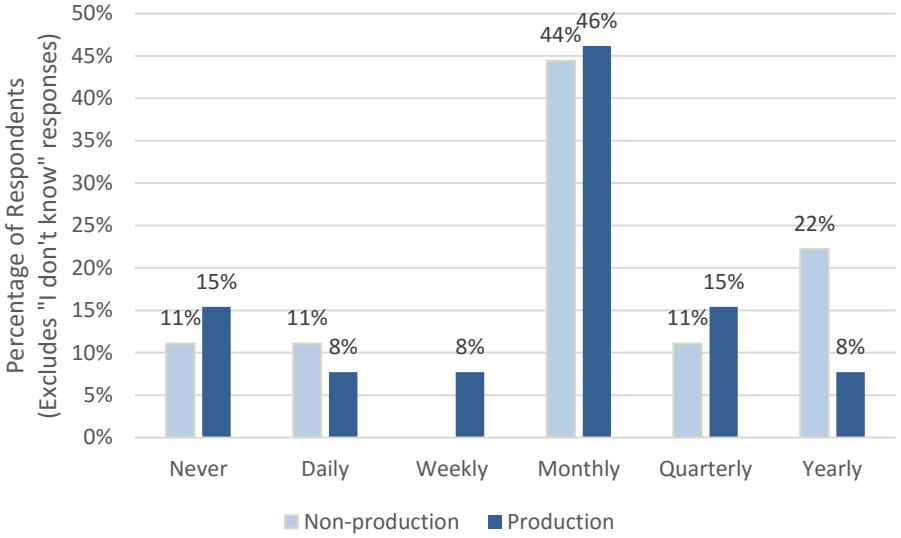
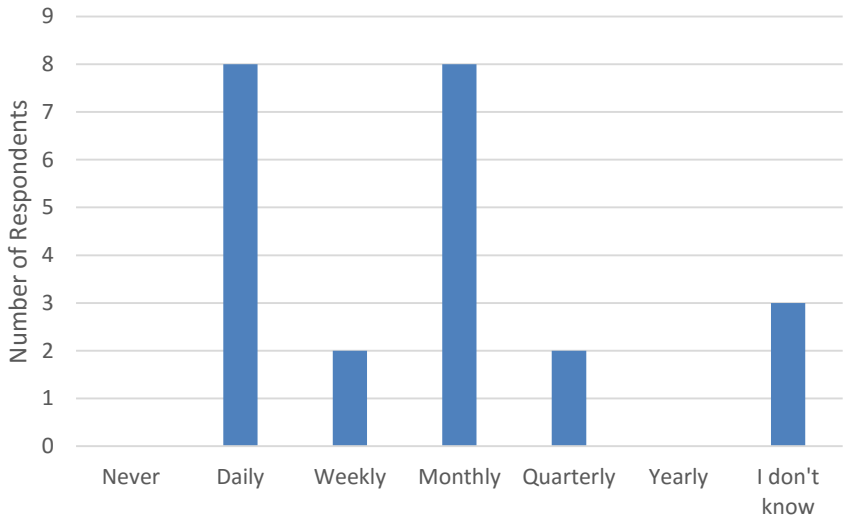


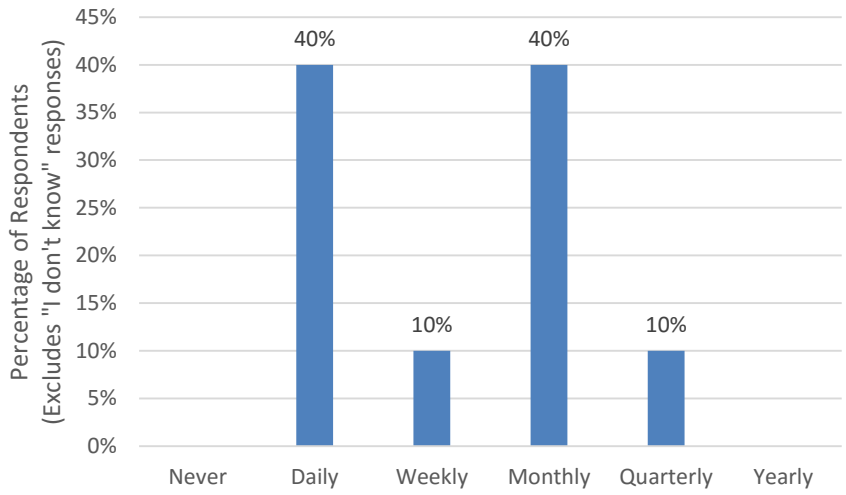
Figure E.7 graphs the number of responses that answered the survey question of "How often are quality control goals communicated with management and employees?" The most common responses were "daily" and "monthly", which each received eight responses. Three respondents did not know how often these goals were communicated.

Figure E.7
How Often Are Quality Control Goals Communicated with Management and Employees?



As shown in Figure E.8, 80% of respondents who were able to identify how often quality control goals were communicated indicated that these goals were communicated either daily or monthly, while 20% of respondents indicated that these goals were communicated either weekly or quarterly.

Figure E.8
How Often Are Quality Control Goals Communicated with Management and Employees? (Percentage of Responses)



The biggest difference between production and non-production workers in answering the question of "How often are quality control goals communicated with management and employees?" was the percentage of each type of employees who answered "monthly". As shown in Figure E.9., of non-production employees, 60% answered monthly, compared with 20% of production employees.

Figure E.9

How Often Are Quality Control Goals Communicated with Management and Employees? (Percentage of Responses for Production versus Non-production Employees)

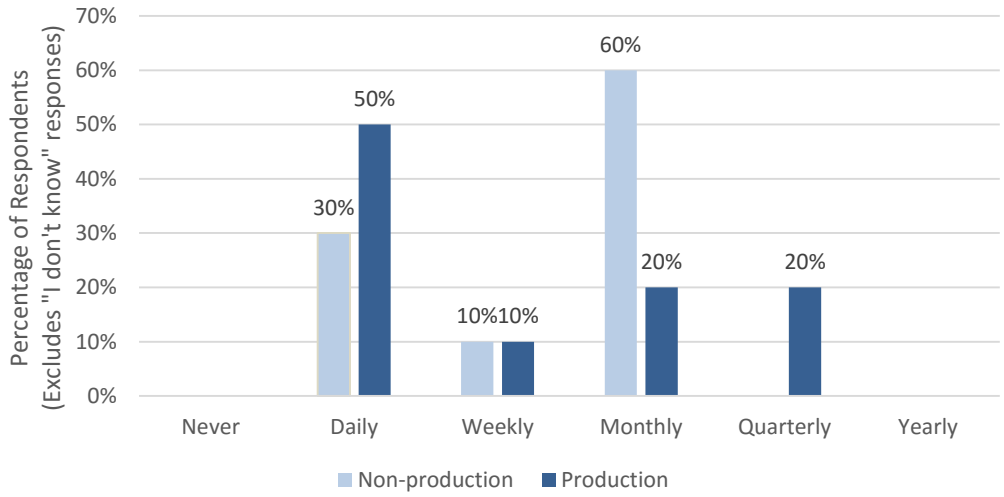
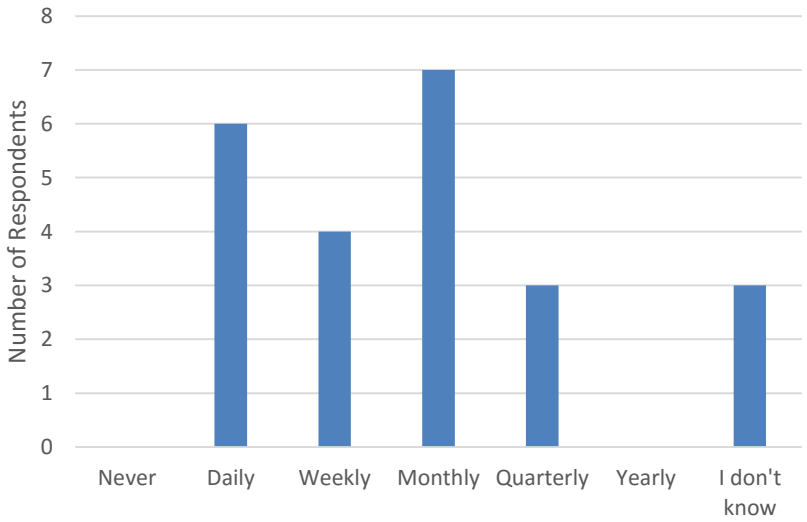


Figure E.10 shows the number of respondents who answered the question of "How often are quality control data results communicated with management and employees?" The most common responses were "monthly", with seven responses, and "daily", with six responses.

Figure E.10

How Often are Quality Control Data Results Communicated with Management and Employees?



As shown in Figure E.11, 35% of respondents who were able to identify how often quality control data results are communicated to management and employees indicated that results were communicated monthly, while 30% indicated that results were communicated daily, 20% indicated results were communicated weekly, and 15% indicated that results were communicated quarterly.

Figure E.11
How Often are Quality Control Data Results Communicated with Management and Employees?
(Percentage of Responses)

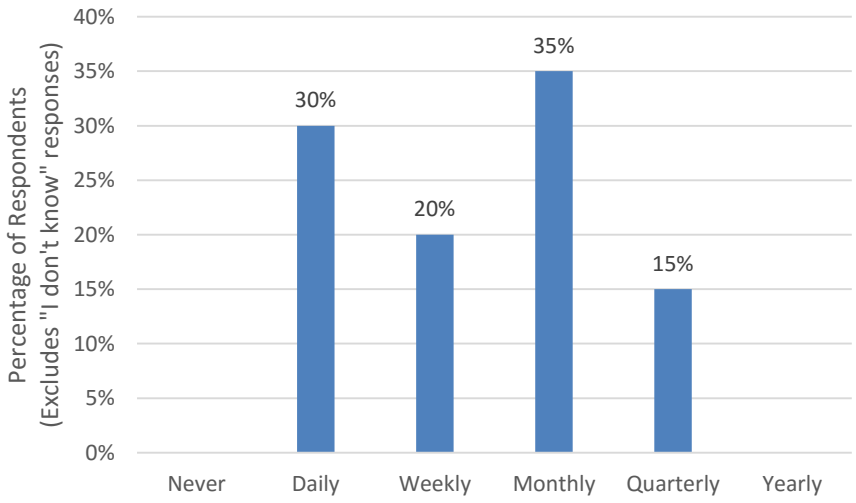
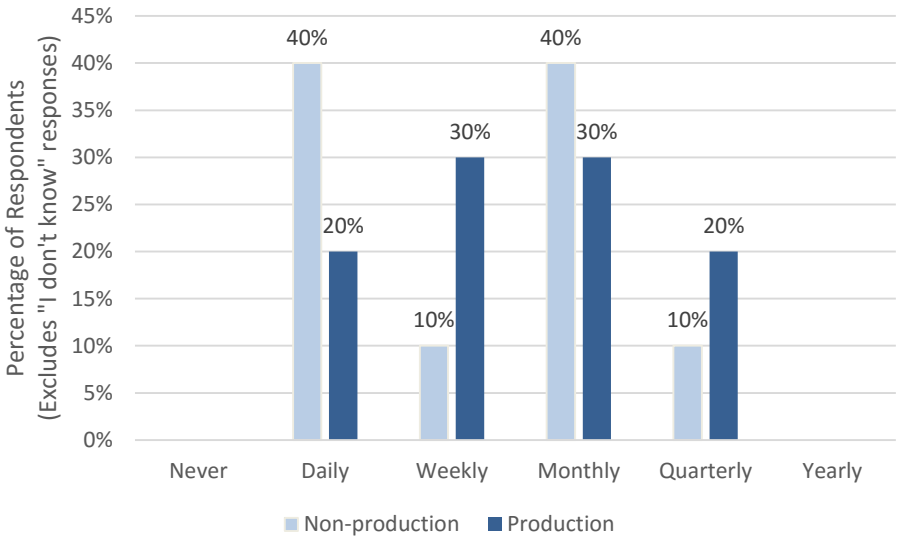


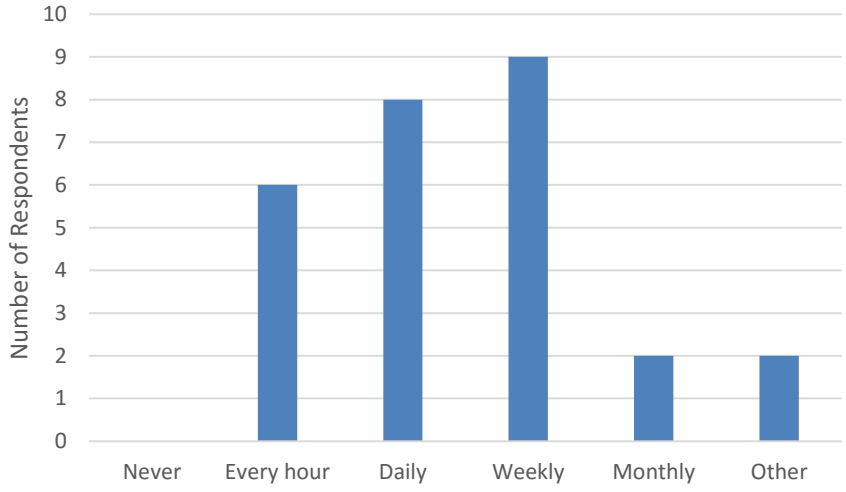
Figure E.12 compares how production versus non-production employees identified the frequency that control data results are communicated. The biggest differences were that 40% on non-production workers indicated that results are communicated daily, compared with 20% of production workers, and 10% of non-production workers indicated that results are communicated weekly, compared with 30% of production workers.

Figure E.12
How Often are Quality Control Data Results Communicated with Management and Employees?
(Percentage of Responses for Production versus Non-production Employees)



The final categorical question administered to respondents was "How often are quality control data gathered?" Respondents were able to select multiple answers for this question. As shown in Figure E.13, the most common answers were "weekly", "daily", and "every hour."

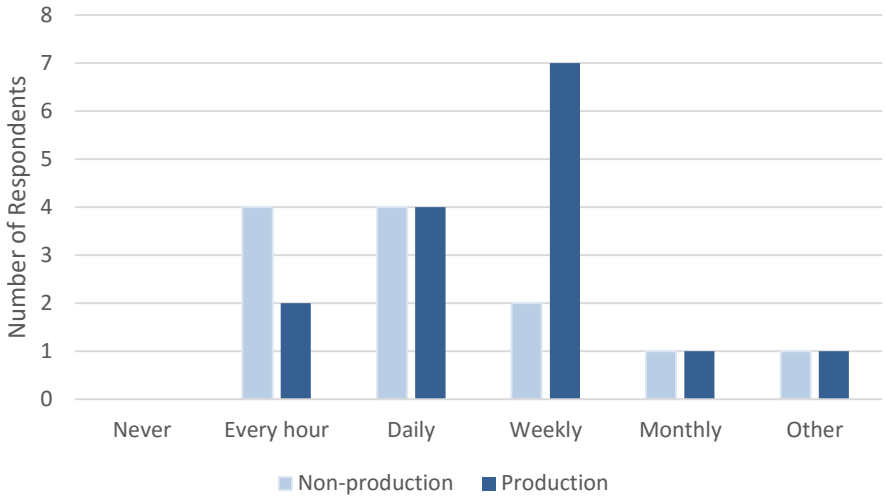
Figure E.13
How often are Quality Control Data Gathered?



As shown in Figure E.14, the only differences between production and non-production employee responses concerning how often quality control data are gathered are in the number

of respondents who answered “every hour” and “weekly”. Seven production employees indicated that quality control data are gathered weekly, compared with two non-production employees. However, four non-production employees indicated that quality control data are gathered every hour, compared with two production employees selecting this answer.

Figure E.14
How often are Quality Control Data Gathered?[1]
(Number of Responses for Production versus Non-production Employees)



[1]“Other” responses were: “per piece”, and “continuously through InfinityQS, SPC software”.