An Empirical Tool to Measure the Effectiveness of Kaizen Events: A Case Study in the Wood Products Industries

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Abstract

Kaizen events are used in business organizations to lower manufacturing costs and increase product value. However, little research has focused on measuring the effectiveness of Kaizen events as a continuous improvement tool. The goal of this article is to introduce an empirical tool to measure the effectiveness of Kaizen events on the basis of employees' perceptions of their knowledge of, barriers to, motivators for, drivers for, and effectiveness of Kaizen. The design of the tool included a questionnaire for the upper management and a questionnaire for production and nonproduction employees, and it was implemented in a wood products company located in the United States where Kaizen events had been conducted for several years. The interview with the Kaizen manager revealed critical aspects related to strategic issues, structure and support, and implementation of Kaizen events. The analysis of the questionnaire implemented with production and nonproduction employees indicated that perceptions regarding motivators and barriers did not differ among the type of employee. In addition, statistical analysis revealed that only the driver ''teamwork efforts'' was a predictor of Kaizen effectiveness. The design of a Kaizen effectiveness tool and its implementation in a case study firm is an important contribution in the area of continuous improvement to help practitioners and researchers measure the effectiveness and impacts of Kaizen events.

As of 2015, the US secondary and primary wood products manufacturing industry (North American Industry Classification System [NAICS] 321 and 337; US Department of Labor, Bureau of Labor Statistics 2016) employed more than 692,000 people in over 30,000 establishments. Sales for this industry exceeded $161 billion in the same year (US Department of Commerce, Census Bureau 2015). Even though the wood products industry continues to be an important source of economic development in urban and rural settings in the United States, the industry has struggled to remain competitive during the last 15 years. This loss of competitiveness is mainly related to the strong competition imports of wood products (Schuler and Buehlmann 2003, Ray et al. 2005, Wang et al. 2011, Espinoza and Smith 2015).

Several studies have cited higher production costs as the main reason for the loss of competitiveness of the wood products industry. Other suggested reasons include lack of manufacturing flexibility, difficulties finding skilled labor, resistance to adapt best manufacturing practices, low investments in technology, poor innovation practices, and lengthy delivery times (Cumbo et al. 2006, Quesada-Pineda et al. 2009, Espinoza et al. 2011).

The primary wood products industry (NAICS 321) was severely affected by the Recession that took place between 2008 and 2011. The sudden drop in residential housing construction rates negatively affected suppliers of lumber (softwood and hardwood), composites, and engineered wood products (Buehlmann et al. 2008). For example, about 50 percent of the hardwood lumber industry was forced to shut down or permanently close operations (Arias 2014) because of the lack of local demand for their products. In addition, many softwood lumber and composite

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Forest Prod. J. 67(3/4):164–178.
doi:10.13073/FPJ-D-16-00044

producers saw their sales decrease in a dramatic fashion. The need to find additional market share forced many US lumber companies to venture into international markets to replace their domestic sales. For example, hardwood lumber producers were able to maintain stability by placing their products in Europe and Asia (Snow 2014) where there is a demand for hardwood lumber. Softwood lumber producers also became interested in international markets and have expanded their portion of export sales.

Secondary wood products companies (NAICS 337) have had a more difficult time. Solid wood furniture plants started losing competitiveness by the turn of the century, where hundreds of plants closed operations in several regions of the United States (Quesada and Gazo 2006), mostly due to heavy (and sometimes unfair) competition from overseas suppliers. Many furniture facilities moved production to other countries where they were able to compete on cost, but others permanently closed operations as they did not have the resources or capacity to implement similar strategies. The fate of the kitchen cabinet industry has been different from the bedroom and office furniture industry, because the kitchen cabinet industry involves a higher level of customization in terms of products and customer service (Luppold and Bumgardner 2009). These two added-value components have not been offered in an efficient manner by foreign competition as they have language, location, and cultural barriers that are difficult to overcome. Today, the kitchen cabinet industry continues to remain competitive, not just because of their level of customization, but also because the industry has been willing to adopt better manufacturing practices, including continuous improvement initiatives such as Kaizen.

The implementation of continuous improvement methodologies such as Kaizen, Lean Thinking, Six Sigma, and Total Quality Management have been proven to improve quality and product delivery, reduce manufacturing and product costs, and ultimately increase competitiveness (Terziovski and Sohal 2000). Kaizen is a continuous improvement strategy that addresses manufacturing challenges through the sustained involvement of both management and production employees working together to meet customer needs (Modarress et al. 2005). However, there is no strong evidence in the literature regarding the adoption of Kaizen as a continuous improvement methodology in the US wood products industry and it has been suggested that wood products firms might need to overcome too many Kaizen implementation barriers. Velarde et al. (2011) found low levels of lean implementation and continuous improvement within the US wood products industry. Similarly, a nationwide mail survey of secondary wood products manufacturers by Smith et al. (2004) found that 83 percent of respondents indicated that their operation had not successfully implemented continuous improvement practices. These could potentially indicate that there are some specific barriers that wood products firms need to overcome to successfully implement Kaizen. But also, little is known about what motivates and drives employees to engage in the Kaizen process, and there is a lack of specific research on specific tools or methodologies to measure the effectiveness of Kaizen events.

In light of the limited research conducted on Kaizen in the wood products industry, this study was conducted to better understand the inhibitors, motivators, and drivers affecting the implementation of Kaizen events in this industry and to develop a tool to measure the effectiveness of Kaizen events. A case study approach was used to apply the Kaizen tool to measure the effectiveness of Kaizen events in a selected wood products firm.

Literature Review

History and basics of Kaizen

New management principles have been adapted to maintain competitiveness in global manufacturing. These new principles include Kaizen, which is the Japanese term (''Kai'' meaning ''change'' and ''Zen'' meaning ''good'') used to define continuous improvement (Palmer 2001). Ohno (1988) describes Kaizen as one of the pillars of the Lean Management System and a continuous improvement method as it follows the renowned Plan-Do-Study-Act (PDSA) methodology. 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. 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 with lean implementation. 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 methods and activities is sometimes referred to as a ''Kaizen event'' (Doolen et al. 2007).

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). Bessant et al. (2001), as well as Doolen et al. (2007), identify the importance of such cross-functional problem-solving teams in improving employee cooperation and goal setting. The need for ongoing and active engagement of all members within an organization highlights Kaizen's commitment to continuous improvement principles.

Motivators for Kaizen and continuous improvement

Several studies identify factors that contribute to companies' desires to implement Kaizen methods and other continuous improvement practices. For example, Schuler and Buehlmann (2003) studied how US wood furniture industries compare with other nations that have a globally competitive furniture industry. Czabke (2007) and Pirraglia et al. (2009) highlight the importance of training sessions and trade conferences in affecting companies' decisions to implement Kaizen activities. Kaye and Anderson (1999) identify leadership from company management as an essential motivating factor for the implementation of continuous improvement initiatives. In the analysis of survey data conducted by Smith et al. (2004), ''cost reduction'' was shown to be a main motivator for implementing lean continuous improvement practices; other important motivators were changes in customer demand, and the desires to remain competitive, reduce lead times, and increase flexibility.

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 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 (1999) cite employee and managerial resistance as obstacles to implementation. Similarly, the case study of Madrigal-Sánchez and Quesada-Pineda (2012, p. 910) noted that the wood products company studied had no ''standardized steps to follow up and start the innovation process'' after ideas were received from customers or employees. 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.

Brashaw and McCoy (2007) identify slow changes and adaptation of new technology, imported manufactured products, waste reduction, high fuel costs, lack of innovation, environmental issues, and raw material costs as additional barriers in implementing continuous improvement practices such as Kaizen and lean thinking in the wood products industry. In addition, surveys of secondary wood products manufacturers also highlighted barriers related to the variability of demand, performance measurement constraints, and long changeover times such as the case of the work published by Smith et al. (2004).

Drivers of Kaizen

Research has also identified several topics and strategies that have been shown to be influential in the success of implementing Kaizen and other continuous improvement initiatives. Table 1 summarizes these drivers and the literature that highlights their importance for continuous improvement.

Kaizen drivers should have an impact on productivity improvement. Specific components of productivity improvement include cost savings, lead time, labor productivity, cut time, branding time, and on-time delivery as measures in the wood products industry (Liker 1997, Gunasekaran et al. 2004, Czabke 2007).

Although drivers and barriers for the implementation of Kaizen events have been documented, there is no tool that allows managers to measure such implementation and how effective Kaizen is on increasing productivity. Therefore, the goal of this work was to design and implement an empirical tool to evaluate the effectiveness of Kaizen activities as related to motivators, barriers, and knowledge of Kaizen as well as to measure the impact of Kaizen drivers in productivity improvement.

The Kaizen tool was implemented in a wood products firm and statistical procedures were used to evaluate the impact of Kaizen barriers, drivers, and its effectiveness on the basis of the perception of production and nonproduction employees. This study provides a tool to evaluate the effectiveness of Kaizen events as part of the continuous improvement initiatives for practitioners and researchers. The implementation of the tool through a case study can be used as a guideline for practitioners.

Methodology

The methodology used builds upon the initial case study research of Atkinson (1994) and Bessant et al. (2001) 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. The first step was to review previous research on Kaizen events to determine barriers, motivators, and drivers that could predict Kaizen effectiveness. Findings from the literature review were used to design a tool in the form of a questionnaire to measure the effectiveness of the Kaizen events. The Kaizen tool could be used to measure production and nonproduction employees' perceptions and to understand how the upper management supports Kaizen events. The tool included two different sections: section or questionnaire one was used to measure perceptions of production and nonproduction employees and included demographic aspects, Likert statements (to measure perception on motivators, barriers, Kaizen effectiveness, and Kaizen's drivers), and open-ended questions. The second section or second questionnaire was designed to capture Kaizen events' strategic aspects from the Kaizen manager. This second questionnaire was designed to better understand how the upper management supports the implementation of the Kaizen events at the case study firm.

Once the two questionnaires were designed, the following step was the validation of the Kaizen tool by implementing it in a real setting. Two companies in the wood products industry where Kaizen had been implemented were contacted and invited to participate in the implementation phase. After explaining the purpose of the research, confidentiality issues, and potential impacts of the implementation, one company agreed to participate in the implementation of the tool. An interview with the Kaizen or continuous improvement manager was conducted over the telephone and a visit to the company was scheduled to better understand the production process and how the Kaizen strategy was being implemented.

The next step required collecting data from nonproduction (administrative) and production employees. The

Table 1.—Drivers of Kaizen.

	Components	Research consulted
Teamwork	Cross-functional teams, educational efforts	Kaye and Anderson (1999), Devlin (2005)
Quality planning and control	Cause and effect diagrams, scatter diagrams, Pareto analyses, quality circles	Atkinson (1994), Bessant et al. (2001), Das et al. (2008)
Employee awareness and training	Awareness of company goals and implementation strategies, regularly scheduled trainings, plan-do-study-act (PDSA) problem-solving-cycle training	Atkinson (1994), Yusof and Aspinwall (2000), Van Aken et al. (2010)

employees participating in the survey were chosen by convenience (they were asked to voluntarily participate) by the continuous improvement manager. Descriptive and inferential statistical procedures were used to analyze the responses. Comparisons based on the type of employee (production and nonproduction) on the perceptions of knowledge, barriers, motivators, and Kaizen effectiveness were conducted using analysis of variance procedures. In addition, multiple regression analysis was used to determine which of the Kaizen's drivers (quality, teamwork, Kaizen awareness, and training) could be used as predictors of productivity improvement (Brayfield and Rothe 1951, John and Reve 1982, Santos 1999). The resulting multiple regression model is outlined as follows:

$$\begin{aligned}\text{Productivity improvement} &= \text{quality planning and control construct} \\ &\quad + \text{teamwork construct} \\ &\quad + \text{employee awareness and training construct} \\ &\quad + \text{error} \end{aligned} \tag{1}$$

Results from the questionnaire applied to the upper management were used to provide additional insights in helping to understand how barriers, motivators, and drivers were affecting the effectiveness of the Kaizen process.

Results

Kaizen effectiveness tool design

The findings of the literature review were used to formulate the Kaizen tool. The tool includes two questionnaires and has the following structure:

- Questionnaire for upper management: Before implementing the Kaizen tool with production and nonproduction employees in the case study firm, an interview with the continuous improvement manager was conducted with the goal to obtain general information on the strategic aspects related to Kaizen. The specific topics that were asked of the Kaizen manager were
  - Frequency of Kaizen events
  - Design of Kaizen activities
  - Performance metrics
  - Support from upper management
  - Participation and attendance to Kaizen events
  - Training related to Kaizen
- Questionnaire for production and nonproduction employees: This questionnaire had the following sections:
  - Section I: Demographic questions about position, knowledge of time that the company has been involved in continuous improvement, and the type of continuous improvement initiatives being implemented in the company
  - Section II: Likert statements to measure perception on the constructs of Kaizen knowledge (4), effectiveness (9), motivators (9), and barriers (10). The number in parentheses indicates how many items per construct.
  - Section III: Likert statements to measure perception on Kaizen driver's constructs: employee awareness (6), employee training (3), teamwork (10), quality planning and control (10), and productivity improvement (5). The number in parentheses indicates how many items per construct.
  - Section IV: Closed questions on frequency of training activities, frequency of employee participation in Kaizen events, frequency of communication of Kaizen goals by upper management, frequency of communication of quality-control goals by upper management, and frequency of quality-control data collection.

The questionnaire for production and nonproduction employees is included in the Appendix. Likert statements were chosen to measure the employees' perception on the knowledge, motivators, drivers, barriers, and effectiveness of Kaizen. A scale from 1 to 5 was designed for the users to indicate their level of perception using the following format: 1 = strongly disagree, 2 = disagree, 3 = not applicable, 4 = agree, and 5 = strongly agree. The direction of the Likert statement was positive in all cases.

Implementation of the Kaizen effectiveness tool

The manufacturing facility used for the case study is one of several manufacturing facilities across the United States owned by a parent corporation. With a daily production capacity of about 800,000 ft^2, the case study plant produces kitchen cabinets using soft maple, hard maple, and cherry lumber. Rough lumber is purchased from suppliers within a 250-mile radius and kiln-dried in the facility. The operations include ripping, cross-cutting, moulding, machining, and assembly. There are approximately 200 employees working at the company over two shifts, with an almost equal number of male and female employees.

Interview with upper management.—Table 2 shows the key findings related to the interview with the upper management. The interview was conducted with the Kaizen manager, who dedicates 100 percent of his time to the implementation of Kaizen events. The Kaizen manager highlighted several Kaizen and other continuous improvement practices used by the case study firm. The use of Kaizen events was identified by the continuous improvement staff interviews as a positive way to create targeted increments in productivity and change. The interview also helped to identify specific aspects of the implementation and continuity of Kaizen events.

The case study company combines Kaizen with value stream mapping (VSM) to fit Kaizen within a larger vision for the company and to build upon and sustain past improvements. VSM is a graphic technique to represent the flow of materials and information for a production process. VSM also includes critical performance metrics such as lead time, inventory levels, and value-added time. This graphic technique helps managers and employees to understand and visualize where to perform process improvements. These practices follow the suggestions of Liker and Meier (2006). The company actively worked to include production-level employees in getting their support for and participation in Kaizen events. The firm did not cite language barriers between production and nonproduction staff as existing to a large degree, which likely increased their initial ability to communicate and get ''buy-in'' from production employees.

The Kaizen manager in the case study firm indicated that VSM was used as a strategic tool and starting point to conduct Kaizen events. VSM was used to develop a strategic vision; the gap between the current and future state of the VSM generated tension that led to an effort in closing that gap. The Kaizen manager indicated that VSM is valid for 6 to 12 months and after that period, the VSM

Table 2.—Key results of the interview with the Kaizen manager.

Interview aspect	Answer
No. of employees	• Approximately 200
Employees surveyed	• Both production and management staff
Products produced	• Kitchen cabinetry
Types of continuous improvement	• Just-in-time, Kaizen, Lean thinking, Six Sigma, 5s
Specific practices used	• Cross-functional teams
	• Employee training, awareness, and recognition; and value stream mapping (VSM)
Strategic issues	• Kaizen events are used to close the gap between current and future state VSM
Structure and support	• 100% dedicated Kaizen manager and leadership team
	• Involvement of production and nonproduction employees in Kaizen events
	• Culture change is the main goal with focus on developing discipline, creativity, responsibility, and alertness values
	• Once the culture is changed, employees will think proactively and cost savings and productivity measures will be revealed
Implementation of Kaizen events	• Conducted each week during working hours, recruiting voluntarily production and nonproduction employees
	• Team members: subject-matter expert, member of the leadership team, production line operator, members of nonrelated areas, and upper management
	• Provide employee recognition for their participation
	• The participants should do a walk-through of the process with focus on quality, safety, quality in the source, and waste
	• Most important tools in order are: 5s, total productive maintenance, standard work, visual control
Audits	• Focus on Demings' plan-do-check-act (PDCA) cycle
	• Daily: quality, safety, and operational aspects
	• Weekly: productivity aspects
	• Monthly: medium-term goals of the VSM
	• Quarterly: long-term goals of the VSM

should be revised. After the gap between the current and the future state is closed, the Kaizen leadership team should get together to generate a new current and future VSM. The support from upper management to Kaizen events is fundamental. This includes the hiring of a 100 percent dedicated Kaizen manager who oversees the strategic plan and implementation of Kaizen events to close that gap between the current and future VSM. As the manager of the case study firm indicated, the most important outcome of the lean journey (in the form of Kaizen events) is the change in culture of the company's employees. New values that are developed include discipline, creativity, responsibility, and alertness. More important, the impact on cost and productivity will come as the culture and values are being changed.

In regard to the Kaizen implementation itself, there are several important take-away points resulting from the interview with the Kaizen manager. The manager indicated that Kaizen events are conducted at least once a week and that they last a few hours in most of the cases. The recruiting process for the events includes sending invitations to all employees (production and nonproduction) and providing sign-up sheets. The composition of each Kaizen event should include the following participants: a subject matter expert, a member of the leadership team, the operator or production staff involved with the actual problem or opportunity, at least three members of nonrelated areas, and one upper manager. The structure of the Kaizen teams ensures that everyone is involved and the problem can be addressed in the proposed timeline. As far as the time for the events, it was recommended by the Kaizen manager that the event be held during working hours and not finish until the problem is finally addressed. Participants in the Kaizen events should receive appropriate training and be recognized for their efforts with lunch, T-shirts, or a certificate to recognize their participation.

As for activities to be conducted during the Kaizen events, the Kaizen manager responded that the process or areas of concern should include a walk-through by all of the events' participants. The goal of this walk-through is to identify the improvement opportunities with focus on the quality, safety, self-proof devices (poka-yoke), and waste identification. In addition, participants should be able to take basic productivity measurements such as travel distances, times, and production rates. Once the team has conducted the walk-through, the team will identify the appropriate lean tools to solve the issues. The Kaizen manager recommended focusing on the ''low-hanging fruit'' and start with the easy-to-implement lean tools in this order: 5s (sort, set in order, shine, standardize, and sustain), total productive maintenance (TPM), standard work, visual controls, and quality in the source. As the need arises, the manager suggested incorporating other higher-level lean tools such as Six Sigma, just in time, one-piece flow, and cells. The manager highlighted that 5s and TPM are perhaps the most critical tools, as a stopped and unorganized production line are perhaps the biggest sources of waste in the system.

The Kaizen manager also provided interesting insights regarding the sustainability of Kaizen events. The manager should conduct daily, weekly, monthly, and quarterly audits to make sure Kaizen events are sustained over time. Daily audits should be conducted by the process owners or operators using a list of items that should be inspected or checked. These daily audits should focus on quality, safety, 5s, maintenance aspects, and productive issues. The results of the audits should be reported immediately to the Kaizen leadership team and the issues found should be addressed immediately. Weekly and monthly audits should be conducted by the line production supervisors and by the

Kaizen manager. These weekly and monthly audits should be focused on medium to long-term aspects of the Kaizen process. Quarterly audits should be conducted by the upper management with the goal to check on the strategic long-term goals of the Kaizen events.

Survey to production and nonproduction employees.—The questionnaire for production and nonproduction employees was mailed to the Kaizen manager at the case study company for its implementation. Employees (production and nonproduction) were asked by their Kaizen manager to voluntarily participate in the process of responding to the questionnaire. After 1 month, a total of 15 responses were gathered and mailed back, where 6 corresponded to production employees and 9 to administrative employees. A potential pitfall is that sample size is small and the number of responses is not equal between the types of employees. However, in this particular case, the main interest was to evaluate the potential of the Kaizen tool to provide insights about the implementation of Kaizen in a specific company and not to use the results to generalize about other companies in the same industry sector.

Effectiveness of Kaizen events

This section of the tool was designed to measure the employees' perceptions of the effectiveness of Kaizen events. Production and nonproduction employees were asked about the impact of Kaizen events in helping to achieve different internal metrics and goals such as profits, cost reduction, lead time, product quality, and customer satisfaction among others. A Likert scale with the following values was used: 1 = strongly disagree, 2 = disagree, 3 = not sure, 4 = agree, and 5 = strongly agree, and the values shown in Table 3 correspond to the median as a measure of central tendency. The results in Table 3 indicate that production and nonproduction employees have similar perceptions regarding the effectiveness of Kaizen events. A nonparametric median test was used to compare each group on each question and none of the comparisons were found as significant (using an α value of 0.1).

Knowledge, motivators, and barriers of Kaizen events

Employees were also asked about their perception on the knowledge, motivators, and barriers of Kaizen events. Using the same type of Likert statements, Table 4 shows the results by type of employee (administrative [nonproduction] and production). In the case of Kaizen knowledge, it was found that both administrative and production workers have similar perceptions. A nonparametric median test (with $\alpha = 0.05$) was conducted and no significant differences were detected between the two groups.

Similar results were found for the Kaizen motivators where no differences were found when comparing both groups ($\alpha = 0.1$). When employees (production and nonproduction) were asked about cost efficiencies as a motivator, both groups indicated that they were not sure, and similar results were found for the statement related to their knowledge using kaizen in other companies.

When examining the perceptions on barriers for Kaizen events, it appeared that some differences between the groups might exist. However, when a nonparametric media test was conducted, none of the differences were found to be significant ($\alpha = 0.1$), except for the statement ''There is resistance to generating new measurements of improvement for Kaizen activities'' that yielded a *P* value of 0.02. In this case, the statistical evidence suggests that production employees disagree (median = 2) with this statement, whereas nonproduction employees are not sure (median = 3). A statistically significant difference was also found for the statement ''There is a lack of technological capability to be able to implement Kaizen activities,'' with a *P* value of 0.08 (α level of 0.1). The median for nonproduction employees was 4 and for production employees it was 2, which indicates that production employees perceive that technological capability does not influence the implementation of Kaizen activities. For the rest of the statements in the barriers constructs, the results were not found significant among the groups and the whole sample tended to disagree (median = 2) or strongly disagree (median = 1) with the different statements.

Effect of knowledge, motivators, and barriers on Kaizen effectiveness

From the previous section, the perception of nonproduction and production employees was found to be the same ($\alpha = 0.1$) except for one statement. Therefore, the groups can be treated as one for posterior analysis. Four different constructs were designed to measure the perceptions of production and administrative employees on the knowledge, motivators, barriers, and effectiveness of Kaizen. Instead of doing a comparison based on each individual Likert statement, a subscale was created by adding all Likert statements in each construct. This approach allowed for a multiple regression analysis to be conducted, where the new variables knowledge, barriers, and motivators are continu-

Table 3.—Median of statements related to effectiveness of Kaizen events.[a]

No.	Statement	NP	P
1	Since we introduced Kaizen we have increased our competitiveness	4	4
2	After we implemented Kaizen activities we have increased profits	4	4
3	Since we applied Kaizen activities we have decreased costs	4	4
4	Application of Kaizen helped us improve lead time	4	4
5	Since we introduced Kaizen we have increased productivity	4	4
6	Adopting Kaizen activities enabled us to improve product quality	5	4
7	Since we introduced Kaizen we have improved employee motivation	4	4
8	After we started practicing Kaizen we have improved customer satisfaction	4	4
9	Since we introduced Kaizen we have improved the time it takes to cut the dimensions of a product (cut time)	4	4

[a] NP = nonproduction employees; P = production employees.

Table 4.—Median values of knowledge, motivators, and barriers of Kaizen events.[a]

Statements	NP	P
Kaizen knowledge		
Our company has knowledge of continuous improvement strategies	4	5
Our company has knowledge of Kaizen activities	5	4
Our company is advanced in its implementation of Kaizen activities	5	5
Our company uses value stream mapping to observe the needs for lean improvement strategies	5	5
Motivators		
Customer feedback influenced our company's decision to implement Kaizen methods	3	4
Cost efficiencies influenced our company's decision to implement Kaizen methods	3	3
Improved quality outcomes influenced our company's decision to implement Kaizen methods	5	5
Sales growth influenced our company's decision to implement Kaizen methods	4	4
Lead time reduction influenced our company's decision to implement Kaizen methods	4	4
Inventory reduction influenced our company's decision to implement Kaizen methods	4	3
Leadership from within the company influenced our company's decision to implement Kaizen methods	4	4
Attending a training session or trade conference influenced our company's decision to implement Kaizen methods	5	4
Knowledge of another company's use of Kaizen activities influenced our company's decision to implement Kaizen methods	3	3.5
Barriers		
There is little interest in changing or adopting Kaizen activities	2	2
There is not enough expertise on how to implement Kaizen activities	2	1
There is resistance to generating new measurements of improvement for Kaizen activities	3	2
Middle management resists implementing Kaizen activities	3	2
Employee staff resist implementing Kaizen activities	2	2
Implementing Kaizen would pose a challenge to our workplace culture	2	1
There is not enough time for the company to currently implement Kaizen activities	2	1
There were a small amount and only poor experiences with past Kaizen projects	2	2
There is a lack of technological capability to be able to implement Kaizen activities	4	2
Financial resources that are dedicated for Kaizen projects are fairly limited in the company	2	2

[a] Scale: 1 = strongly disagree; 2 = disagree; 3 = not sure; 4 = agree; and 5 = strongly agree. NP = nonproduction employees; P = production employees.

ously independent, and the new variable effectiveness is the continuous dependent variable. The model is:

$$\text{Effectiveness} = \text{knowledge} + \text{motivators} + \text{barriers} + \text{type of employee} + \text{error} \quad (2)$$

Before creating the new subscales of variables, it was necessary to test the internal reliability of each construct by conducting the Chronbach's α procedure. For this test, α values above 0.7 indicated that the internal reliability of each construct was acceptable; therefore, the subscales or new variables could be created (Table 5).

In addition, a normality test was conducted on each of the newly created variables to make sure the individual new variables followed a normal distribution. In the case presented, the null hypothesis (the data follow a normal distribution) was not rejected for any of the new variables at a significance level of 0.1 (Table 5).

Table 5.—Structure, reliability analysis, and normality test of Kaizen constructs.

Construct name	No. of Likert statements	Reliability analysis[a]	Sample size	*P* value[b]
Knowledge	4	0.822	16	0.033
Motivators	9	0.728	14	0.135
Barriers	10	0.803	15	0.200
Effectiveness	9	0.952	16	0.200

[a] Cronbach's α.
[b] Normality test of Kolmogorov-Smirnov.

The means of each type of employee on the dependent variable Kaizen effectiveness is shown in Table 6. Therefore, a statistical test is necessary to test the significance of these differences when controlling for Kaizen knowledge, Kaizen barriers, and Kaizen motivators (covariates). A preliminary analysis of covariance (ANCOVA) test was run to make sure there was no interaction between the continuous independent variables (covariates) and the factor (type of employee). This test indicated that for a significance level of 0.1, there was no significant interaction between the factor and the covariates. In addition, a Levene's test was conducted to test for the equality of variances and the results indicated that there was not a significant difference (*P* value of 0.289 with an α of 0.1). Therefore, the variances are considered equal.

The results of the ANCOVA test in Table 7 indicate that there were no significant differences by type of employee when using a significance level of 0.1. Also, the test shows that there is no influence of the covariates Kaizen knowledge, Kaizen motivators, and Kaizen barriers on the variable Kaizen effectiveness when using the same significance level.

Table 6.—Descriptive statistics for Kaizen effectiveness.

Type of employee	Mean	SD	*n*
Nonproduction	36.9	3.8	7
Production	34.5	7.2	6

Table 7.—Univariate test for Kaizen effectiveness.[a]

Source	df	Mean square	F	P value
Corrected model	7	56.61	3.24	0.07
Intercept	1	1.88	0.11	0.75
Type of employee	1	20.16	3.28	0.13
Kaizen knowledge	1	2.80	0.16	0.70
Kaizen barriers	1	55.82	3.20	0.11
Kaizen motivators	1	22.91	1.13	0.29

[a] $R^2 = 0.916$. df = degrees of freedom.

Drivers of Kaizen activities

The same procedure to prepare and validate data that was conducted in the previous section was also performed for the analysis of Kaizen's drivers. The new variables employee awareness (EA), employee training (ET), teamwork (TW), quality planning and control (QC), and productivity improvement (PI) were constructed by adding their individual Likert items (Table 8). A reliability analysis showed that for all constructs, the internal reliability of the Likert items was acceptable (>0.7). A normal test was conducted on each of the new variables. Results show that all variables follow a normal distribution except for TW. The data for TW were revised and an outlier was identified. Once the outlier was removed, the normal test was rerun, now showing that TW fits a normal distribution. The P values of the normality test in Table 8 are the recalculated values after the removal of the outlier.

Table 9 shows the descriptive statistics of the Kaizen's drivers. The standard deviations are similar except for variable QC. The means are different because they are dependent on the number of items on each subscale. For example, variable ET only includes three Likert items. Table 8 shows the Pearson correlations of the Kaizen's drivers against the variable PI. These correlations are considered moderate and some of them are significant (at the 0.01 and 0.1 levels), as shown in Table 10.

An important question that Kaizen practitioners need to know the answer to is if Kaizen's drivers influence the productivity of the company, variable PI. The correlations in Table 8 suggest that there might be some level of association for these variables. Therefore, a multiple regression test was conducted to know if PI can be predicted by any of the Kaizen's drivers as follows:

$$\text{PI} = \text{EA} + \text{ET} + \text{TW} + \text{QC} + \text{error} \quad (3)$$

Table 8.—Reliability and normality test for Kaizen driver's constructs.

Construct name[a]	No. of Likert statements	Reliability analysis[b]	Sample size	P value[c]
EA	6	0.87	16	0.10
ET	3	0.83	16	0.89
TW	10	0.74	16	0.80
QC	10	0.77	15	0.71
PI	4	0.73	16	0.97

[a] EA = employee awareness; ET = employee training; TW = teamwork; QC = quality planning and control; PI = productivity improvement.
[b] Cronbach's α.
[c] Normality text of Shapiro-Wilk.

Table 9.—Descriptive statistics of Kaizen's drivers.[a]

	n	Minimum	Maximum	Mean	SD
EA	15	22	30	26.27	2.890
ET	15	6	15	10.80	2.455
TW	15	30	39	34.73	2.282
QC	15	28	45	35.00	4.870
PI	15	12	20	15.87	2.167

[a] EA = employee awareness; ET = employee training; TW = teamwork; QC = quality planning and control; PI = productivity improvement.

Table 10.—Correlations of Kaizen's drivers with construct Kaizen effectiveness.[a]

	EA	ET	TW	QC	PI
EA	1	0.491**	0.033	0.315	0.645*
ET		1	0.015	−0.125	0.424
TW			1	0.129	0.411
QC				1	0.501**
PI					1

[a] EA = employee awareness; ET = employee training; TW = teamwork; QC = quality planning and control; PI = productivity improvement. * = Significant at the 0.01 level; ** = significant at the 0.1 level.

Given that some of the correlations are significant, a collinearity diagnostics test was conducted. Observing the values of eigenvalues and a condition index, it was determined that there is a critical problem with collinearity. To mitigate that potential problem, factor analysis was conducted to reduce the number of variables in the model. Using a principal component as the method of extraction, varimax as the rotation method, and a cutoff value of one, two factors were extracted. Factor one is composed of variables ET and EA (called A_T) and Factor 2 of variables TW and QC (called T_Q), and the two factors explained 68 percent of the variability. Therefore, the final model looks like:

$$\text{PI} = \text{A\_T} + \text{T\_Q} + \text{error} \quad (4)$$

To run regression analysis, factor scores are generated for each observation. The results of the multiple regression analysis in Table 11 indicate that both factors are significant for an α value of 0.1.

Discussion and Conclusions

Researchers and practitioners investigating or practicing Kaizen events can use the tool introduced in this article to identify factors that have the largest contribution to Kaizen effectiveness and productivity increase. For practitioners,

Table 11.—Regression analysis coefficients.[a]

Model	Unstandardized coefficients		Standardized coefficients		
	B	SE	Beta	t	Significance
Constant	15.867	0.346		45.833	0.000
A_T	1.274	0.368	0.588	3.55	0.004
T_Q	1.238	0.358	0.517	3.454	0.005

[a] A_T = composed of variables EA (employee awareness) and ET (employee training); T_Q = composed of variables TW (teamwork) and QC (quality planning and control). Significance was set at the 0.01 level.

this could mean focusing on a specific functional area of their company or on a particular type of desired performance outcome. Companies could apply this step to their own operations by identifying employees within their own company to interview or survey, but these employees must come from a variety of levels within their company to better understand the business as a whole.

The main goal of this article is to introduce a tool to measure the effectiveness of Kaizen events. The tool included a series of Likert-type statements to measure perceptions of employees on Kaizen knowledge, Kaizen barriers, Kaizen motivators, and Kaizen effectiveness. In addition, the tool also included additional Likert-type statements to measure the perception of employees on Kaizen drivers such as EA, ET, TW, and QC, and their relationship with PI. The statistical procedure to analyze the data capture when applying the tool can easily be adapted by practitioners and variables can be added or subtracted from the regression model to accommodate the needs of practitioners or companies. After the tool is applied and the data analyzed, the procedure could provide new insights into the use of Kaizen and other continuous improvement events that can be of use to those working within the US wood products industry as well as those in academia and elsewhere.

The tool was implemented in a wood products firm in the secondary sector where Kaizen events have been used for several years. Perception of production and nonproduction employees on the knowledge, barriers, and motivators of Kaizen events was analyzed using nonparametric statistical methods. For this particular implementation of the tool, the analysis indicated that the perception on these constructs is basically the same for both types of employees. Further analysis was conducted to investigate if the type of employee is a determinant on perception of Kaizen effectiveness when controlling for knowledge, barriers, and motivators. The results indicated that for this particular company, there are no differences of the perception of Kaizen effectiveness by type of employee.

The fact that there are no differences in the perceptions of barriers, motivators, and knowledge could be an indication that the company's employees are all aligned and sharing the same principles and values. The most important outcome determined from the interview with the Kaizen manager was the change of the company's culture. After conducting Kaizen events for several years, the employees have developed new values such as discipline, creativity, responsibility, and alertness. Once these values are consolidated and embedded into the company's culture, the impact on cost and productivity will come as a consequence as the company's culture changes. This result could be considered as a strong signal of agreement for employees within the case study firm regarding what prevents or encourages Kaizen.

In terms of the relationship between productivity improvement and Kaizen's drivers, it was found that EA and ET (Factor 1) and TW and QC (Factor 2) could be used as predictors of productivity improvement. This was also observed in previous studies found in the literature (Radharamanan et al. 1996, Laraia et al. 1999).

The main conclusions from the development and implementation of this Kaizen tool are the following:

- The implementation of Kaizen events is an effective agent of change to shape the company's culture.
- Kaizen events should be conjointly developed and implemented along with VSM. VSM is the tool to capture the current situation of the process in analysis and it should be used as a strategic tool to indicate the direction in which the company wants to go (vision). Kaizen events are the systematic strategy to bring employees together to analyze each problem and develop appropriate solutions to navigate toward the company's vision.
- Training, teamwork, planning, and quality control are the main drivers to achieve productivity improvement. Organizations where employees constantly receive training and work in teams in solving specific problems are on track to achieve high levels of productivity. Along with training and teamwork, the effort also requires that a good system for planning and quality control is in place because performance metrics are critical to assess if the organization is achieving the goals and targets indicated in the VSM.

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Appendix

Survey Questions for Production and Nonproduction Employees

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

II. Motivators of Kaizen Activities

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

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 influenced our company's decision to implement Kaizen methods				1 2 3 4 5	N/A
Knowledge of another company's use of Kaizen activities influenced 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 in 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 costs				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 in 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: _____