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Approaching Error-Free Customer Satisfaction through Process Change and Feedback Systems

By Kristin M Berglund and Timothy D Ludwig

ABSTRACT

Employee-based errors result in quality defects that can often impact customer satisfaction. This study examined the effects of a process change and feedback system intervention on error rates of 3 teams of retail furniture distribution warehouse workers. Archival records of error codes were analyzed and aggregated as the measure of quality. The intervention consisted of a process change where teams of 5 employees who had previously been assigned a specific role within the process were cross-trained to know and help with other team members' functions. Additionally, these teams were given performance feedback on an immediate, daily, and weekly basis. Team A reduced mean errors from 7.47 errors per week during baseline to 3.53 errors per week during the intervention phase. Team B experienced a reduction in mean number of weekly errors from a baseline of 11.39 errors per week to 3.82 errors per week during the intervention phase. Team C did not experience significant error rate reduction.

ARTICLE

Customer service is a key component of successful businesses. Customers consider the level of personal service they receive to assist in their purchasing choice across competing retailers. In addition to customer service, the quality of merchandise is an important consideration for customers deciding between retailers (Leung, Li, & Au, 1998). When customers pay premium prices for high-end products, they expect to receive a high quality, error-free product (Goering, 1985).

In order to achieve the attention to detail required and to appease demanding and discriminating customers, quality control is essential (Bullington, Easley, Greenwood, & Bullington, 2002). Quality control helps to identify and reduce errors in products before they leave for delivery to the customer. Each aspect of the product is inspected and repaired as necessary. Without quality control, damaged and otherwise imperfect products may be delivered to the customer. However, quality control programs are not foolproof. Despite efforts to the contrary, some product errors make it past these inspection and repair processes that depend on employee behavior to detect and correctly fix errors.

CROSS-TRAINED TEAMS

Of the tasks performed in the workplace, some may be performed by individuals working together. When people interact with each other to complete specific assigned roles, a team is formed (Salas, Dickinson, Converse, & Tannenbaum, 1992). Within a team, members are able to utilize the collective ideas, knowledge, and experience each team member contributes. Most teams are composed of individuals with specific job functions within a linear work process whereby individuals depend on others' functions to get their jobs done. In contrast, members of a cross-trained team are not just knowledgeable about their own duties and responsibilities; they are also knowledgeable and can perform their teammates' job functions as well (Goldstein & Ford, 2002).

There is scarce research on how and why cross-trained teams work (Volpe, Cannon-Bowers, Salas, & Spector, 1996). Hollenbeck, DeRue, and Guzzo (2004) noted that there is a "science-practice knowledge gap" regarding cross-trained teams. Until recently, and due in large part to the lack of research, cross-trained teams have been regarded as counterproductive to team performance, serving only to duplicate processes and slow production time (Hollenbeck et al., 2004). However, among the few research studies performed, cross-trained teams were effective methods in employee organization (Volpe et al., 1996; Cannon-Bowers, Salas, Blickensderfer, & Bowers, 1998; Marks, Sabella, Burke, & Zaccaro, 2002).

When team members were cross-trained, as opposed to receiving taskspecific training only, teams tended to experience enhanced team functioning, especially engaging in more effective teamwork, team interactions, and communication processes. Additionally, cross-trained teams reported higher interpositional knowledge and maintained their process quality better than non-cross-trained teams (Cannon-Bowers et al., 1998; Volpe et al., 1996). Cross-trained teams responded better than traditional teams to high workload situations and were seen as a critical factor in team success (Cannon-Bowers et al., 1998). Research by Cooke et al. (2003) revealed that teams that were fully cross-trained had more task work and teamwork knowledge than control teams, resulting in higher team performance outcomes for the cross-trained teams.

Marks et al. (2002) argued that when teams are cross-trained, they benefit from enhanced shared team-interaction models, or mental models. Cross-training allows performers to share a common understanding of the process or processes required to complete a task or set of tasks. Team members can then share such processes as coordination and backup (task assistance) behaviors that can be helpful in establishing opportunities for communication.

It has long been established that teams require specific team process behaviors such as communication, leadership behaviors, coordination, and planning (Foushee, 1984; Stout, Salas, & Carson, 1994; Zalesny, Salas, & Prince, 1995). Cross-trained teams are no exception. Organizations that adopt crosstrained teams without fully committing to the team process behaviors decrease their chances of success (Foushee, 1984; Stout et al., 1994; Zalesny et al., 1995).

Cross-trained teams require open lines of communication in order to disseminate information among team members quickly and easily. When cross-trained teams fail, it is often because of the breakdown of feedback and communication systems throughout the team and process (Cannon-Bowers et al., 1998; Stout et al., 1994). One important component of this communication system is a feedback system that informs team members of their performance and errors.

Improved feedback in cross-trained teams increases technical quality and excellence (Foushee, 1984; Stout et al., 1994). Feedback augments team members' opportunities to discuss their performance and to learn about how their teammates perform their job. In the present study, team members participated in weekly meetings where team members received performance feedback on the previous week's performance and discussed how to reduce errors further in the coming week.

PERFORMANCE FEEDBACK

Performance feedback has been used as a behavioral intervention strategy for many years (Alvero, Bucklin, & Austin, 2001; Daniels, 1994; Prue & Fairbank, 1981; Rummler & Brache, 1995; Sulzer-Azaroff & Mayer, 1991). Daniels (1994) defines performance feedback as transmitted information about past performance that gives the performer (or team) the opportunity to alter their future behavior. Balcazar, Hopkins, and Suarez (1985) conducted a review of 11 years (1974–1984) of performance feedback literature followed by an updated review by Alvero, Bucklin, and Austin (2001) in the years following (1985–1998). Both reviews indicated that the addition of rewards and goal-setting interventions to performance feedback helps to make intervention effects more reliable. Alvero et al. (2001) further revealed that more consistent effects were found when feedback was delivered at the group level as opposed to the individual level.

Another consideration is the schedule with which performance feedback is delivered to participants. Performance feedback schedules have been delivered in various intervals, including but not limited to immediate, daily, and weekly delivery. The review of Balcazar et al. (1985) revealed that daily feedback was used in 54% of the performance feedback applications, and that daily and weekly performance feedback produced the most consistent effects at 42% and 41%, respectively. Alvero et al.'s (2001) subsequent review found that the most frequently used performance feedback intervention schedule, representing 39% of the examined performance feedback interventions, was weekly performance feedback. The most consistent effects were both monthly performance feedback and a combined application of daily and weekly performance feedback.

Despite the lapse in time between the event and the performance feedback delivery, weekly feedback can also be an effective feedback schedule. A study by Laitinen and Ruohomaki (1996) targeted teams of construction workers at two construction sites and their safety behaviors. With the implementation of the weekly public feedback, the aggregate safety index rose substantially. Additionally, several of the most critical safety subindexes (those including protection from falling, machine safety, scaffoldings, and personal protection devices) saw increases to nearly 100%.

Daily performance feedback allows performers to gain knowledge of their task performance levels on a much more frequent basis than does weekly feedback. Pampino, MacDonald, Mullin, and Wilder (2003) examined the differences between daily and weekly performance feedback in a retail setting. When combined with an intervention package consisting of task clarification, goal setting, and access to reinforcement, weekly performance feedback increased the percentage of completed targeted secondary duties from 59% during baseline to 75% at the first setting and from 18% during baseline to 66% at the second setting. When the same intervention package was applied with daily feedback, the percentage of targeted secondary duties completed jumped from 75% to 91% at the first setting and from 66% to 86% at the second setting. These results suggest that daily feedback was more effective than weekly feedback in increasing the daily percentage of completed secondary tasks.

It has been suggested that performance feedback may be most effective when that information is delivered proximal to the performance (Ludwig & Goomas, 2007). Immediate feedback provides participants information about their performance directly after engaging in the target activity and may alter how an individual performs the work following the feedback. Data presented in immediate feedback is typically not aggregated across time to include many behaviors or work tasks. Instead, it targets the specific behaviors exhibited during the completion of the task rather than the aggregate of the entire day's process or work tasks. Finally, immediate feedback allows performers to correct any performance errors while the outcome is still under their control. In a series of studies (Berger & Ludwig, 2007; Goomas & Ludwig, 2007; Ludwig & Goomas, 2007), human performance technology was implemented at product distribution warehouses to provide employees with immediate feedback at the time they engaged in the targeted behaviors. The immediate feedback provided through these different technologies was associated with substantial increases in both productivity and quality. However, evidence from Goomas and Ludwig (in press) suggests that performance feedback can be aggregated beyond the work-unit level (i.e., at the point of the behavior) to an intermediate task-outcome level (i.e., at the conclusion of many behaviors of a work task) without decreasing the effectiveness of the intervention. Additionally, immediate feedback was found to aid the accuracy of error detection more than delayed feedback when participants were able to self-pace their activities (Mason & Redmon, 1992).

Immediate performance feedback is not only effective, it is also popular among performers. Reid and Parsons (1996) found that when participants were asked to indicate their preference for receiving immediate or delayed feedback or no preference for type of feedback, 13 (of 16) participants indicated they would prefer to receive immediate feedback, no participants indicated a preference for delayed feedback, and 3 participants indicated that they had no preference. The same study revealed that when exposed to both immediate and delayed feedback, 100% of those who indicated a preference for feedback preferred the immediate over the delayed feedback.

The purpose of this study is to reduce the number of errors committed by warehouse employees using a combined intervention of team training and feedback systems. In the present study, a combination of immediate, daily, and weekly performance feedback was used to reduce product errors in a furniture distribution company. Immediate performance feedback provided employee teams information on how many pieces per delivery site were error-free. Daily performance feedback constituted the presentation of the previous day’s average of products that were delivered without error. The previous week’s average was also displayed to serve as a basis of comparison. Finally, weekly performance feedback summed all the error-free products that originated from the team in the previous week. Additionally, data were collected on the source of any errors and this information was reported directly to the team so that discussions could be held regarding how to reduce the prevalence of these errors in the coming weeks.

The combination of immediate, daily, and weekly performance feedback was chosen to provide team members, who had previously been unaware of their performance levels, an insight into their performance as well as to facilitate communication among the team members.

Daily performance feedback allowed all of the immediate feedback data to be aggregated into a daily outcome measure. This aggregated outcome measure could then be compared to similar outcome data among other teams across the organization. In the present study, the daily aggregated outcome measure was “Percent of Clean Stops” and this outcome was used to compare teams across the warehouse to determine which team had the best clean stop to total stop percentage. The daily feedback also served as a benchmark for the individual teams, as team members could compare the team’s overall performance to the previous performance on a daily basis. Weekly feedback served a similar purpose as daily feedback in that it also served as an outcome measure. However, in this case, the weekly feedback provided the task team with regular opportunities to review, discuss, and make improvements to the work process based on the error incident information they had accumulated throughout the week. With the weekly feedback outcome measure, teams also compared their performance across several days and began to see any obvious trends, such as the tendency to commit a certain type of error with a specific brand or model of furniture. The combination of immediate, daily, and weekly feedback allowed team members to have both micro- and macro-level perspectives of their performance. It was expected that the transition to cross-trained teams, as well as the addition of the feedback package, would lead to a systematic reduction in errors across all three truck teams.

METHOD

Participants

The current study was conducted at a retail furniture distributor located in the southeastern United States. The company filled orders of high-end furniture for customers from across the country. When furniture pieces were purchased by the customer at a retail outlet, the company ordered the pieces from vendors; the pieces were then shipped to the 256,000-square-foot company warehouse. At the warehouse, unloaders emptied the arriving tractor trailers of merchandise and inspected the pieces for missing items and damage. Pieces of the order were stored within the warehouse until the complete order, usually consisting of numerous furniture pieces, was acquired and readied for final delivery. When the final piece(s) of the order arrived, the furniture was located and pulled from the warehouse storage racks, grouped by delivery, and brought to the Deluxing Bay (D-bay). The furniture was then unboxed, assembled, inspected, and repaired before it was moved to the Staging Bay (S-bay) and wrapped for delivery to the customer location. (See Figure 1 for a warehouse map.)

Participants in this study were employees working in the D-bay and S-bay and included Assemblers, Inspectors, Deluxers, and Loaders. These employees worked together to move items from the D-bay onto the truck and to the customer. Assemblers began the process by removing shipping materials and by completing any necessary assembly of the product. Then the inspectors scrutinized each piece in order to identify product defects and/or damages.

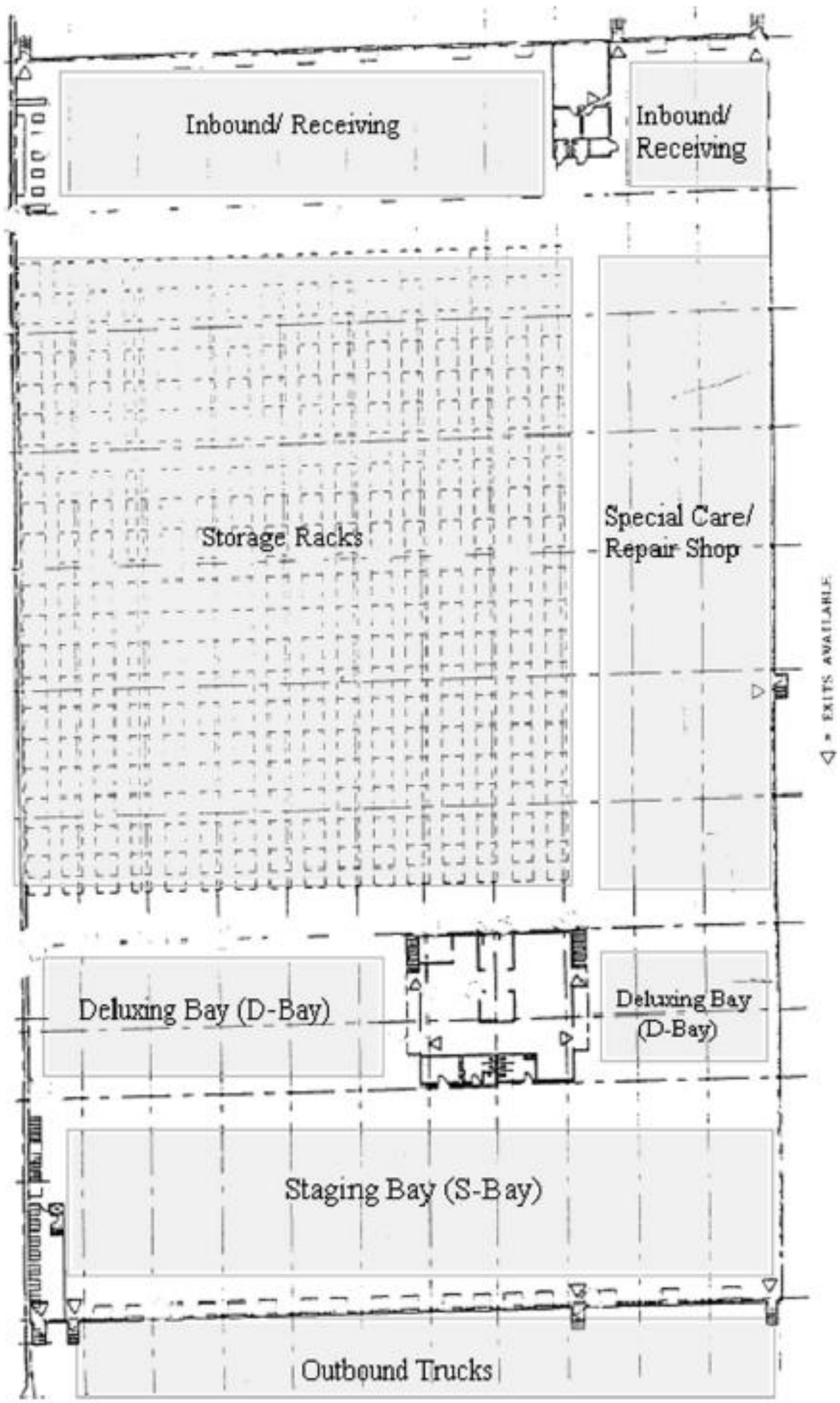

FIGURE 1 Warehouse map.

When a problem was identified, the inspector tagged the problem with a 1 centimeter-wide length of orange tape. Deluxers then repaired the imperfection marked by the tape. After all errors had been identified and repaired, pieces were wrapped and loaded onto the delivery trucks.

Each member of the process depended on the other members to perform their jobs satisfactorily. If one member of the process failed to perform the job adequately, the team could send out a piece with a quality defect, thus failing in the warehouse's ultimate goal of 100% clean pieces (i.e., delivered pieces of furniture without defect).

Each piece of furniture was assigned a unique Unit Control File (UCF) number. This UCF number appeared on the order sheets and on all documentation pertaining to the furniture piece. Each piece was tagged with this number upon its arrival at the warehouse at inbound and stayed attached to the item for the life of the piece. Like a person's Social Security number, this number held the history and specific information regarding a piece of furniture. Each UCF could be linked back to the individual employees who handled it in the warehouse. Therefore, individual employees (and the processes they missed) could be identified for their role in sending a flawed piece to the customer.

ASSEMBLERS

After an order was pulled from the storage racks and placed in the D-bay, assemblers removed the item's shipping packaging, matched the UCF number stickers to the piece, verified that the piece pulled from the storage racks was actually the piece that needed to be delivered, and assembled the item. Assemblers used tools to open boxes and remove the furniture without cutting or otherwise damaging the piece. After the piece was out of the box, assemblers ensured that the piece was indeed the correct piece that the customer had ordered. Next they completed any assembly required. Assembly for all items was completed in the warehouse prior to delivery to ensure that all necessary parts and pieces were accounted for before the items left for delivery to the customer. Items such as bed frames were assembled within the warehouse, but later disassembled after they had passed all inspections, in order to allow them to fit onto the delivery trucks.

INSPECTORS

Upon assembly of the product, an inspector examined the furniture and other materials for defects and wear. Obvious errors included broken chair legs, deep surface scratches, ripped upholstery, etc. Less obvious errors included inconsistencies in surface finishes, dimples in wood, mismatched wood grains, elevated nail heads, imperfect seams on upholstery, etc. Upon discovery of these imperfections, inspectors marked each damage occurrence on the piece itself with a length of 1 centimeter-wide orange tape. The orange tape signaled to the deluxers the areas that were to be repaired before the piece could be delivered to the customer.

DELUXERS

Deluxers repaired and refinished any damaged or worn pieces that took less than 15 minutes to complete. Common repairs performed by deluxers were filling in scratches in product surfaces, rematching the color of finishes, and applying final layers of product sealant. They identified areas to repair by finding the pieces of orange tape the inspectors placed on the pieces. After repair, the piece was reinspected by the inspector and, if not in need of additional deluxing, moved from the D-bay to the S-bay to be wrapped and loaded onto the truck for delivery to the customer.

REPAIR TECHNICIANS

For more substantial or time-consuming repairs, the item was removed from the D-bay and taken to the repair technicians in the Repair Shop or Special Care area. Examples of such repairs include reattaching and finishing broken chair or table legs, reupholstering fabric pieces, and filling in deep gouges in the pieces. After the item was repaired, the inspector again examined the piece in the repair bay, and if it was satisfactorily repaired, the item was returned to the S-bay.

LOADERS

After all necessary repairs or touchups were made to the products, delivery items were moved from the D-bay to the S-bay. Here, items were grouped by delivery stop and staged for loading in the truck. Deliveries were staged such that the last delivery of the route was placed at the front end of the staging area so that it could be loaded first into the delivery truck. In the S-bay, loaders ensured this proper sequencing and grouped all pieces of a customer’s delivery together to reduce confusion and time spent finding items to complete the order at the delivery site.

Loaders also blanket-wrapped each item that was put on the truck. This wrapping helped to protect the furniture from transit damage. After each piece was wrapped, loaders placed furniture on the truck, ensuring that the pieces were properly secured within the truck by restraining belts and platforms.

DRIVERS

A driver delivery team took the completed delivery orders to customers. The transit deliverers were responsible for driving trucks, unloading, and setting up furniture orders in customer homes and businesses. Transit deliverers traveled in teams consisting of a lead driver and a codriver per delivery truck.

CUSTOMER SERVICE REPRESENTATIVE

If any problems arose with the order process or delivery, a customer service representative (CSR) interacted with both the delivery team and the customer to handle and resolve complaints. CSRs contacted each customer to confirm the delivery and the pieces that were ordered and expected by the customer. Upon confirming the order, the CSR would verify with the floor-level workers that the correct pieces had been pulled and prepped for delivery. If necessary, the CSR would share the customer's apprehensions regarding the delivery with the floor-level employees (especially if the piece had already been part of an attempted delivery and was being prepped for a second or third delivery attempt). This helped to open the communication lines and allowed the warehouse employees to be aware of specific customer concerns.

CSRs could receive delivery success and problem information from both the drivers and the customers. They interpreted this information and, if necessary, assigned the most salient error code. Three processes were in place to ensure that all errors were accounted for. The first involved the delivery drivers calling the CSRs after each delivery. During this call, the driver would relay the number of pieces that were delivered successfully (undamaged) and the number of pieces that were damaged. If a piece was damaged, the drivers would log the piece's UCF number so that it could be identified in the future. Second, errors could be recorded if an unsatisfied customer called the customer service department complaining of a defect after the driver had already left the delivery site. Finally, errors could be recorded when the inbound check-in worker inspected furniture returned to the warehouse. Each of these three systems worked in concert to catch and record the defective and damaged products.

After receiving a problem notification, the CSRs then entered the assigned error codes, as well as all relevant information regarding the piece and the customer into the computer, where the data was aggregated into databases. Data regarding the error codes was transferred from the company to the research team via email. The databases used in this study contained weekly and daily records of error code frequencies, specific descriptions of the individual error(s), clean piece and clean stop ratios, trucks responsible for each delivery, driver names, and product UCF numbers.

PARTICIPANTS

The participants at the experimental site were teams (n = 3) of warehouse workers. Three teams were chosen to participate in this study because they provided a representative sample of the work processes that occurred within the warehouse. Examination of the three teams allowed the researchers to understand how team members typically interacted during task completion. The three teams included in this study were chosen from a list of the shortdistance load trucks within the warehouse.

Each team was comprised 5 workers: 1 assembler, 1 inspector, 1 deluxer/ repair technician, 1 loader, and 1 CSR. The average age of the assemblers was 31 (range = 18 to 55) while average tenure with the company was 1 year (range = 1 month to 7 years). All 3 of the assemblers were male. The average age of the inspectors was 42 (range = 31 to 51) while average tenure with the company was 3 years (range = 2 months to 12 years). Of the three inspectors, 2 were male and 1 was female. The average age of the repair technicians was 46 (range = 22 to 63) while average tenure with the company was 5 years (range = 2 months to 18 years). Of the three repair technicians, 1 was male and 2 were female. The average age of the loaders/unloaders was 31 (range = 18 to 53) while average tenure with the company was 3 years (range = 2 months to 12 years). All three of the loaders/unloaders were male. The average age of the CSRs was 40 (range = 27 to 60) while average tenure with the company was 5 years (range = 1 month to 25 years). Of the 3 CSRs, 1 was male and 2 were female.

DEPENDENT VARIABLES

The dependent variables in this study were reported defects in the furniture pieces that were delivered to customers. These defects were identified at the customer's delivery site or reported within 48 hours of the time the delivery truck checked back in at the warehouse. These defects were recorded as a series of error codes that were tracked by the company. Ultimately, error codes could be tracked to the quality of work performed by each individual in the process.

The organization maintained an extensive list of error codes allowing them to determine what went wrong with an item and who was accountable for the error. Of the 145 possible error codes, 12 were identified as directly attributable to the warehouse workers targeted in this study. Several of these 12 error codes had similar themes, and, for the purposes of this study, were aggregated into seven categories: poor inspection, poor repair, wrong item, load damage, warehouse damage, missing parts or pieces, and soiled upholstery (see Table 1 for a description of the error codes used in this study).

The assignment of the appropriate error codes was determined in three ways: (a) a CSR assigned the error codes as phone calls were received from the customers complaining about a delivered piece of furniture; (b) a CSR assigned the error codes as phone calls were received from drivers delivering the furniture and reporting a defect; or (c) the inbound check-in worker

TABLE 1 Description of the Error Codes Identified as Under the Warehouse Team's Control

Poor inspection		
511	Poor inspection	On the "regular" (first-time touch) lines; not the special care lines
525	Inspection, poor, 35	All at least second-time deliveries (as many as a fourth or fifth attempt)
539	Factory defect/inspection	Factory defect with product found within 30 days
Poor repair		
521	Repair, poor, DR01	Unsatisfactory repair by the repair shop
524	Repair, poor, 54	1. Item went to the repair shop, was delivered, and came back because the customer was unhappy. 2. Switch items between customers and retouch as needed
528	Repair, poor, 58	Special-care line works on the item.
Wrong item		
601	Wrong item- warehouse	Item was improperly tagged in the warehouse (receiving department) upon receipt from factory.
Load damage		
403	Load damage/error first	Loader damage; first shift only.
408	Load damage/error second	Loader damage; second shift only.
Warehouse damage		
510	Warehouse damage	Anything that occurs in the warehouse and results in damaged merchandise.
Missing parts or pieces		
520	Missing parts or pieces	Missing items (e.g., bolt, shelf, key, glass pane) that should have been included in the delivery but was missing.
Soiled upholstery		
581	Soiled upholstery	Any residue or filth on fabric items.

assigned the error codes upon inspecting furniture returned to the warehouse. Upon receiving a call from drivers, the CSR decided whether the piece should be left with the customer for an in-house repair or brought back to the warehouse for repair. The inbound check-in worker served as a checks-and-balances system for the first two error-reporting methods, as customers may have incorrectly identified the source of the defect and drivers may have misattributed or intentionally underreported errors to make themselves look better.

The host company labeled a delivery of a furniture piece without any product defects as a "clean piece" and full orders without defects as "clean stops." Clean piece percentages were calculated by the CSRs as the number of undamaged pieces delivered successfully to customers divided by the total number of pieces that went out on a truck for delivery in a given day. The clean stop percentage was defined as the number of clean stops divided by the day's total number of attempted deliveries. If all but one of the pieces was delivered successfully, the stop was considered unclean.

RESEARCH DESIGN

The research design was an AB multiple baseline across groups. Three teams participated in the study. After a baseline period, implementation of the intervention was staggered across three groups in 4-week increments. Baseline for the Truck Team A was collected for 19 weeks. The process change and feedback system intervention was implemented with Truck Team A at the onset of the 20th week of the study. Truck Team B began the intervention after 23 weeks of baseline data (4 weeks after Truck Team A). Finally, Truck Team C began the intervention at the onset of the 28th week, allowing for 27 weeks of baseline data and 7 weeks of intervention data. The intervention stayed in place for each team through the end of the study.

The baseline phase consisted of employees (assemblers, inspectors, deluxers, loaders, and CSRs) working independently from their coworkers to finish their respective jobs as described above. Individuals performed only their duties as defined in their job descriptions and would wait for individuals whose job preceded them in the process to finish their task. At this point, employees would then perform their task on a given piece and, upon completion, pass the piece along to the job function that followed (see Figure 2 for a baseline process map).

Intervention: Cross-Trained Teams and Team Feedback

CROSS-TRAINED TEAMS

After the baseline period, the first team (Truck Team A) changed their product preparation process to one in which each team member was trained and able to perform another employee's function within the team (cross-trained team). Each team member was able to assist with another team member's job duties and responsibilities. The team members initially performed their own jobs, as they did under the previous system. However, as they finished their individual tasks, the team members were able to begin to assist other team members who were finishing their tasks. For example, when the repair team member was finished repairing any items needing repair, he/she would assist the loader with wrapping the pieces.

The CSR also came down to the floor during the product preparation process to inform team members of customer and piece history. For example, the CSR would inform the team if a customer was particularly picky or the piece had already been through a number of unsuccessful delivery attempts. This allowed special attention to be placed on the pieces that were determined to be possible problem pieces. The focus on communicating salient information allowed the pertinent information to be passed along to the team and the drivers and helped to reduce errors by focusing employee attention on previous and potential problems.

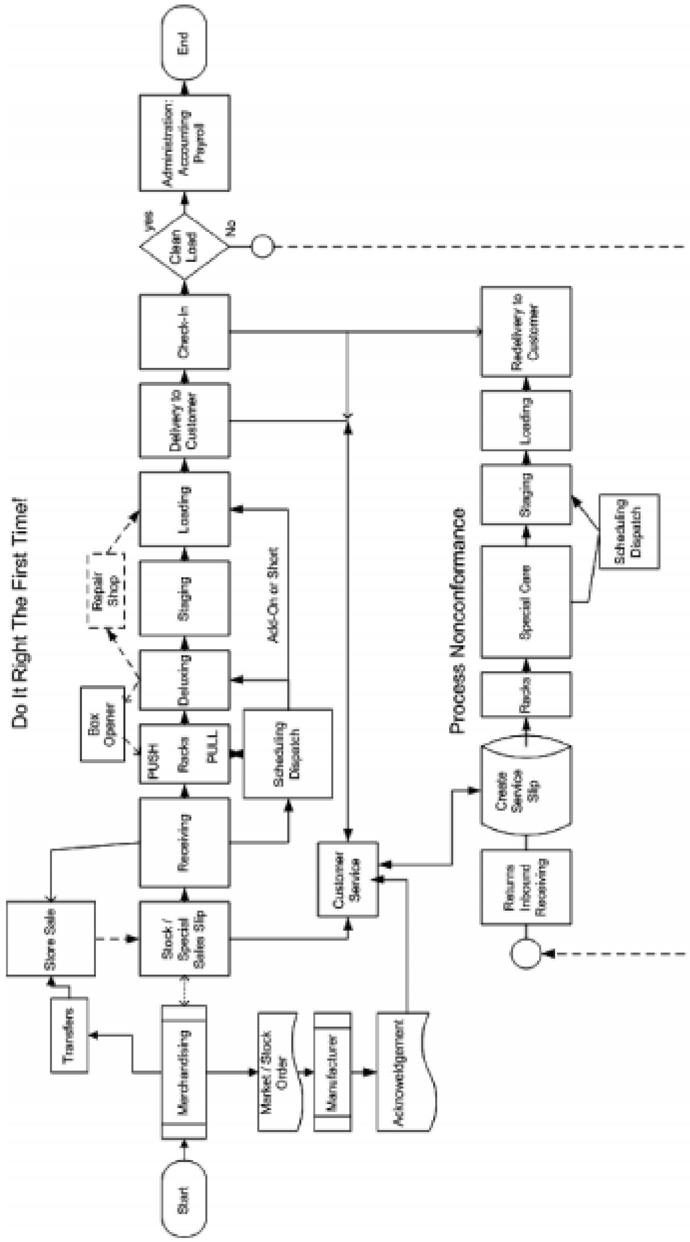

FIGURE 2 Baseline process map.

Customer Order Feedback

IMMEDIATE FEEDBACK

After the driver called in to report the results of the delivery stop and the CSR informed the team leader of the clean stop percentages, the team leader would display this information on the whiteboard. This allowed the team to know their clean stop percentage with each customer delivery. This whiteboard displayed a list of the current day's individual stops (by customer name) and a “Clean Customer” column. The sections of the board were taped off so that only the date and the numbers had to be changed every day. An example of the structure and data presented on this board is presented in Figure 3. The “Clean Customer” column was marked with a “100%” if the stop had no errors and the customer was satisfied. An air horn was sounded that was audible across the entire warehouse, including in the corporate offices. Each team had a different sounding air horn signal. If there was an error, the clean piece percentage was calculated and displayed.

DAILY FEEDBACK

Daily feedback was presented to the team via whiteboards that were placed next to the customer order feedback. Daily feedback consisted of clean stop and clean piece percentages for the previous day as well as the previous week’s clean stop and clean piece percentages. An example of the structure and data presented on this board is presented in Figure 4.

WEEKLY FEEDBACK

Weekly meeting feedback paper forms (see Figure 5) provided teams with information regarding their weekly performance from the previous week,

Date:___________________________

CUSTOMER	CLEAN CUSTOMER %
Jones	100%
Brown	94.4%
Smith	97.8%
Rogers	100%
White	100%
Cooper	100%
Dawson	92.1%
Henderson	100%
Gerber	93.7%
Anderson	98.3%
Edwards	100%
Langston	96.6%
Jennings	100%

FIGURE 3 Example of an immediate feedback whiteboard.

Date: _______________

	% CLEAN STOPS	% CLEAN PIECES
YESTERDAY		
LAST WEEK		

FIGURE 4 Example of a daily feedback whiteboard.

how that performance related to the team's performance data from 2 weeks prior, and the error codes that were most prevalent during the prior week. Team leaders received performance data from the Quality Manager and were trained regarding how to accurately read the database printouts in order to fill out the weekly meeting feedback form. Weekly feedback was presented during a team meeting attended by all team members at the beginning of the work week to review the previous week's feedback. During this meeting, the team leader reviewed the weekly meeting feedback form covering the current and previous weeks' clean stop and clean piece percentages.

Additionally, a frequency count of specific error codes was reported to the team. This allowed the team to understand exactly where in their process any errors had been made. The causes of any errors were discussed and ideas were generated by the team regarding how to reduce unclean stops for future deliveries. Finally, the team members initialed the bottom of the feedback sheet, indicating that they were present and participated in the weekly feedback meeting. These signed feedback sheets were kept in a work drawer in the team's area and copies of the forms were made for the researcher's records.

RESULTS

Error Rate

Three teams of employees participated in the 34-week project. These three teams were responsible for assembling, inspecting, repairing, and loading over 21,743 pieces of furniture for 6,902 different delivery stops throughout the duration of this study. Truck Team A made an average of 67.91 stops per week, accounting for an average of 3.31 delivered pieces per stop. Similarly, Truck Team B made an average of 70.03 stops per week, with an average of 2.97 pieces of furniture delivered per stop. Finally, Truck Team C made an average of 65.06 stops per week, and delivered an average of 3.18 pieces per stop.

Date:______________________________ Meeting Leader:___________________________________

Weekly Performance

This Week		Last Week	
% Clean Stops		% Clean Stops	
% Clean Pieces		% Clean Pieces	

Total Number of Clean Stops: ____________________

Total Number of Stops: ____________________

Total Number of Clean Pieces (across all deliveries): ____________________

Total Number of Pieces Scheduled to be Delivered: ____________________

Weekly Count of Error Codes:

_____ 403 (Load Damage/Error 1st)
_____ 408 (Load Damage/Error 2nd)
_____ 510 (Warehouse Damage)
_____ 511 (Poor Inspection)
_____ 520 (Missing Parts/Pieces)
_____ 521 (Repair, Poor, DR 01)
_____ 524 (Repair, Poor, 54)
_____ 525 (Inspection, Poor, 35)
_____ 528 (Repair, Poor, 58)
_____ 530 (Wrong Item)
_____ 539 (Factory Defect/Inspection)
_____ 581 (Soiled Upholstery)
_____ 601 (Wrong Item- Warehouse)
_____ Other (Please Specify): _________________

Things we'll do differently next week to reduce errors:

Team Member Initials:

FIGURE 5 Example of a weekly feedback meeting form.

In addition to mean calculations, effect size (Cohen's *d*) statistics of the data were calculated. This produced a measure of the standardized difference between the two given means (Cohen, 1988; Howell, 2002). In his discussion of effect sizes and the magnitudes that must be achieved to attain relevance, Cohen (1988) proposed a rule of thumb for three levels of significance: small effect size = 0.2, medium effect size = 0.5, large effect size = 0.8.

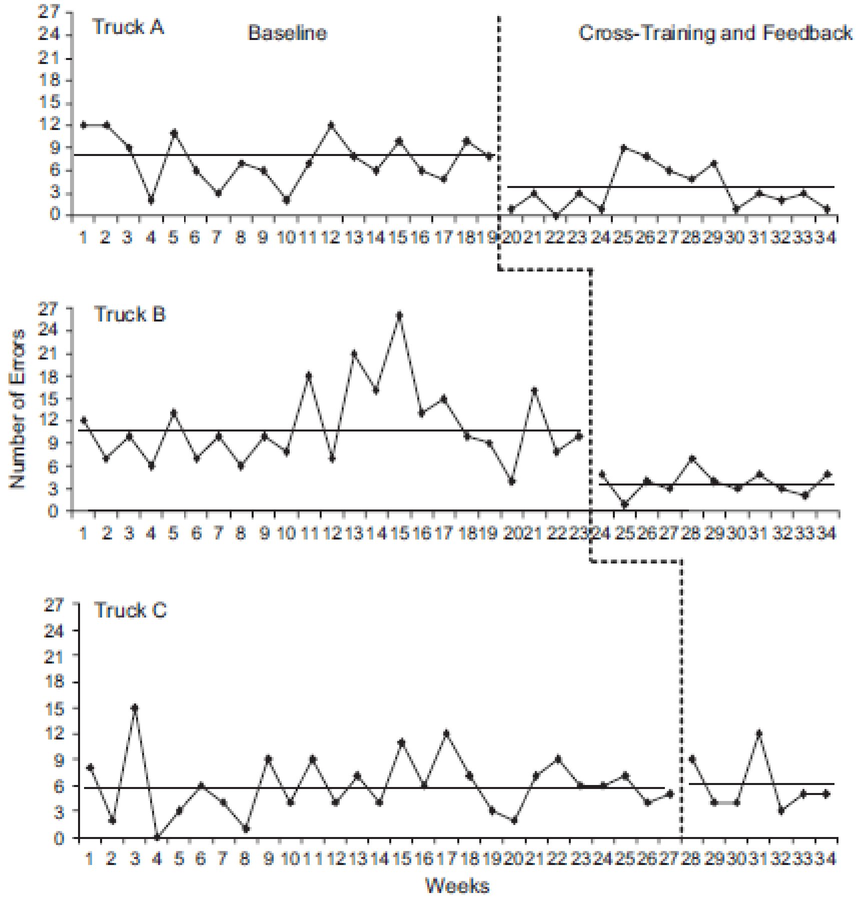

FIGURE 6 Graph of aggregate error code frequency by truck.

Please see Figure 6 for the aggregate error code frequency by truck. Results of error codes (n = 12) aggregated indicated a baseline mean for Truck Team A of 7.47 (SD = 3.2; range = 2 to 12) errors per week. During the intervention phase, the Truck Team A aggregate mean error rate decreased to 3.53 (SD = 2.83; range = 0 to 9) errors per week. Effect size calculations revealed an effect size of d = 1.30 for Truck Team A. Baseline data for Truck Team A were characterized by high levels of variability from week to week. Intervention data appeared to be characterized by less variability, with low error rates immediately following implementation of the intervention, followed by slightly raised error rates for a period of 5 weeks during the middle of this phase, and finally stabilizing and reducing of error rates for the last 5 weeks of data collection.

Truck Team B entered the intervention phase 4 weeks after Truck Team A. Truck Team B's aggregate mean baseline error rate was 11.39 (SD = 5.31; range = 4 to 26) errors per week. During the intervention phase, the aggregate mean error rate decreased to 3.82 (SD = 1.66; range = 1 to 7) errors per week. Truck Team B's results were characterized by an effect size of d = 1.92. Truck Team B's aggregate mean baseline error rate, similar to Truck Team A during the same phase, was highly variable with dramatic peaks in the error rates. Upon implementation of the intervention phase, the aggregate mean rate of errors per week immediately decreased and stabilized among Truck Team B. Truck Team B experienced a dramatic reduction in variance when the intervention was implemented.

Truck Team C entered the intervention phase 4 weeks after Truck Team B. During baseline, the aggregate mean rate of errors in Truck Team C was 5.96 (*SD* = 3.45; range = 0 to 16) errors per week. During the intervention phase, the aggregate mean rate of errors was 6.00 (*SD* = 3.27; range = 4 to 12) errors per week. Effect size calculations revealed an effect size of *d* = -0.01 for Truck Team C.

Cost Benefit Analysis

A cost benefit analysis was performed to determine the value of the intervention program to the company. The only costs involved with implementing this system were the cost of the time to cross-train the team members, the lost work time for the weekly feedback meetings, and the cost of the dry-erase feedback boards. The new teams were cross-trained during regular shift hours. Because it was a linear process during baseline, the team members did not lose much production time during cross-training. An individual team member performed the work while the others observed. When one task was complete, the next team member in the process would demonstrate how to perform the specific job. The Warehouse Manager supervised this training.

The weekly feedback meetings were also held during regular shift hours and took only 5 to 10 minutes, so the interference with productivity was negligible. With team members making an average of $13.90 an hour, 5 team members taking about 10 minutes of their time to participate in the weekly feedback meeting, the estimated cost to the company was $11.58 per 10-minute meeting. Each week, the weekly feedback meetings for Truck Teams A, B, and C cost an average total of $34.74. If the process change and feedback intervention was implemented across all 49 truck teams, the 10-minute weekly feedback meetings would cost the company $29,514.33 annually.

Finally, the six dry erase boards used in this study cost approximately $20 each for a total cost of $120. If applied to the entire organization, the 49 teams would each require two whiteboards, resulting in a one-time cost of $1,960 to purchase the feedback whiteboards.

Benefit analyses were conducted individually for each truck, and again at an aggregate level across all three truck teams. Truck Team A experienced 142 errors during its 19-week baseline. If this baseline rate of errors had continued during the 15-week intervention period, the total cumulative number of errors for Truck Team A would have been 254 errors over a 34-week period. With the intervention in place, the actual total cumulative number of errors was 195, resulting in a difference of 59 errors from the estimated number of errors. Analyses of financial information done by the Operations Manager of the host organization indicated that the estimated cost of an error was $4.87. The average savings experienced per week due to the errors caught and corrected by Truck Team A was $19.16. On a yearly basis, this truck alone would save the company $996.08 with the use of the intervention system.

Truck Team B experienced even more substantial savings than Truck Team A. Truck Team B experienced 262 errors during their 23-week baseline. As part of the multiple baseline design, Truck Team B had a longer baseline period than Truck Team A. Due to this multiple baseline design, the raw count of baseline errors was greater for Truck Team B. However, Truck Team B also had a higher rate of baseline errors. If this baseline rate of errors had continued during the intervention period, the total cumulative number of errors for Truck Team B would have been 387. In reality, only 297 cumulative errors occurred in Truck Team B by the end of the intervention, resulting in a difference of 90 errors from the projected cumulative number of errors to the actual cumulative number of errors. Again, with each error estimated to cost $4.87, the average savings experienced per week due to the errors caught and corrected by Truck Team B was $39.85. On a yearly basis, using the intervention system, Truck Team B would save the company $2,071.96.

Truck C experienced 161 total errors during its 27-week baseline period, the longest baseline period of the study. If the baseline error rates had been extended to the end of the 7-week intervention period, the predicted cumulative number of errors for Truck Team C would have been 203. Unlike Truck Teams A and B, Truck Team C did not experience the same intervention effects as the other two teams when the intervention was applied. Because of this, the baseline rate of errors continued during the intervention phase, resulting in an actual cumulative number of errors of 203 by the end of the intervention. There were no savings achieved by Truck Team C.

Combined, Truck Teams A, B, and C realized average weekly organizational savings of $59.00. By using the intervention system, Truck Teams A, B, and C would save the company $3,068.04 annually. If the intervention system was applied to the entire warehouse, across all 49 truck teams, with the assumption that the results would mimic those of this study with 2 of 3 teams having significant intervention effects, the company’s potential annual savings would reach $50,111.34. However, potential annual savings could be significantly higher, reaching $75,167.00 if the source preventing Truck Team C’s successful implementation of the intervention was identified and corrected, allowing Truck Team C to decrease errors at a rate similar to Truck Teams A and B.

Considering the costs, the total annual net gain experienced by the organization could be $18,637.00 if the intervention is assumed to be successful on only two of three teams, or $43,692.67 if adjustments were made that resulted in significant error reduction across all teams. Additionally, the reduction in errors indicates an increase in customer satisfaction, as each reduction in the rate of errors represents an increase in the total number of satisfied customers. With the intervention in place, 149 errors were detected prior to customer delivery for Truck Teams A and B relative to baseline levels. On a yearly basis, this figure would reach 629 avoided errors. Across all truck teams, 15,410 yearly errors would have been prevented by the implementation of this training and feedback intervention. The reduction in errors itself is significant, but when we are reminded that each reduction in the rate of errors represents a customer who has received high-end furniture without having to experience a defect, the intervention becomes even more salient.

DISCUSSION

The team-based cross-training and performance feedback intervention was effective in reducing the number of errors committed by the warehouse teams in 2 of the 3 teams examined in this study. After the intervention was implemented, the number of errors committed per week reduced dramatically in two Truck Teams, as the employees worked in cross-trained teams and received an abundance of performance feedback. This allowed Truck Teams A and B to reduce their already relatively low error rates toward their goal of near-perfect quality performance.

To better interpret the results, it is worth noting that the host organization hand-selected the team members of Truck Team A so they would serve as an example to the other teams of how a team should function and demonstrate the possible success of the intervention. Additionally, researchers were informed (after the fact) that for nearly the first month after implementation, Truck Team A's delivery load order had been manipulated to include easier pieces that were less likely to be associated with errors. This continued until Truck Team B entered the intervention phase in the 24th week. At this time, the number of errors committed by Truck Team A rose to baseline levels as more difficult pieces and deliveries were reintroduced to the team. Gradually, the team adjusted to this shift in demand and lowered and stabilized the number of weekly errors committed.

The aggregate error code frequency comprised seven individual error code categories, each representing a different type of error that could be made by teams in the warehouse process. Across all three Truck Teams, the Poor Inspection error code accounted for nearly three-quarters of the total number of errors committed. Thus, overall error frequency mimicked Poor Inspection error frequency.

Several explanations can be offered for the abundance of Poor Inspection error codes. The frequency of Poor Inspection errors may indicate that employees did not know how to properly perform the inspection tasks. The teamwork and feedback delivered in the intervention may have helped employees improve their inspection behaviors. If this were the case, more training may be necessary to ensure employees know how to inspect pieces for delivery properly. Secondly, the Poor Inspection error code category may have been used as a "catch-all" category for other problems. For example, if a customer suffering from buyer's remorse decided to reject a piece of furniture and ask for a refund or simply did not like the piece, they may have complained that some aspect of the furniture was unsatisfactory such as the finish or direction of the wood grain. In this case the problem was more of a customer preference issue than a Poor Inspection error. However, if such a complaint were made, it could often have been recorded as a Poor Inspection error that should have been corrected in the warehouse. Although the researchers were assured that such occurrences did happen, it is impossible to determine how many Poor Inspection errors were attributed to customer factors beyond the control of the truck teams.

In the weeks following the implementation of Truck Team B's intervention phase, the sudden spike in errors committed by Truck Team A was reflected in both the Poor Inspection and Aggregate error code graphs. A similar, but less dramatic, spike in errors was seen in Truck Team B during the 28th week when Truck Team C began its intervention phase. However, in each case, after a few weeks, error rates began to decline. This may be indicative of a learning curve, where team members familiarize themselves with the new process.

Because this intervention involved both cross-trained teams and the addition of layers of performance feedback, it is difficult to determine which technique was more responsible for the intervention effects. However, consistent with the studies of Volpe et al. (1996) and Cannon-Bowers et al. (1998), these teams may have benefited from enhanced task communication facilitated by the cross-trained team structure and weekly performance feedback meetings. Presumably, team members were able to examine the errors that had previously hurt quality and then communicate to fix the problems.

The performance feedback components of this study were based upon the notion that more frequent performance feedback results in better performance (Alvero et al., 2001; Balcazar et al., 1985). Employee teams were provided with information regarding their performance, compared to previous days' performance and current goals. When performance feedback was provided to the employees who had not previously received it, employees were more effective at their work tasks (see also Bailey & Thompson, 2000).

This study allowed employee teams to receive performance feedback that was proximal to the performance behaviors. The immediate feedback allowed employee teams to receive feedback on behaviors they performed most recently, rather than behaviors they had performed long ago, and allowed them to adjust behaviors as the tasks continued to be performed (see also, Berger & Ludwig, 2007; Codding et al., 2005; Goomas & Ludwig, 2007; Ludwig & Goomas, 2007). With the aid of this feedback, employee teams were better able to reduce the number of errors committed.

Daily performance feedback provided a summative report of the day's productivity and quality (Pampino et al., 2003). Additionally, the daily feedback allowed employee teams to compare their performance to the previous week's performance. Because employee teams involved in this study were shift workers, the daily summative feedback allowed the teams to have a total picture of the previous day's performance and a benchmark for the current day’s performance.

The weekly performance feedback provided yet another summative report, on a wider scale, and provided opportunities for enhanced communication among the team members (Alvero et al., 2001; Laitinen & Ruohomaki, 1996; Laitinen, Saari, & Kuusela, 1997). The weekly feedback provided employee teams an opportunity to review their previous week’s performance, identify trends, and overtly discuss ways to reduce the number of errors relative to the previous week.

All three of these performance feedback applications worked in concert to provide the teams with up-to-date information on their performance and to provide communication opportunities.

Limitations

There are several limitations that may require the findings of this study be viewed with caution. First, the membership of Truck Team A was selected by the organization’s management. In Truck Team B and C, team member assignment was random. Truck Team A was composed of the best individual workers within the organization and special care was taken to ensure the early success of Truck Team A. Such team manipulation may have skewed the error rates of Truck Team A lower than that of the average truck team.

Another limitation is the use of a bundled intervention. Because both the cross-trained team and performance feedback components of the intervention were implemented as a bundle, it is impossible to discern the extent to which each of the interventions contributed to the overall success of the study. If only one, rather than both in concert, of the interventions was the main driver behind the success of the intervention, it would be impossible to determine whether both were worthy of the effort and resources associated with implementation.

A third limitation was the relatively short length of the intervention phase for Truck Team C. This team’s intervention phase lasted only 7 weeks, as opposed to the 15- and 11-week intervention phases for Truck Teams A and B, respectively. This short intervention phase did not allow for a reliable analysis of the effects of the intervention on Truck Team C. A longer intervention phase would have allowed the researchers to examine any trends in the data such as the learning curve seen in the other truck teams. Truck Team C’s lack of immediate reduction in errors may have occurred because they did not have adequate time to experience the intervention before data collection ceased.

It should be noted that while researcher observation ceased after week 34 of the study, the intervention stayed in place for all truck teams. However, examination of the intervention effects could not continue after week 34 because the host organization suddenly and unexpectedly changed the measurement system that was used to capture the necessary data. Some individual error codes were carried through to the next system while others were altered or dropped completely from use. Because this new measurement system was not consistent with the old system, any comparisons between the two would be erroneous.

While the intervention in this study was successful in reducing error rates among the targeted truck teams, the successes experienced by these three teams may not generalize to the other truck teams working in the facility. The three teams examined in this study were all similar in size, volume, and trip delivery distance. The truck teams that participated in this study were associated with short-distance deliveries. Truck teams associated with different delivery variables, such as longer trip delivery distances, may not experience the same benefits as the trucks used in this study. If this were the case, analyses should be performed to determine what intervention would be successful in facilitating performance improvement under different scenarios.

Because this experiment took place in a functioning warehouse environment, it was impossible to completely prevent other teams from gaining knowledge of the intervention prior to receiving it. Diffusion of the intervention may have occurred between Team A and Teams B and C prior to the intended acquisition of the intervention by those teams. Because teams throughout the warehouse, including Teams B and C, were able to observe the formation and work process of the cross-trained team(s) working to reduce errors, and because the intervention resulted in reduced errors, other teams may have prematurely begun to model some of the behaviors of the teams already engaged in the intervention. This would have cast doubt upon the actual intervention start date for Teams B and C. If diffusion of the intervention had occurred, the actual start of the intervention for Teams B and C could have been earlier than the specified implementation date.

Finally, because the teams were already fairly successful at catching errors during the baseline phase, a floor effect may have limited the intervention impact. All the teams studied had relatively low numbers of errors relative to the total number of pieces handled per week. Thus, a further reduction in errors would have been more difficult to achieve than if the teams had all started with higher weekly error rates.

CONCLUSIONS

Future studies should consider extending the intervention duration to determine whether or not these effects could be sustained on a long-term basis. Furthermore, researchers should consider the addition of incentive systems for teams in this study. The bank of incentive system literature indicates that when incentive systems are incorporated, results can be even more dramatic (Bucklin & Dickinson, 2001; Bucklin, McGee, & Dickinson, 2003; Dickinson & Gillette, 1993; Matthews & Dickinson, 2000; Stoneman & Dickinson, 1989). Such applications could further reduce and eliminate errors across teams while contributing to employee buy-in to the system. Additionally, future research should include component analysis research on team process components of interventions.

The purpose of this study was to reduce the number of errors committed by teams of workers in a furniture distribution warehouse. During the initial planning phases of the study, the researchers noted that teams were all already fairly proficient at producing mostly error-free products. However, management wanted their customer service to approach perfection. Throughout the intervention phase, perfection was celebrated by both the teams and the executives. Teams were also constantly reminded by company managers of the company's goal of 100% quality. Additionally, teams were given air horns to sound upon the attainment of a clean stop, a stop with no errors. When an air horn was sounded, it was not uncommon to observe the Executive Vice President of Operations, whose second-floor windowed office was located in the middle of the warehouse floor, jumping up with excitement at the sound of the horn and pumping his fists in the air to salute the error-free delivery.

The intervention package of cross-trained teams and multiple forms of performance feedback produced a marked change in two of the truck teams. The intervention reduced the total number of errors committed and helped the organization come closer to attaining its goal of 100% quality. However, because the human element is involved, the question becomes not how to achieve perfection, but rather, can perfection in an environment controlled by human elements ever be fully attained and sustained.

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