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Critical success factors for the sustainability of Kaizen event human resource outcomes: An empirical study

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ABSTRACT

Kaizen events have been widely reported to produce positive change in business results and human resource outcomes. However, sustaining or improving upon the results of a Kaizen event over time can be difficult for many organizations and has received limited empirical research attention to date. This paper identifies the factors that most strongly influence the sustainability of work area employee attitudes and commitment to Kaizen events based on a field study of 65 events in eight manufacturing organizations. The findings also present guidelines for organizations and areas for future research.

1. Introduction

The design of effective improvement programs continues to be a focus in the operations management (OM) and industrial engineering communities (e.g., Warnecke and Huser, 1995; Hales and Chakravorty, 2006; Kumar et al., 2008; Chakravorty, 2009a). As a part of the continued academic study of improvement programs, researchers have recently explored critical success factors (e.g., Chan et al., 2005; Stock et al., 2007; Bayazit and Karpak, 2007; Farris et al., 2009), the social system (i.e., human resource) and technical system (i.e., business-related) factors of improvement (e.g., Olorunniwo and Udo, 2002; Chakravorty, 2009b; Farris et al., 2009), and the long-term success of improvement efforts (e.g., Bayazit and Karpak, 2007).

This paper addresses these areas of interest as they relate to Kaizen events, an increasingly common type of improvement mechanism. A Kaizen event is a "focused and structured improvement project, using a dedicated cross-functional team to improve a targeted work area, with specific goals, in an accelerated timeframe" (Farris et al., 2008, p. 10). In addition to a variety of technical system improvements, practitioners also report significant social system improvements from Kaizen events (e.g., Melnyk et al., 1998; Minton, 1998; McNichols et al., 1999). Kaizen events are one way organizations seek to implement the broader concept of kaizen (Brunet and New, 2003), by introducing the concept of continuous improvement techniques and the development of an organizational culture that supports continuous improvement in the long-term.

However, it can be difficult for many organizations to sustain the outcomes of a Kaizen event after it concludes (Bateman, 2005; Friedli, 1999; Mackle, 2000). While previous research has examined immediate (i.e., initial) Kaizen event social and technical system outcomes (e.g., Farris et al., 2009) and the sustainability of technical system outcomes (e.g., Bateman, 2005), there is little research or practitioner guidance regarding the sustainability of human resource outcomes. Specifically, there is limited research about the factors that may promote the development of positive longer-term attitudes and commitment toward Kaizen events among employees in the targeted work area after the Kaizen event.

This research contributes to the current body of knowledge by increasing the understanding of what factors most contribute to sustaining the human resource outcome *work area attitude and commitment* to Kaizen events. The present work represents the second phase of a multi-year Kaizen event research initiative and builds upon the first phase which identified critical success factors of initial Kaizen event outcomes, assessed immediately after the event's conclusion (i.e., Farris et al., 2009). In the overall study, both technical system and social system outcomes are measured; however, the scope of this paper focuses only on the social system outcome, *work area attitude and commitment*, while

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results related to other technical system and social system outcomes will be presented in future works. Using data from a field study of 65 Kaizen events across eight manufacturing organizations, multiple regression was used to test hypothesized relationships and to identify the critical success factors, i.e., variables, that are the most significant predictors of *work area attitude and commitment*. In addition to examining critical success factors for sustainability of *work area attitude and commitment*, the relationship between this longer-term social system outcome and the perceptions of *attitude* toward Kaizen events among team members immediately after the event were also explored. Qualitative data regarding event goals were used to further interpret the findings. Study results are used to develop recommendations for organizations using Kaizen events.

The remainder of this paper is organized as follows. Section 2 presents the literature used to develop the working theory of Kaizen event outcome sustainability. Section 3 describes the research methodology, Section 4 presents the analysis results, and Section 5 concludes the paper with the research findings, limitations, and areas for future research.

2. Literature review

2.1. Background

Kaizen events are known in the U.S. using other terms as well, for example, "rapid improvement events," "accelerated improvement workshops," "gemba kaizen," and "Kaizen blitz" (Melnyk et al., 1998; Cuscela, 1998; Martin, 2007; Alexander and Williams, 2005). Often used in conjunction with lean production (Alukal, 2006; Manos et al., 2006; Ting, 2004), practitioners report a variety of social system improvements from Kaizen events (e.g., Melnyk et al., 1998; Minton, 1998; McNichols et al., 1999). For example, the development of an increased appreciation and enthusiasm for both Kaizen events and continuous improvement amongst employees who participate in Kaizen events is often a formal objective and a reported benefit of Kaizen events (Sheridan, 1997; Melnyk et al., 1998; Laraia et al., 1999). Kaizen events are also beneficial to participants in that they can serve as a "just-in-time" training mechanism (Drickhamer, 2004), impacting employee knowledge and skills, usually within a cross-functional team. These social system benefits of Kaizen events support previous studies that emphasize the need of employees to have enriched jobs through learning mechanisms such as cross-training (e.g., Muramatsu et al., 1987).

As previously indicated, Kaizen events are related to, but can be clearly distinguished from the broader concept of kaizen (Brunet and New, 2003). Kaizen refers to the continual search for improvement and is recognized as one of the key principles of Japanese manufacturing as developed by the Toyota Motor Company (Imai, 1986). Similar to kaizen, Kaizen events use process improvement tools and techniques (e.g., Melnyk et al., 1998), focus on low-cost changes (Sheridan, 1997), aim to produce an organizational culture of continuous improvement (Imai, 1986; Laraia et al., 1999; Melnyk et al., 1998; Sheridan, 1997), focus on employee empowerment through training and providing opportunities to improve work systems (e.g., Melnyk et al., 1998; Minton, 1998), and emphasize making relatively incremental changes to improve performance (e.g., Laraia et al., 1999; Melnyk et al., 1998). Thus, Kaizen events can be used as a vehicle for the implementation of *kaizen* within an organization, systematically creating change and driving performance improvement (LeBlanc, 1999; Kumar and Harms, 2004). However, in comparison to the improvement mechanisms traditionally used in conjunction with *kaizen,* such as continuous process improvement (CPI) teams, Kaizen events are short-term improvement projects that usually occur across three to five days (Melnyk et al., 1998).

2.2. Kaizen event and general improvement sustainability literature

Previous academic research has reported that the sustainability of technical and social system benefits from Kaizen events varies (e.g., Doolen et al., 2008). One empirical study found that three of the 11 Kaizen events studied (27%) were unable to sustain any of the implemented changes (Burch, 2008). Similarly, some practitioners report difficulty in sustaining 50% or more of the initial improvements over time (Laraia et al., 1999) and others anecdotally report that improvements may disappear entirely within six months of an event (Veech, 2004). Greater understanding of the determinants of Kaizen event outcome sustainability could decrease this variability so that organizations could more systematically sustain Kaizen event outcomes.

While there have been some previous studies that explore Kaizen event sustainability (Bateman and David, 2002; Bateman and Rich, 2003; Bateman, 2005; Burch, 2008; Doolen et al., 2008; Magdum and Whitman, 2007; Marin-Garcia et al., 2009; Patil, 2003), there are opportunities for additional research to extend this body of knowledge and to potentially increase the effectiveness of Kaizen events in organizations. A majority of the current literature focuses on the sustainability of Kaizen event technical system outcomes (e.g., Bateman and Rich, 2003; Bateman, 2005; Patil, 2003; Marin-Garcia et al., 2009), with fewer studies considering social system outcomes (Burch, 2008; Doolen et al., 2008; Magdum and Whitman, 2007).

Also, several of the current Kaizen event sustainability studies represent single organization case studies (Patil, 2003; Magdum and Whitman, 2007; Doolen et al., 2008) and thus, their findings are more likely to be limited in terms of generalizability. To date, it appears that only Burch (2008) has considered the sustainability of social system-related factors across multiple organizations. However, Burch (2008) included only a relatively small number of Kaizen events ($n=13$), and the research model omitted several Kaizen event characteristics and post-event mechanisms, which the academic and practitioner literature suggest may impact Kaizen event outcome sustainability.

Because there is limited research on Kaizen event sustainability specifically, the literature regarding the sustainability of continuous improvement approaches in general (Kaye and Anderson, 1999; Upton, 1996; Readman and Bessant, 2007; Anand et al., 2009) and other process improvement approaches (Dale et al., 1997; Keating et al., 1999; Oxtoby et al., 2002; Pillet and Maire, 2008) was also reviewed to develop a working model of Kaizen event sustainability. The difficulty of sustaining outcomes has also been identified as an issue for other types of improvement mechanisms (e.g., Keating et al., 1999) and organizational change efforts in general (e.g., Cummings and Worley, 1997). The use of these related literature streams to build the model is further justified by the fact that the present research studied only relatively mature organizations that had established standard procedures for using Kaizen events in a "programmatic" sense, which is more similar to the use of other process improvement mechanisms discussed in the literature.

Further, there are currently limitations to the general continuous improvement and process improvement body of knowledge as well that create the need for additional research on the sustainability of the outcomes of improvement approaches in general. For example, most of the continuous improvement literature tends to focus on the improvement program as a whole, rather than individual change interventions (e.g., Kaizen events),

and primarily uses qualitative methods, with a case study research approach being the most common (Bateman, 2005).

The present research addresses gaps in the current Kaizen event sustainability and general improvement sustainability literature through the study of a key social system (human resource) outcome, *work area attitude and commitment*. To the authors' knowledge, this research represents the largest sample size to date considering the individual improvement project (Kaizen event) as the unit of analysis, with 65 events studied across multiple organizations. The present research also considered a larger number of potentially critical success factors than previous studies. These factors represent variables related to the Kaizen event itself, the targeted work area, and post-event mechanisms and activities. The research also uses both qualitative and quantitative methods, which may provide greater understanding of improvement sustainability (Meredith, 1998; Forza, 2002).

2.3. Modeling Kaizen event outcome sustainability

Previous studies have examined social and technical system factors in order to gain a holistic perspective of production system improvement (e.g., Olorunniwo and Udo, 2002; Chakravorty, 2009b). Similarly, this research uses sociotechnical systems (STS) theory (Emery and Trist, 1960; Pasmore and King, 1978; Miner, 2006) to emphasize the need for joint optimization of the technical environment and the human resources in the sustainability of Kaizen event outcomes.

In addition to STS theory, change institutionalization frameworks from the organizational change literature (Goodman and Dean, 1982; Buller and McEvoy, 1989; Cummings and Worley, 1997) were used to provide structure for the model of Kaizen event outcome sustainability. Institutionalization refers to the integration of a change into the usual activities of an organization (Johnson et al., 2004). These frameworks illustrate that the structure of the change and organizational characteristics jointly influence a set of institutionalization processes that, in turn, influence business and human resource-related outcomes. The adaptation of the change institutionalization framework to provide structure for the present model of Kaizen event outcome sustainability was supported by the similar use of Kaizen events in the organizations studied and the improvement efforts described in the institutionalization research. Based on STS theory and change institutionalization frameworks, the model of Kaizen event outcome sustainability (Fig. 1) was developed and includes the following groups of variables: Kaizen Event Characteristics, Work Area Characteristics, Post-Event Characteristics, and Sustainability Outcomes. The model variables were identified based on a systematic literature review of 152 academic and practitioner Kaizen event resources (see Glover, 2010) with an emphasis on the Kaizen event sustainability research literature. As described previously, the general continuous improvement literature and change institutionalization literature were also used to support the inclusion of variables in the model. A summary of the model variables, their definitions and measures, and the supporting literature for each variable is provided in Appendix A. The following provides a brief explanation of each variable group and the model variables.

Kaizen Event Characteristics are the group design, task design, and organizational context input factors that describe the design of the initial Kaizen event (Farris et al., 2009) or the structure of the change (Goodman and Dean, 1982; Cummings and Worley, 1997). Four Kaizen Event Characteristics that may impact Kaizen event outcome sustainability were identified and measured: *goal clarity, goal difficulty, team functional heterogeneity,* and *management support* as defined and operationalized in the first phase of the larger Kaizen event research initiative (e.g., Farris et al., 2009). Furthermore, other factors related to the initial success of Kaizen events (Farris et al., 2009) that were not directly discussed as critical factors in the sustainability literature,

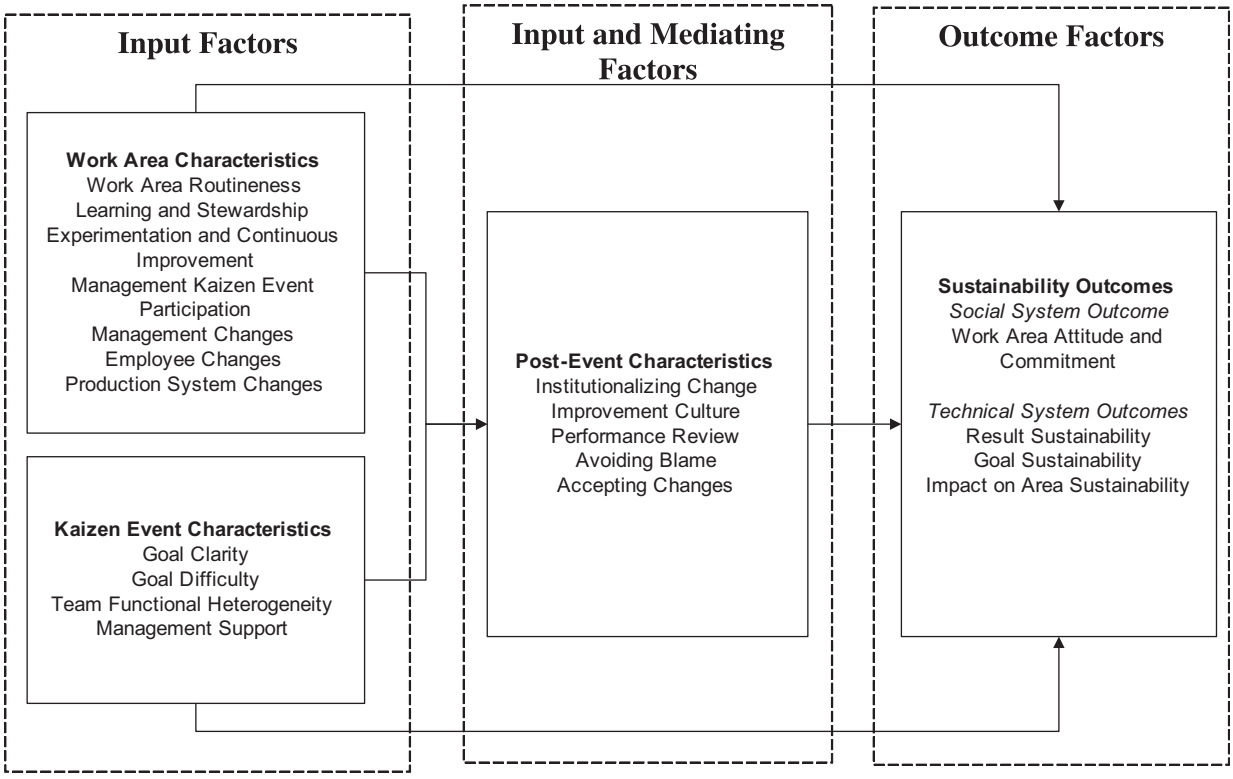

Fig. 1. Kaizen event outcome sustainability research model.

specifically *team Kaizen experience, team leader experience, team autonomy, event planning process, action orientation, internal processes, tool quality,* and *tool appropriateness,* were tested in post-hoc analysis and were not found to be significant predictors of the outcome; therefore these factors are not discussed further in this paper.

Work Area Characteristics are the contextual input factors related to the targeted work area of the Kaizen event. This research identified and measured three perceptual Work Area Characteristics: *work area routineness* (e.g., Farris et al., 2009), *learning and stewardship,* and *experimentation and continuous improvement,* which were adapted from previous measures of group learning behaviors, stewardship, and knowledge of continuous improvement (Doolen et al., 2003; Groesbeck, 2001). Four objective Work Area Characteristics were also measured: *management Kaizen event participation, management changes, employee changes,* and *production system changes* (including changes to work area equipment, product volume and product mix). These variables are similar to the organizational characteristics included in the change institutionalization frameworks (Goodman and Dean, 1982; Cummings and Worley, 1997) but relate to the targeted work area of the Kaizen event.

Post-Event Characteristics are the institutionalization processes (Goodman and Dean, 1982; Cummings and Worley, 1997) or activities conducted after the conclusion of a Kaizen event in order to fully integrate, monitor, and support the changes in the targeted work area. The present research identified and measured five Post-Event Characteristics that were analyzed as input and mediating factors in the model: *institutionalizing change, avoiding blame, improvement culture*, *performance review,* and *accepting changes*. These variables had not been defined prior to this research and were operationalized based on frequently cited post-event activities found in the literature review.

Sustainability Outcomes are the social and technical system outcomes of the Kaizen event over time. As mentioned in the introduction, this paper focuses only on the determinants of one social system outcome variable, *work area attitude and commitment. Work area attitude and commitment* relates to work area employees' liking for Kaizen events, as the change mechanism under study (Goodman and Dean, 1982), as well as work area employees' belief in the value and need for Kaizen events (Buller and McEvoy, 1989). This variable was adapted from previous measures of Kaizen event team member attitudes and commitment (Doolen et al. 2003; Farris, 2006; Farris et al., 2009) and was initially operationalized to represent two factors (*attitude* and *commitment*). However, these two factors were not found to be empirically distinct based upon analysis described in Section 3.3.

Based on these groups of variables, the following research hypotheses were tested:

Hypothesis H1. Kaizen Event Characteristics have a direct relationship to *work area attitude and commitment*.

Hypothesis H2. Work Area Characteristics have a direct relationship to *work area attitude and commitment*.

Hypothesis H3. Post-Event Characteristics have a direct relationship to *work area attitude and commitment*.

Hypothesis H4. Post-Event Characteristics mediate the relationship of Kaizen Event Characteristics and Work Area Characteristics to *work area attitude and commitment*.

This research also explored the relationship between the *attitude* of team members toward Kaizen events immediately after the event and *work area attitude and commitment* (which was assessed nine to 18 months following the event), to determine the extent to which initial perceptions may influence longer-term perceptions. This relationship was examined in the context of the following hypothesis:

Hypothesis H5. The *attitude* of team members immediately after the Kaizen event and *work area attitude and commitment* approximately nine to 18 months after the Kaizen event will be significantly and positively correlated.

3. Methodology

3.1. Sample selection

This research used a multi-site field study design of eight manufacturing organizations (Table 1) with data collected at two time periods. The term "T0 data" is used in this research to refer to the data collection phase that occurred during and immediately after each Kaizen event. The term "T1 data" is used in this research to refer to the data collection phase that occurred approximately nine to 18 months after each Kaizen event. This timeframe was selected based on previous improvement sustainability studies (e.g., Doolen et al., 2008; Patil, 2003), as shorter time periods were not believed to be sufficient for assessing long-term outcomes (e.g., implementation efforts were more likely to be still ongoing) and longer time periods were more likely to encounter cases where work area changes made the sustainability study no longer relevant (it should be noted that a Work Area Characteristic was included to measure some work area changes).

Organizations were selected for this study based on researcher-to-company relationships due to the need for access to data from multiple events, the need to collect data at two time periods, and the need to access data on certain organizational variables. However, several boundary conditions and event sampling selection criteria were applied to increase the reliability and validity of study results (Yin, 1994; Eisenhardt, 1989). The boundary conditions used to select organizations were: the organization manufactures products of some type, had been conducting Kaizen events for at least one year prior to the start of the study, had been using Kaizen events in a systematic (vs. in an ad-hoc way), and had been conducting Kaizen events relatively frequently (i.e., at least one per month on average). At T0, Kaizen events were randomly sampled within each organization. Four organizations agreed to provide data for all events conducted during the study period; therefore, a census sampling approach was used in those organizations. The other organizations requested a lower data collection frequency. In these organizations, a systematic sampling procedure was used (Scheaffer et al., 1996). For instance, if the average number of events per month in the organization was n, a number k was selected between one and n, such that every kth event was targeted for study.

T0 data were collected from 102 Kaizen events across 16 organizations (October 2005–July 2008). However, 19 individual events were ultimately removed from the analysis due to incomplete data. Therefore, the complete T0 dataset included 83 Kaizen events from nine organizations. The research team successfully collected T1 data from 68 of the 83 Kaizen events across eight organizations (October 2006–April 2009). Two of the 68 cases were removed from the analysis due to incomplete data, and one of the 68 cases was considered inappropriate for inclusion because it was still in implementation phase at T1. For data analysis, a complete dataset (T0 and T1 data) was needed for a given event. Thus, the total sample size (with complete T0 and T1 data) for this research is 65 Kaizen events across eight organizations. Table 1 describes each organization and the number of events studied per organization.

Table 1
Characteristics of the organizations studied.

Org. description	Org. A Secondary wood product manufacturer	Org. B Electronic motor manufacturer	Org. C Secondary wood product manufacturer	Org. E Specialty equipment manufacturer	Org. F Steel component manufacturer	Org. G Aerospace engineering and manufacturer	Org. Q IT component manufacturer	Org. R Aerospace engineering and manufacturer
SIC code	2434	3621	2434	3843	3443	3721	3577	3721
Public/private	Public	Public	Public	Private	Private	Public	Public	Public
Year founded	1946	1985	1946	1964	1913	1916	1939	1916
No. employees	560	700	500	950	3500	153,000	321,000	153,000
First Kaizen event	1998	2000	1992	2000	1995	1993	2004	1998
Event rate during research	2–3 per month	1 per month	2 per month	6–8 per month	1 per month	4 per week	2 per month	4 per week
Percent of org. experiencing events (%)	100	90	Data not available	100	20	70	10	100
Major processes targeted	Operations	Operations, sales and marketing, customer service and technical support, product design, production planning and inventory control, process design	Operations	All areas of organization	Manufacturing, order entry, accounts receivable, distribution, vendors, engineering product development	All areas of organization	Manufacturing, test	All areas of organization
Percent of events in manufacturing areas	Almost 100% manufacturing	75% manufacturing	Almost 100% manufacturing	Data not available	80–85% manufacturing	70% manufacturing	95% manufacturing	60% manufacturing
No. Kaizen events sampled at T0 (retained at T0)	19 (19)	9(9)	11(7)	16 (15)	7(7)	8(7)	6(6)	8(6)
No. Kaizen events sampled at T1 (retained at T1)	19 (19)	5(4)	4(4)	15(13)	7(7)	7(7)	5(5)	6(6)

Table 2
Data collection instruments and variables used in this research.

Instrument	Factors collected in this research	Measures used in this research	Timing	Description	Data source
Kickoff questionnaire	• Kaizen Event Characteristics	Goal clarity, goal difficulty	Immediately following the kickoff meeting at the beginning of the Kaizen event (T0)	19 item survey questionnaire with cover page and instructions	Team members
Report out questionnaire	• Kaizen Event Characteristics	• Management support	Immediately following the report-out of team results at the end of the Kaizen event (T0)	39 item survey questionnaire with cover page and instructions	Team members
Event Information Questionnaire	• Kaizen Event Characteristics	• Team functional heterogeneity	Following the report-out meeting – target was one to two weeks after the event (T0)	15 item questionnaire with cover page and instructions	Facilitator
	• Work Area Characteristics	• Work area routineness			
Post-Event Information Questionnaire	• Sustainability Outcomes	• Work area attitude and commitment	Nine to eighteen months after the Kaizen event (T1)	67 item questionnaire with cover page and instructions	Facilitator or Work Area Manager
	• Post-Event Characteristics	• Improvement culture, institutionalizing change, performance review, accepting changes			
	• Work Area Characteristics	• Learning and stewardship, experimentation and continuous improvement, management Kaizen event participation, management changes, employee changes, and production system changes			

3.2. Data collection instruments

In total, three instruments were used to collect the data that were analyzed in this research. Table 2 summarizes the administration sequence, the content of the data collection instruments, and the variables assessed in each instrument. Additional instruments, including a Kaizen event program interview and a team activities log, were used as a part of the larger research initiative to provide a better understanding of the organizational context of the events studied, as well as the context of each event (Farris et al., 2009), but these were not used directly in the study of Kaizen event sustainability described in this paper.

In this study, T0 data were collected from Kaizen event team members (via the Kickoff and Report-out Questionnaires) and from facilitators (via the Event Information Questionnaire (Farris et al., 2009)). The Kickoff Questionnaire was completed by team members at the start of the event and the Report-out Questionnaire was completed by team members at the end of the event. The Kaizen event facilitator completed the Event Information Questionnaire usually within four weeks after the event. T1 data were collected nine to 18 months after the Kaizen event through the Post-Event Information Questionnaire. This questionnaire was administered either to the facilitator of the Kaizen event or to the work area manager. Both the Event Information Questionnaire and Post-Event Information Questionnaire were either self-administered or a member of the research team gathered the data via a telephone interview. The collection method was based on the preference and availability of the respondent. Using this mixed collection method could introduce some bias in the data. However, because a majority of the measures were either objective measures or related to the extent to which objectively observable activities were conducted, the benefits of being able to collect more data were preferred over this potential bias.

3.3. Instrument validation and descriptive statistics

Before assessing the validity of the survey scales, the data for all survey items were screened to assess their adherence to basic distributional assumptions of standard parametric methods (Neter et al., 1996; Johnson, 1998; Field, 2009). Overall, the data were non-normal but examination of the histograms of the distributions and the skewness values suggested that this deviation was not severe enough to exclude the use of parametric analysis methods, i.e., no skewness values were greater than 2.0 (DeCarlo, 1997).

Exploratory factor analysis (EFA) was used to examine the construct validity of all multi-item survey scales. All factor analyses were conducted with principal components extraction, and an oblique rotation method was used because theory suggested that the survey scales may be correlated (Jennrich, 2002; Johnson and Wichern, 2007). Following Kaiser's rule, components with an eigenvalue greater than 1.0 were extracted (Johnson, 1998). In cases where the eigenvalue was close to 1.0, a solution that considered the additional component(s) was explored. The results of the exploratory factor analysis for the T0 measures are presented in Farris et al. (2009), and results of the exploratory factor analysis for the T1 measures are presented in Glover (2009, 2010). Items with high primary loadings (>0.500) and low secondary loadings (<0.300) were accepted as items for a given factor (Kline, 1994). Appendix A provides a summary of items that loaded to each factor. In summary, some of the proposed items did not load onto separate factors as initially

expected. For example, *work area attitude and commitment* was initially proposed to represent two factors, *work area attitude* and *work area commitment*; however, the items did not load as distinct factors. Two of the *work area attitude* items (AT1-1 and AT1-3) and four of the *work area commitment* items (CKE1, CKE3, CKE4, CKE5) loaded onto a single factor. These items are conceptually related as they all refer to the attitudinal outcomes of work area employees, and particularly, the perceived value of Kaizen events. One set of items (the original *attitude* scale) refers to the perceived value of Kaizen events to employees, e.g., enjoyment of Kaizen event activities, while the other (the original *work area commitment* scale) refers to perceived value to the larger organization. Therefore, the solutions found through the exploratory factor analyses were retained.

After the factors were extracted to form revised survey scales, the reliability of each scale was assessed using Cronbach's α, a common measure of internal consistency for interval, multi-item scales (Cronbach, 1951). Cronbach's α values for all scales were higher than the commonly-recommended threshold of 0.70 for survey scales (Nunnally, 1978). Table 3 summarizes the following information for each survey scale, organized by variable group: the timing of the data collection, the number of items that comprised each scale, an example item for each survey scale (all variables in Table 3 were measured as multi-item survey scales), and Cronbach's α.

Following the reliability analysis, scale averages for each team in the dataset were calculated using the revised scales. The resultant scale averages and other study variables were assessed to determine their statistical moments, distributional properties, and the collinearity of the independent variables. In general, the variables appeared to be relatively normally distributed. While formal tests of normality were rejected for several variables, they appeared to only demonstrate mild departures from normality. Finally, the collinearity of the resultant independent variables was assessed using the variance inflation factor (VIF) to measure the extent to which each predictor covaries with all of the other predictors considered in the regression model for *work area attitude and commitment*. An individual VIF greater than 10.0 (Neter et al., 1996) or an average VIF greater than 3.0 generally indicates a problem with multicollinearity. In this research, the maximum observed VIF was 3.09, and the average VIF was 2.24. Thus, multicollinearity did not appear to be problematic in the dataset.

4. Results

Exploratory multiple regression models using generalized estimating equations (GEE) were used to build the model of *work area attitude and commitment*. Introduced by Liang and Zeger (1986), GEE provides a method of analyzing correlated data in which measures are taken on subjects who share a common characteristic and can be grouped into common clusters (Hox, 2002), e.g., teams within organizations. Other multilevel methods were considered, including hierarchical linear modeling (HLM) and structural equations modeling (SEM). However, HLM experts suggest that at least 10 observations per predictor per level are needed for analysis (Raudenbush and Byrk, 2002), and SEM requires balanced "time-structured" data within subpopulations (Raudenbush and Byrk, 2002). Further, a large sample size of five to ten cases per estimated model parameter is historically recommended for SEM (e.g., Bentler and Chou, 1987). Based on the sample size concerns and the fact that there were not balanced time intervals in the data, HLM and SEM were not deemed appropriate for this research.

The following GEE modeling specifications were used to analyze the dataset. Because the dependent variable exhibited a relatively continuous distribution, it was modeled as normal, and an identity link function was used (Garson, 2009). Of the several types of working correlation matrices that can be used to account for clustered data, an exchangeable correlation matrix was chosen, which assumes equal correlation between all observations within a given cluster, i.e., teams within a given organization. The exchangeable correlation matrix is the most appropriate for this research because of the lack of natural ordering of the observations and the expected presence of the correlations of teams within organizations (Hardin and Hilbe, 2003; Garson, 2009). Finally, either empirical or "model-based" standard error estimates can be used to assess the regression findings. The model-based standard error estimates were chosen because these estimates are based on the estimated exchangeable correlation matrix (Hanley et al., 2003) and tend to give more consistent estimates of covariance even when the working correlation matrix is misspecified (Garson, 2009) or even when the cluster-level sample size is relatively small (Hanley et al., 2003).

4.1. Identification of direct predictors of work area attitude and commitment

There was no established hierarchy of variable importance. Therefore, for the model building process, an exploratory manual backward selection procedure was used. The procedures used to identify the direct predictors are presented in Table 4.

All of the selection procedures (OLS and GEE) converged upon a three predictor model (Table 5) that included the following predictors:

- *performance review* (GEE $\beta=0.161$, $p=0.012$)
- *experimentation and continuous improvement* (GEE $\beta=0.288$, $p=0.007$), and
- *accepting change* (GEE $\beta=0.202$, $p=0.005$).

These variables were found to be significant at the adjusted α level ($0.10/4=0.025$).

As shown in Table 5, the direct predictors of *work area attitude and commitment* toward Kaizen events explained approximately 50% of the variance (GEE $R^2=0.5026$). The observed intraclass correlation reported by the GEE procedure was 0.1750, which suggests that there is more variation that occurs within clusters versus between clusters (organizations), providing additional support for the use of the exchangeable matrix for the GEE analysis to study this outcome.

Finally, the residual plots and partial regression plots did not indicate departures from linearity. All standardized residual values were less than 2.0, thus presenting no strong evidence of influential cases. However, the Wald–Wolfowitz run test (Chang, 2000) indicated that there was not a random pattern in the residuals ($p=0.003$). Graphical observation of the residuals by organization suggested that the lack of randomness may be caused by heteroscedasticity at the organizational level; i.e., the residual variance is not similar in each organization, and additional organizational variables may improve the overall model fit. To explore this possibility, the additional organizational variables, *year of first Kaizen event, Kaizen event rate,* and *total number of employees*, were tested but were not found to be significant. While the heteroscedasticity potentially presents limitations, conclusions about the sample can still be made, and the variables identified in the model are likely to be among the most influential in explaining *work area attitude and commitment*.

In summary, the null hypothesis for H1 failed to be rejected in that no Kaizen Event Characteristics were found to be significantly

Table 3
Survey scales used in this research study.

Variable grouping	Variable	Data collection timing	Number of items in survey scale	Example survey item	Smallest primary loading	Largest cross-loading	Initial Eigenvalue	Percentage of variance explained (%)	Cronbach's Alpha
Kaizen Event Characteristics	Goal Clarity	Kickoff Questionnaire (T0)	4	Our goals clearly define what is expected of our team.	−0.754	0.098	1.39	10	0.876
	Goal Difficulty	Kickoff Questionnaire (T0)	4	It will be hard to improve this work area enough to achieve our team's goals.	0.723	−0.122	2.51	18	0.813
	Management Support	Report Out Questionnaire (T0)	3	Our team had enough materials and supplies to get our work done.	−0.655	0.148	1.39	1	0.779
Work Area Characteristics	Work Area Routineness	Event Information Questionnaire (T0)	4	The work the target work area does is routine.	n/a[a]	n/a[a]	n/a[a]	n/a[a]	n/a[a]
	Learning and Stewardship	Post-Event Information Questionnaire (T1)	7	Work area employees feel a shared sense of responsibility for the work they do.	0.561	0.284	6.56	63	0.930
	Experimentation and Continuous Improvement	Post-Event Information Questionnaire (T1)	4	Work area employees try out new things by applying them in practice.	0.555	0.291	0.98	9	0.875
Post-Event Characteristics	Institutionalizing Change	Post-Event Information Questionnaire (T1)	6	Updating work method and process documentation (e.g., standard work charts, formal job descriptions, etc.) for changes made due to the Kaizen event.	0.641	−0.224	8.12	41	0.881
	Improvement Culture	Post-Event Information Questionnaire (T1)	3	Work area management supporting the use of Kaizen events in the organization.	0.693	0.251	1.11	6	0.796
	Performance Review	Post-Event Information Questionnaire (T1)	5	Regularly reviewing performance data related to Kaizen event goals.	−0.719	0.255	1.825	9	0.879
	Avoiding Blame	Post-Event Information Questionnaire (T1)	2	Avoiding blame or negativity when changes are made, but results are different than expected.	0.928	0.070	1.451	7	0.947
	Accepting Changes	Post-Event Information Questionnaire (T1)	4	Now, employees in the work area accept the changes made as a result of the Kaizen event.	0.788	0.204	3.156	16	0.947
Outcome	Work Area Attitude and Commitment	Post-Event Information Questionnaire (T1)	6	Most of our team members liked being part of this Kaizen event.	0.790	−0.132	7.16	65	0.951

[a] *Work area routineness* is a composite measure of the stability of product mix and the degree to which the production flow in the targeted work area was routine. Therefore, exploratory factor analysis was not conducted and Cronbach's alpha was not calculated for this measure.

Table 4
Procedures used for the identification of direct predictors.

1. GEE Manual Backward Selection Procedures	Procedures: At each step in the selection procedure, if the p-value for one or more variables was greater than $\alpha=0.10/k$, where k is the number of parameters in the model (i.e., the number of predictor variables plus one), the variable with the largest p-value was removed. This procedure was repeated until all remaining variables were significant at the $\alpha=0.10/k$ level.
2. OLS Automated Selection Procedures	Procedures: OLS regression procedures using PROC REG in SAS 9.2, including examination of the automated backward, stepwise, R2, MAXR, and Cp selection procedures, were used to support the GEE results.
3. Indicators of Variance Explained	Indicators: OLS R^2 and adjusted R^2 values automatically generated using the OLS procedures; GEE R^2 and adjusted R^2 values manually calculated (Hardin and Hilbe, 2003); The observed intraclass correlation reported by the GEE procedure
4. Residual Analyses and Indicators	Purpose: To assess potential departures from linearity and normality Indicators: Residual plots, partial regression plots, standardized residual values less than 2.0, and the Wald–Wolfowitz run test (Hardin and Hilbe, 2003)
5. Final Model Selected	Procedures: The model is confirmed and adjusted as needed based on previous steps

Table 5
Regression model of direct predictors of work area attitude and commitment.

		GEE regression findings			OLS regression findings		
		GEE β	**SE GEE**	**α GEE**	**OLS β**	**SE OLS**	**α OLS**
	Regression Model Intercept	1.653	0.467	0.000	1.380	0.437	0.003
Work Area Characteristic	*Experimentation and Continuous Improvement*	0.288	0.107	0.007	0.301	0.111	0.009
Post-Event Characteristics	*Accepting Changes*	0.202	0.072	0.005	0.247	0.076	0.002
	Performance Review	0.161	0.064	0.012	0.168	0.063	0.010

OLS $R^2=0.504$, OLS $R^2_a=0.479$.
GEE $R^2=0.503$, GEE $R^2_a=0.477$, $\rho=0.175$.

related to *work area attitude and commitment*. There was partial support for H2 and H3 in that *work area attitude and commitment* was significantly predicted by one Work Area Characteristic (*experimentation and continuous improvement*) and two Post-Event Characteristics (*performance review* and *accepting changes*).

4.2. Mediation analysis to identify indirect predictors of work area attitude and commitment

Mediation analysis was used to determine whether any input factors, i.e., the Kaizen Event Characteristics or Work Area Characteristics, had indirect effects on *work area attitude and commitment* through the mediating Post-Event Characteristics, *performance review* and *accepting changes*. A mediator is a variable that is in a causal sequence between two variables (MacKinnon et al., 2007), and mediation occurs when an input variable acts indirectly upon an outcome variable through a mediating process variable (Baron and Kenny, 1986). GEE was also used to analyze the mediation relationships. A five-step process was used to perform the mediation analysis (Judd and Kenny, 1981; Baron and Kenny, 1986; MacKinnon et al., 2000; Kenny, 2009); the first steps are the identification of the potentially mediating variables and the primary mediation analysis testing, while the last two steps were post-hoc analyses used to test the robustness of the solution found in the primary mediation analysis testing. These steps are illustrated in Table 6. The first three steps tested three paths to evaluate each mediation hypothesis (the paths from the potential mediators to the outcome – i.e., Step 1 – had already been tested in the direct regression). Therefore, an α level of $0.05/3=0.0167$ was adopted as the significance level for each path to preserve an overall 0.05 confidence level for the test (Kenny, 2009).

Table 7 presents the mediation results. In summary, *performance review* was a significant mediator of the effect of *work area routineness* and *learning and stewardship* on *work area attitude and commitment*. It should be noted that in Step 3 of the mediation analysis, regression coefficient b was only marginally significant at the adjusted level for *learning and stewardship* ($p=0.0295$). However, the marginally supported full mediation of *learning and stewardship* is retained in the model to emphasize the potential influence that *learning and stewardship* may have on *work area attitude and commitment*. Also, for Step 5, the p-value for *work area routineness* was very high (0.680). This finding may indicate a suppression effect (MacKinnon et al., 2000), as the direct effect of *work area routineness* is negative (-0.030) and its indirect effect is positive (0.095), which may be canceling out the direct effect (MacKinnon et al., 2000)

Accepting changes was a significant mediator of the effect of *production system changes* and *experimentation and continuous improvement* on *work area attitude and commitment*. Again, it should be noted that at Step 5, *production system changes* ($\beta=0.095$, $p=0.3461$) was not significant. In this case, the direct effect and indirect effect of *production system changes* were both positive. Conceptually, the finding may relate to a confounding effect (MacKinnon et al., 2000), i.e., the increase in the magnitude of the effect of *production system changes* on *work area attitude and commitment* may have occurred because *accepting changes* explained variability in *production system changes*. In summary, H4 was partially supported with two significant mediation effects for *work area attitude and commitment*.

4.3. Correlation analysis of T0 and T1 social system outcomes

Analysis of the non-parametric bivariate correlations, Kendall's tau and Spearman's rho, between the *attitude* of Kaizen event team members immediately after the event (Farris et al., 2009) and *work area attitude and commitment* was conducted (see Table 8). In summary, the correlation finding was not significant (p-value >0.90). Thus, H5 was not supported.

4.4. Qualitative assessment of the event primary goals

Finally, a qualitative assessment of the primary goals of the events with the five highest and five lowest *work area attitude and commitment values* via an extreme case sampling approach (Yin, 1994) provided additional insight into the regression

Table 6
Mediation analysis procedures used for the identification of indirect predictors.

1. Establishing a relationship between mediator and outcome	• The process variables that were significant in the direct regression as potential mediators were selected.
2. Establishing a relationship between mediator and input variable	• The mediating process variable (z) was separately regressed on each input variable individually (x), and the resulting coefficient (a) was tested for significance.
3. Establishing a relationship between outcome and mediator, controlling for input variable	• If a significant relationship was demonstrated in Step 1, the outcome variable (y) was regressed on both the input variable (x) and the mediating process variable (z), and the resulting regression coefficients were tested for significance. • A significant regression coefficient (b) for the mediating process variable (z) is necessary for the demonstration of a mediation effect. • The regression coefficient (c') for input variable (x) can be either significant (partial mediation) or non-significant (full mediation).
4. Confirming the unique effect of each input variable on mediator	• After the two preceding steps were accomplished for all input variables, the mediating process variable (z) was simultaneously regressed on all the input variables (xi) significant in Step 1. • This step was performed to confirm whether each input variable (xi) was a significant unique predictor of the mediator (z), after controlling for the other input variables.
5. Evaluating the direct relationship between input variable and outcomes	• The direct relationship between each input variable (x) and the outcome (y) was tested for significance. • A significant direct relationship further supports the mediation hypothesis but is not strictly necessary (MacKinnon et al., 2000).

findings. The primary goals of four of the five Kaizen event teams with the highest *work area attitude and commitment* values were related to standardizing work. Standard work techniques often include the integration of best practices, updating documentation, and implementing visual cues; thus, these techniques may support existing standard operation efforts, e.g., genba kanri, which have been suggested to assist employees with sustaining improvements (Martin, 2007; Veech, 2004). The targeted activities of these events included the implementation of standard work documentation that appears to support accepting changes, as well as the adoption of an auditing or inspection process, a performance review activity.

Four of the five teams with the lowest *work area attitude and commitment* values had primary goals that were related to addressing quality issues, including the reduction of errors and testing failures. Kaizen events and other improvement mechanisms are often successfully used to address errors and other quality-related issues (e.g., Melnyk et al., 1998). However, the continuous improvement literature emphasizes the importance of avoiding blame when addressing quality issues (Kaye and Anderson, 1999). It is possible that because these events addressed quality issues, work area employees may relate Kaizen events to the identification of mistakes made in the work area. Therefore, if additional supportive structures were not present during these quality-focused Kaizen events, work area employees may have developed negative attitudes toward the improvement mechanism (i.e., the Kaizen event). Hence, there is a need for more research to understand the cultural aspects and support structures that may be needed to sustain *work area attitude and commitment* for quality-related Kaizen events.

5. Conclusions

5.1. Determinants of work area attitude and commitment

Accepting changes was the strongest predictor of *work area attitude and commitment* ($\beta=0.202$, $p=0.005$). This is in alignment with previous research, which has suggested that management's reinforcement of continuous improvement by regularly checking and raising continuous improvement awareness and the understanding of employees (Kaye and Anderson, 1999), plays a primary role in supporting the sustainability of change.

Furthermore, the mediation analysis found that *production system changes* and *experimentation and continuous improvement* were positively related to *work area attitude and commitment* through *accepting changes*. The finding related to *production system changes* aligns with previous research which found that organizations with flexible production capabilities, i.e., organizations that often and rapidly implement changes in product mix, etc., tend to create cultures that are more accepting of change in general (Yeung et al., 1999). The finding that *experimentation and continuous improvement* impacted *accepting changes* (and thereby *work area attitude and commitment*), is also aligned with Yeung et al. (1999) as well as other previous research (e.g., Keating et al., 1999).

Performance review was also found to be a significant, positive predictor of *work area attitude and commitment*, which suggests that the establishment of activities such as reviewing work area performance measures, conducting audits, and meeting with higher-level management regarding the Kaizen event progress encourages positive employee attitudes toward Kaizen events. This finding aligns with previous research that has reported that the use of measurement systems and related activities may increase visibility and employee awareness of change (Bradley and Willett, 2004; Melnyk et al., 1998; Tanner and Roncarti, 1994) and may prevent the deterioration of process-related improvements over time (Bateman and Rich, 2003; Kaye and Anderson, 1999; Dale et al., 1997).

Acting indirectly through *performance review, learning and stewardship* and *work area routineness* were also positively related to *work area attitude and commitment.* This aligns with previous performance measurement research which has reported a positive relationship between performance review and organizational learning and stewardship (e.g. Kloot, 1997; Mausloff and Spence, 2008). However, the relationship has most often been hypothesized in the reverse of the direction studied in this research, i.e., performance review as a determinant of learning and stewardship. For instance, previous research in the continuous improvement domain has also found that *performance review* activities may serve as group learning experiences because they provide a platform to share experiences and progress on improvement

Table 7
Mediation analysis results for work area attitude and commitment[a].

Step 1: y' = *Work area attitude and commitment*, separate regression	**Coef.**	**SE**	***p*-value**			
Accepting changes	0.202	0.072	0.005			
Performance review	0.161	0.064	0.012			
	Significant direct predictors, potentially significant mediating variables					
	Performance review			***Accepting changes***		
Step 2: y' = Mediator, separate regression	**Coef. (a)**	**S.E.**	***p*-value**	**Coef. (*a*)**	**S.E.**	***p*-value**
Goal Clarity	0.19	0.311	0.5407	−0.194	0.27	0.4733
Goal Difficulty	0.193	0.220	0.3809	−0.160	0.205	0.4348
Team Functional Heterogeneity	0.184	0.866	0.8322	0.771	0.769	0.3158
Management Support	0.108	0.290	0.7094	0.250	0.257	0.3295
Work Area Routineness	0.353	0.138	0.0108*	0.255	0.13	0.0509
Management Change	0.052	0.262	0.8429	−0.34	0.243	0.1624
Production System Changes	0.049	0.199	0.805	0.408	0.173	0.0186*
Management Kaizen Event Participation at T1	−0.283	0.388	0.4249	0.195	0.345	0.5732
Management Kaizen Event Participation at T0	−0.415	1.069	0.6981	0.820	0.957	0.3914
Employee Change Ratio	−0.698	0.837	0.4045	0.631	0.567	0.2651
Learning and Stewardship	0.636	0.187	0.0007*	0.884	0.155	< .0001*
Experimentation and Continuous Improvement	0.324	0.194	0.095	0.553	0.171	0.0012*
Step 3: y' = *Work area attitude and commitment*, separate regression	**Coef. (*b*)**	**SE**	***p*-value**	**Coef. (*c'*)**	**SE**	***p*-value**
Performance Review	0.270	0.068	< 0.0001*			
Work Area Routineness				−0.13	0.082	0.1137
Performance Review	0.145	0.067	0.0295			
Learning and Stewardship				0.408	0.109	0.0002*
Accepting Changes	0.299	0.071	< 0.0001*			
Production System Changes				−0.028	0.11	0.8017
Accepting Changes	0.226	0.071	0.0014*			
Experimentation and Continuous Improvement				0.332	0.106	0.0018*
Accepting Changes	0.165	0.079	0.0375			
Learning and Stewardship				0.354	0.121	0.0035*
	Performance review			***Accepting changes***		
Step 4: y' = Mediator, simultaneous regression	**Coef. (*a'*)**	**SE**	***p*-value**	**Coef. (*a'*)**	**SE**	***p*-value**
Work Area Routineness	0.383	0.132	0.0039*			
Learning and Stewardship	0.672	0.178	0.0002*			
Production System Changes				0.362	0.176	0.0403*
Experimentation and Continuous Improvement				0.514	0.169	0.0023*
Step 5: y' = Work area attitude and commitment, separate regression	**Coef.**	**SE**	***p*-value**			
Work Area Routineness	−0.030	0.073	0.680			
Learning and Stewardship	0.500	0.096	< 0.0001*			
Production System Changes	0.095	0.101	0.3461			
Experimentation and Continuous Improvement	0.449	0.100	< 0.0001*			
			Total mediated effect ($a \times b$)			
Mediation analysis results for work area attitude and commitment			***Performance review***		***Accepting changes***	
Work Area Routineness			0.095	Full		
Learning and Stewardship			0.092	Full		
Production System Changes					0.122	Full
Experimentation and Continuous Improvement					0.125	Partial

[a] An asterisk (*) indicates a significant relationship.

Table 8
Bivariate correlations of work area attitude and commitment and attitude.

	Kendall's tau		**Spearman's rho**	
	Correlation coefficient	**Sig. (2-tailed)**	**Correlation coefficient**	**Sig. (2-tailed)**
Work area attitude and commitment and attitude	0.005	0.954	0.013	0.919

projects (Kaye and Anderson, 1999). It is also possible that performance review and organizational learning and stewardship share a bi-directional, reinforcing relationship, which could be a focus of future research.

Meanwhile, the finding related to *work area routineness* suggests that *performance review* activities may be more effective in less complex work areas, due to difficulties in defining performance measures (e.g., Beamon, 1999) or greater variability in

performance (e.g., Martin and Smith, 2005) for more complex work systems. Thus, companies with more complex work may want to consider additional strategies to offset this inherent disadvantage, e.g., more focus on developing learning and stewardship behaviors.

Finally, *experimentation and continuous improvement* was also directly related to *work area attitude and commitment.* This finding is also aligned with previous studies, which have found that direct employee participation in designing changes (Bradley and Willett, 2004; Melnyk et al., 1998; Tanner and Roncarti, 1994), employee understanding of continuous improvement (Kaye and Anderson, 1999), and employee understanding of the benefits of improvement via participation in continuous improvement activities (e.g., Keating et al., 1999) are critical to the continued success of an improvement program. In addition to the discussion of the significant variables, it should be noted that several model variables were not found to be significant predictors of *work area attitude and commitment,* after controlling for the most significant predictors, including: *goal clarity, goal difficulty, management support, team functional heterogeneity, management change, employee change*, *institutionalizing change,* and *improvement culture*. However, some of these variables were found to be significantly related to other sustainability outcomes (Glover, 2010).

5.2. Relationship between immediate and long-term social system outcomes

Based on the correlation analysis, there is no support for the relationship between the *attitude* of Kaizen event team members toward Kaizen events immediately after the event (Farris et al., 2009) and *work area attitude and commitment*. The fact that *attitude* and *work area attitude and commitment* appear to be uncorrelated may be explained based on differences in the respondent, i.e., the respondents for *attitude* were the team members while the respondent for *work area attitude and commitment* was the facilitator or work area manager. However, this finding does at least partially align with previous research that suggests that positive attitudes at the conclusion of a successful event do not necessarily translate to sustained employee enthusiasm (Doolen et al., 2008) and that work area employees may be more influential to the long-term sustainability of Kaizen event outcomes than the original Kaizen event team members (Burch, 2008).

Examination of the most significant predictors of *attitude* (Farris et al., 2009) compared to those of *work area attitude and commitment* provides additional insight into the similarities and differences in the mechanisms underlying the development of both outcomes. As described in Farris et al. (2009), *attitude* toward events was positively related to *management support* and *internal processes* (a measure of team harmony) and negatively related to *team functional heterogeneity* (an index measuring the cross-functional diversity of the team). Thus, there are some clear differences between the most significant predictors of *attitude* compared to those of *work area attitude and commitment*. For example, *team functional heterogeneity* was not a predictor of *work area attitude and commitment*, measured at T1.

There are also similarities to note between the predictors of *attitude* versus *work area attitude and commitment*. Both emphasize the role of group processes—i.e., having harmonious team processes during the event, accepting and following changes, practicing learning and stewardship, and experimentation and continuous improvement after the event. Both also include predictors that relate to the role of management, i.e., providing resources during the event, and promoting changes and holding employees accountable for adhering to changes after the event. These findings suggest that the two attitudinal outcome variables are strongly influenced by similar types of factors (i.e., group behaviors and management support), although the outcomes themselves are distinct and uncorrelated.

5.3. Findings from the qualitative analysis

Qualitative observations of the Kaizen events with the highest and lowest work area attitude and commitment values suggest that managers may find it beneficial to periodically hold standard work events, e.g., using a standard work event to implement techniques that may enhance the acceptance of change and may encourage employees to follow new work methods, as they may help support the critical factors of work area attitude and commitment. In addition, managers may wish to place additional emphasis on those critical factors when using Kaizen events to address quality issues.

5.4. Limitations and future research

The research design is an observational field study that sampled Kaizen events and their targeted work areas across multiple manufacturing organizations in order to test a working model of Kaizen event outcome sustainability. Key study limitations include those related to the size and nature of the sample, the consideration and treatment of organizational variables, the timing of the data collection, and the variables omitted from the research model. Each of these limitations is further discussed below, along with related areas for future research.

The sample was limited in terms of the type, number, and geographic location of organizations, i.e., eight manufacturing organizations located in states on the East Coast and West Coast of the United States of America. Further research could consider a larger number of participating organizations from a wider variety of industries and additional geographic locations in order to increase the generalizability and robustness of the findings. For example, researchers have found that there are limitations with the transfer of some management innovations from other cultures e.g., the transfer of quality circles from Japan to the U.S., due to a lack of understanding of the organizational and strategic significance of the innovation (Lillrank, 1995), the lack of a supporting improvement infrastructure within the organizations (Ishikawa, 1985), and the existence of very different management paradigms and principles in U.S. organizations (Lillrank, 1995); i.e., a different organizational culture. The present research controlled for some organizational characteristics—for instance, the organizations studied all used Kaizen events as a mechanism within a structured, strategic Kaizen event program. However, further research should consider additional organizational characteristics, including, for example, comparing the sustainability of Kaizen event outcomes across organizations from varying cultures. Further, the residual analysis suggests that additional organizational variables may increase the predictive capabilities of the model. The continuous improvement literature hypothesizes that several organizational and external environmental variables may influence improvement sustainability, including organizational structure and policies (Dale et al., 1997), competitors (Dale et al., 1997; Keating et al., 1999), and the ethnic diversity of the organizations. Future research, including the testing of additional organizational variables and the consideration of other multilevel modeling approaches, e.g., HLM, is thus needed to further understand the variation in the outcome across organizations.

Due to limitations in collecting data (e.g., delayed data collection from respondents), data were collected at T0 (at the beginning and within four weeks of the Kaizen event) and at T1 (approximately nine to 18 months after the Kaizen event). Using

a constant time difference between T0 and T1 (e.g., collecting all T1 data at exactly twelve months after the Kaizen event) could have strengthened the internal validity of the study (Davis and Cosenza, 1985), although clearly difficult to achieve in practice. In addition, future study of Kaizen events using a research design that considers the collection of data at more than two points in time would be beneficial (e.g., T0=immediately after the event, T1=6 months, T2=12 months, T3=18 months).

Further, T1 survey data, e.g., Work Area Characteristics and Sustainability Outcomes, were collected from facilitators or work area managers as opposed to collecting the data directly from the workforce. While collecting data regarding the perceptions of the workforce throughout the research would have been beneficial, the approach in this research of using a facilitator or the work area manager to assess the perceptions of the workforce is supported as it has been used in previous studies of improvement teams (as summarized in Cohen and Bailey, 1997). Furthermore, it is possible that the data collected from the facilitator or manager may be more accurate than collecting data from the work area employees, because employees responding may not have been in the work area at the time of the Kaizen event (due to turnover), while the facilitator or manager responding to the questionnaire was present at the time of the Kaizen event. In addition, the research team made initial pilot attempts to survey work area employees as well, but this survey approach was discontinued due to low response rates. However, future research that collects data from both work area employees and facilitators/work area managers should be considered.

Finally, this research did not attempt to study all Kaizen event characteristics, work area characteristics or post-event characteristics that could potentially impact the sustainability of *work area attitude and commitment*. Instead, the factors chosen for this research were selected from the Kaizen event body of knowledge and related theory as dominant, recurring factors indicated by multiple sources as likely determinants of event outcomes. For example, the impact of the facilitator's experience and the need for the Kaizen event as perceived by the work area manager could also be included in future research, although they are currently at least partially reflected through other Kaizen event characteristics included in the model, e.g., *management support*. It should be noted that additional characteristics related to the experience and maturity of the organization and its use of Kaizen events should also be considered in modeling the sustainability of *work area attitude and commitment* resulting from Kaizen events in future research. Several organizational variables were reflected in this research either as controls (i.e., the organizational selection criteria) or measured work area characteristics, e.g., *employee changes*, or the turnover of work area employees since the Kaizen event, which was used to indirectly account for the use and percentage of temporary workers in the work area; however given the findings related to the non-homogeneity of error terms across organizations and the need to compare findings across different cultural contexts, additional research on the influence of organizational characteristics is needed.

In summary, the present research has contributed to the body of Kaizen event knowledge and practice in a number of ways. To the authors' knowledge, this research uses the largest sample size at the Kaizen event level to date ($n=65$), including both studies of Kaizen event initial outcomes and Kaizen event outcome sustainability. This research also identified and operationalized new Post-Event Characteristic survey scales. These scales can be used to inform future research on Kaizen events and other process improvement approaches. While these data collection instruments were used for research purposes in the participating companies, organizations could also use these instruments as a tool to manage Kaizen event activities. Thus, this work provides direction for both future research and future Kaizen event practice, based on large-sample, quantitative findings related to the most critical success factors for Kaizen activities and the development of supporting assessment methods and tools.

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Appendix A

See Appendix Table A1 below.

Appendix A1
Summary of study variables, supporting literature, and measures.

Variable and literature support	Data collection instrument, measurement scale, and items
Goal clarity describes the extent to which the team's objectives have been explicitly defined (Farris et al., 2009). Organizational change research emphasizes the importance of clear goals in order to sustain organizational change (Oxtoby et al., 2002).	Data collected through *Kickoff Questionnaire* 6-point Likert type scale GC1: "Our team has clearly defined goals." GC2: "The performance targets our team must achieve to fulfill our goals are clear." GC3: "Our goals clearly define what is expected of our team." GC4: "Our entire team understands our goals."
Goal difficulty describes the subjective difficulty of event objectives as perceived by team members (Farris et al., 2009). Process improvement literature suggests that project scope and project complexity may negatively impact sustainability of improvement (Keating et al., 1999).	Data Collected through *Kickoff Questionnaire* 6-point Likert type scale GDF1: "Our team's improvement goals are difficult." GDF2: "Meeting our team's improvement goals will be tough." GDF3: "It will take a lot of skill to achieve our team's improvement goals." GDF4: "It will be hard to improve this work area enough to achieve team's goals."
Management support describes the support that senior leadership provided to the team, including materials and supplies, equipment, and assistance from organizational members (Farris et al., 2009). A lack of management support has been found to be an inhibitor of Kaizen event outcome sustainability (Bateman, 2005).	Data Collected through *Kickoff Questionnaire* 6-point Likert type scale MS2: "Our team had enough materials and supplies to get our work done." MS3: "Our team had enough equipment to get our work done." MS5: "Our team had enough help from others in our organization to get our work done."

Appendix A1 (*continued*)

Variable and literature support	Data collection instrument, measurement scale, and items
Team functional heterogeneity describes the diversity of functional expertise within the Kaizen event team (Farris et al., 2009). Kaizen event sustainability literature suggests that the development of a cross-functional team supports the sustainability of Kaizen event outcomes (Patil, 2003).	Data Collected through *Kickoff Questionnaire* Continuous Measure *Team Functional Heterogeneity* is measured by an index of variation for categorical data, *H*.
Experimentation and continuous improvement is a combination of the measures, *knowledge of continuous improvement* (Doolen et al., 2003) and *experimentation* (Groesbeck, 2001). Research has found that an awareness and understanding of continuous improvement knowledge (e.g., Kaye and Anderson, 1999) and active experimentation with new ideas (Upton, 1996) may be important to the sustainability of improvement.	Data Collected through *Post-event Information Questionnaire* 6-point Likert type scale EXPER2: "Work area employees try out new things by applying them in practice." EXPER3: "Work area employees test new ideas to help themselves learn." KCI2: "Work area employees understand how continuous improvement can be applied to Work area." KCI4: "Work area employees believe they have a role in continuous improvement in Work area."
Learning and stewardship is a combination of the group learning behavior and stewardship measures, *external perspective, experimentation,* and *internal collaboration,* and *group stewardship* (Groesbeck, 2001). Group learning behaviors (e.g., Upton, 1996; Kaye and Anderson, 1999; Burch, 2008; Anand et al., 2009) and group stewardship (e.g., Mann, 2005) have been reported to influence improvement outcome sustainability.	Data Collected through *Post-event Information Questionnaire* 6-point Likert type scale EP1: "Work area employees understand how their work fits into the "bigger picture" of the organization." EP3: "Work area employees understand how their work relates to that of other parts of the organization." INT2: "Work area employees ask each other for help when they need assistance." INT3: "Work area employees freely share information with one another." STEW1: "Work area employees feel a shared sense of responsibility for the work they do." STEW2: "Work area employees feel a sense of accountability for the work they do." STEW3: "Work area employees want to do what is best for the organization."
Work area routineness measures the general complexity of the target system, based on the level of stability of the product mix and degree of routineness of product flow (Farris et al., 2009). The complexity of a work area may influence the complexity and scope of an improvement effort which may negatively impact sustainability of improvement (Keating et al., 1999).	Data Collected through *Kickoff Questionnaire* 6-point Likert type scale WAC1: "The work the target work area does is routine." WAC2: "The target work area produces the same product (SKU) most of the time." WAC3: "A given product (SKU) requires the same processing steps each time it is produced." WAC4: "Most of the products (SKUs) produced in the work area follow a very similar production process."
Management Kaizen event participation relates to having a supportive infrastructure and management that has an understanding of process improvement techniques which can be developed through participation in improvement activities (Bateman, 2005).	Data Collected through *Post- Event Information Questionnaire* Binary dummy variable "Have the current managers *all* participated in *at least one* Kaizen event?" (1=yes, 2=no) "At the time of the Kaizen event, had work area managers *all* participated in *at least one* Kaizen event?" (1=yes, 2=no) *Management Kaizen event participation at T0*=1 when current management had participated in at least one Kaizen event at the time of the observed Kaizen event AND current management had NOT participated in at least one Kaizen event since the observed Kaizen event. Otherwise, *Management Kaizen event participation at T0*=0. *Management Kaizen event participation at T1*=1 when current management had NOT participated in at least one Kaizen event at the time of the observed Kaizen event AND current management had participated in at least one Kaizen event since the observed Kaizen event. Otherwise, *Management Kaizen event participation at T1*=0.
Management change relates to the stability of the organization's environment (Goodman and Dean, 1982) and the management support of improvement activities (Bateman, 2005; Bateman and Rich, 2003) which may be influenced by a change in management over time.	Data Collected through *Post- Event Information Questionnaire* Binomial variable "Has work area management changed since the Kaizen event?" (1=yes, 2=no)
Employee change relates to staff turnover which has been cited as an inhibitor of Kaizen event sustainability (Bateman and Rich, 2003).	Data Collected through *Post-Event Information Questionnaire* Continuous variable "The number of current employees in the work area that were working in the work area at the time of the Kaizen event" "The number of current employees in the work area" *Employee Change*=The number of current employees in the work area that were working in the work area at the time of the Kaizen event' divided by 'The number of current employees in the work area'
Production system changes including changes to work area equipment, product volume and product mix may indicate that the work area is less stable, which may negatively influence improvement sustainability (Keating et al., 1999).	Data Collected through *Post- Event Information Questionnaire* Polynomial variable "Have there been any major equipment changes in the work area since the Kaizen event?" (1=yes, 2=no) "Have there been any major volume changes in the work area since the Kaizen event?" (1=yes, 2=no) "Have there been any major product mix changes in the work area since the Kaizen event?" (1=yes, 2=no) *Production System Changes*=The number of "yes" responses across the three questions (ranges from zero to three)

Appendix A1 (*continued*)

Variable and literature support	Data collection instrument, measurement scale, and items
Institutionalizing change activities include training employees in new work methods (Heard, 1997; Goldacker, 2005), providing support for employees to complete action items after the event (Magdum and Whitman, 2007), and documenting changes to work methods (Miller, 2004; Patil, 2003; Magdum and Whitman, 2007; Heard, 1997; Mann, 2005; Powell and Hoekzema, 2008).	Data Collected through *Post- Event Information Questionnaire* 6-point Likert type scale IChange1: "Formal documentation of follow-up action items (e.g., through a Kaizen newspaper) from the Kaizen event." IChange2: "Individual team members working on follow-up action items from the Kaizen event." IChange3: "Training work area employees in new work methods and processes from the Kaizen event." IChange4: "Updating work method and process documentation (e.g., standard work charts, formal job descriptions, etc.) for changes made due to the Kaizen event." IChange5: "Involving work area employees (not on the Kaizen event team) in follow-up and completion of action items from the event." PR3: "The Kaizen event team meeting as a whole to review progress and/or develop follow-up strategies for the Kaizen event."
Avoiding blame relates to the extent to which blame and negativity are avoided. The literature suggests that blame and punishment should be avoided when addressing mistakes as it make inhibit innovation and a continuous improvement culture (Kaye and Anderson, 1999).	Data Collected through *Post- Event Information Questionnaire* 6-point Likert type scale ICulture3: "Avoiding blame or negativity when changes are made, but results are different than expected." ICulture4: "Avoiding blame or negativity when team goals are not achieved."
Improvement culture activities include recognition of employees (Oxtoby et al., 2002) and the allocation of the necessary resources (e.g., human resources, equipment, and information) at all stages of a Kaizen event program (Heard, 1997), including the allocation time form work area employees to complete action items after the event (Palmer, 2001) and to work on continuous improvement activities (Bateman, 2005).	Data Collected through *Post- Event Information Questionnaire* 6-point Likert type scale ICulture6: "Work area management supporting the use of Kaizen events in the organization." ICulture7: "Work area management championing the value of continuous improvement." ICulture8: "Work area management allowing work area employees time to work on continuous improvement activities."
Performance review activities include the review of Kaizen event performance measurement data (Kaye and Anderson, 1999; Bateman, 2005; Martin and Osterling, 2007; Adamson and Kwolek, 2008), use of audits and audit reporting tools (Kaye and Anderson, 1999; Martin and Osterling, 2007; Patil, 2003; Powell and Hoekzema, 2008), regular follow-up meetings of the Kaizen event team (Martin and Osterling, 2007; Palmer, 2001), and regular follow-up reports and meetings to management (Goldacker, 2005; Destefani, 2005; Magdum and Whitman, 2007).	Data Collected through *Post- Event Information Questionnaire* 6-point Likert type scale PR1: "Regularly reviewing performance data related to Kaizen event goals." PR2: "Conducting regular audits on changes made due to the Kaizen event." PR4: "Meetings with higher-level management about Kaizen event progress or follow-up." PR5: "Meetings with Kaizen coordinator or facilitator about Kaizen event progress or follow-up." PR7: "Informing higher-level management of issues with follow-up and sustaining results from the Kaizen event."
Accepting changes describes the extent to which changes made during Kaizen event are accepted, followed, and reinforced by management and refers to the refers to the socialization of the change and the commitment of the individual to the change (Goodman and Dean, 1982; Cummings and Worley, 1997).	Data Collected through *Post- Event Information Questionnaire* 6-point Likert type scale AcChg2-1: "Now, the management of the work area accepts the changes made as a result of the Kaizen event." AcChg3-1: "Now, the management of the work area holds employees accountable for following the new work methods from the Kaizen event." AcChg4-1: "Now, employees in the work area accept the changes made as a result of the Kaizen event." AcChg5-1: "Now, employees in the work area follow the new work methods from the Kaizen event."
Work area attitude and commitment relates to the extent to which the work area employees like or dislike the change (Goodman and Dean, 1982) and to the overall perception that changes was needed and valued by employees that has been found to impact the institutionalization of change (Buller and McEvoy, 1989).	Data Collected through *Post-Event Information Questionnaire* 6-point Likert type scale AT1-1: "In general, the Kaizen event has increased the work area employees' willingness to be part of Kaizen events in the future." AT1-3: "In general, the Kaizen event has improved the work area employees' attitudes toward Kaizen events." CKE2: "In general, the Kaizen event has increased the work area employees' belief in the value of Kaizen events." CKE3: "In general, the Kaizen event has increased the work area employees' belief that Kaizen events are a good strategy for this organization." CKE4: "In general, the Kaizen event has increased the work area employees' belief that Kaizen events serve an important purpose." CKE5: "In general, the Kaizen event has increased the work area employees' belief that Kaizen events are needed in this organization."

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