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Research Results

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Behavior-Based Safety at Amtrak-Chicago Associated with Reduced Injuries and Costs

SUMMARY

The Federal Railroad Administration (FRA) Human Factors Research and Development (R&D) Program is sponsoring the Clear Signal for Action Program (CSA) to evaluate whether an approach that combines behavior-based safety (BBS) and continuous improvement (CI) techniques can improve safety in the railroad industry, as it has in other industries. The Station Services Department at Chicago's Amtrak terminal participated in a CSA demonstration project carried out by Behavioral Science Technology, Inc. (BST) in May 2001 through September 2002 (Phase 1) and October 2003 through March 2005 (Phase 2).

In analyses conducted at the John A. Volpe National Transportation Systems Center (Volpe Center), a statistically significant drop in injury rates occurred following employee training on CSA methods held in December 2004 (see Figure 2). Furthermore, the number of worker-hours between injuries tended to increase as the total number of observation-feedback sessions increased, and the greater the rate of observation-feedback sessions, the lower the injury rate tended to be. These data suggest that a full and consistent implementation of CSA at Station Services could save this department of 200 employees over $300,000 per year (Figure 1).

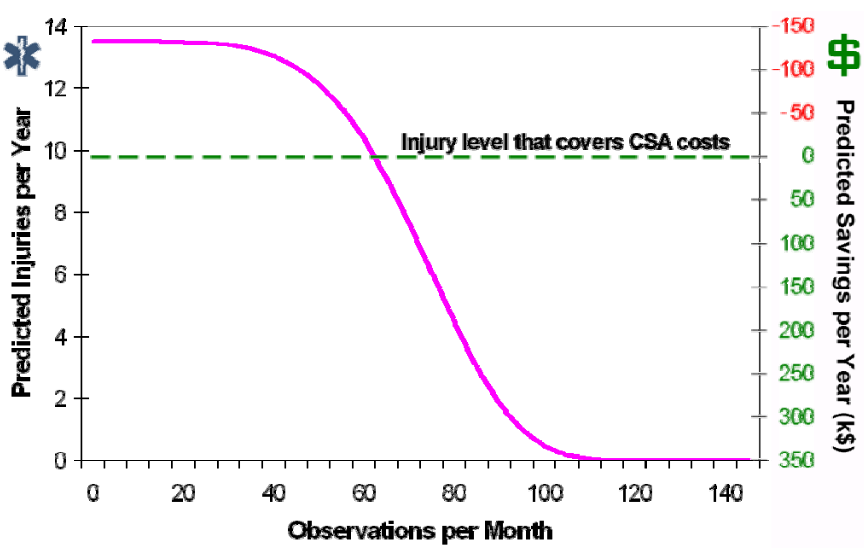

Figure 1. Feedback rates of over 60 per month predict dramatic improvement in injuries and cost savings.

BACKGROUND

The FRA is sponsoring this demonstration project to evaluate the effectiveness of CSA, a methodology that combines BBS and CI. This approach seeks to promote safe behavior and reduce injuries through observations, feedback, and CI. A steering committee including labor, management, and safety professionals oversees the CSA process in a particular location. They develop a site-specific checklist for observations and feedback by examining past injury reports to identify common behaviors and conditions contributing to injuries. After that, employees conduct anonymous, peer-to-peer observations and provide confidential, coaching feedback about at-risk behavior, encouraging communication about safety and enhancing personal awareness of safety. The steering committee uses trend analysis of the observation-feedback data to identify high-exposure situations that might be addressed through implementing corrective actions. These corrective actions are part of the CI process used to address systemic barriers to safety, such as those related to policies, procedures, and training. One goal of CSA is to provide union representatives and safety managers with information to identify and address hazards before they actually cause injuries.

The Station Services Department at Chicago's Amtrak terminal, which primarily services passengers boarding and disembarking trains at

Union Station, implemented the CSA method. A steering committee of employees implemented and coordinated the CSA process through two non-contiguous phases. Phase 1 includes all observation-feedback sessions and corrective actions completed from October 2001 through September 2002, at which point downsizing at the terminal disrupted the implementation, suspending the demonstration project. Phase 2 includes observation-feedback sessions and corrective actions completed from November 2003 through March 2005. Unlike Phase 1, Phase 2 included a full-time facilitator, all-employee training on safe/at-risk behaviors and conditions, along with a session with managers on their roles and responsibilities. The all-employee training, held in December 2004, involved 8-hour sessions in which employees were shown photographs of safe/at-risk behaviors and conditions on the CSA observation checklist and were encouraged to use the safe ones. During the management session on roles and responsibilities held in January 2005, managers worked together to develop a checklist of practices they needed to perform to support the CSA method.

OBJECTIVES

This paper presents part of the evaluation of the CSA demonstration project by analyzing the relationship between injuries and two components of the methodology: all-employee training and observation-feedback sessions. Two research questions are answered below:

- To what extent did the all-employee training reduce injuries?
- To what extent did the observation-feedback sessions reduce injuries and costs?

DATA ANALYSIS METHODS

Amtrak's Automated Safety Information System provided all the data used in this paper.

All-Employee Training and Injuries

A straightforward before-after analysis evaluated the extent to which the *all-employee training* is related to *injuries*. The overall injury rate for the 12 months prior to the employee training was compared to the injury rate for the 12 months after the training.

Feedback, Injuries, and Cost Reduction

To evaluate the extent to which the observation-feedback sessions reduced injuries, two analyses were performed. One examined the relationship between the *cumulative number of feedback sessions* with the *number of worker-hours between injuries*. The other examined the relationship between the *number of feedback sessions* per month with the monthly *injury rate*.

Cumulative Feedback Sessions

It is believed that feedback sessions have a *cumulative effect* on reducing injuries, where each session encourages a small change in an employee's behavior, which lasts a period of time. A time period of 13 months was selected, representing the gap between Phases 1 and 2; for statistical convenience it is assumed that feedback sessions that occur in Phase 1 do not impact injuries that occur in Phase 2. The cumulative potential of feedback is thus represented by the total number of feedback sessions completed within the 13 months before an injury occurs.

Because it is possible to determine the cumulative number of feedback sessions completed for the date and time of each injury, the relationship between cumulative feedback sessions and injury can be determined by calculating the correlation between cumulative feedback sessions and the number of worker-hours between injuries. Worker-hours between injuries can be thought of as the opposite of injury rate; that is, the more worker-hours that have elapsed between injuries, the less frequent the injuries per 200,000 worker-hours. The opportunity to use worker-hours between injuries in this case is advantageous because it preserves the detail in the data that is lost when it is aggregated with the monthly rate, since the time of each injury is recorded to the nearest quarter hour. For example, injuries average just over one per month in these data, resulting in only three likely values for a given month corresponding to zero, one, or two injuries. In contrast, worker-hours between injuries have thousands of likely values, thus allowing a greater level of confidence in the results.

Feedback Session Rates

In addition to the cumulative impact of feedback sessions, it is believed that there will be a *time lag* between when feedback sessions occur and when fewer injuries are observed. Assuming an instance of feedback encourages a behavior change in an employee, it may be weeks or even months before that employee is in a situation where the behavior change is likely to "save" him or her from an injury. Secondly, the informal influence an observed employee may have on co-workers to encourage them to conform to his/her new behavior may also be expected to have a delay. To account for a possible lag in evaluating the relationship between feedback and injuries, the correlation was calculated between feedback session rate with monthly injury rates. It was calculated for zero, one or two months later.

Cost Reduction

Knowing the costs of each injury and the annual cost of conducting a CSA process, it should be possible to predict the savings Station Services can anticipate by implementing CSA. If a significant correlation is found between feedback session rates and injuries, various mathematical formulas can be fit to the injury data and the best fitting can be used to predict the injury reduction, and therefore the savings, for any given rate of feedback sessions.

RESULTS

All-Employee Training and Injuries

For the 12 months prior to the all-employee training on the observation checklist, the injury rate per 200,000 worker-hours was 12.68 for all injuries (FRA reportable and not reportable) and 10.87 for FRA-reportable injuries. For the 12 months during and subsequent to the training, there were only three injuries, all FRA-reportable, for a rate of 2.59 (see Figure 2). This represents a significant 80 percent drop in injury rates for all injuries ($\chi^2(1) = 8.14$, $p = 0.0043$), and a significant 76 percent drop for FRA-reportable injuries ($\chi^2(1) = 6.26$, $p = 0.0123$).

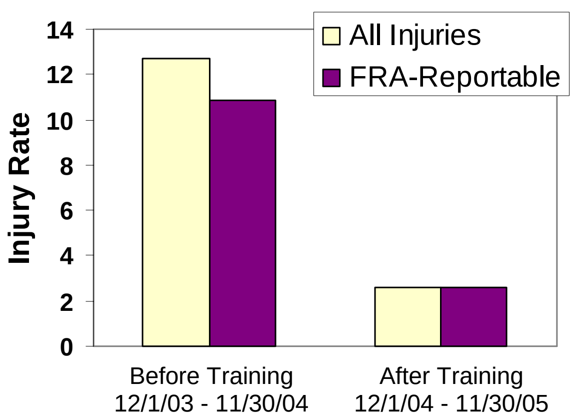

Figure 2. Injury rate per 200,000 worker-hours dropped following training on CSA checklist.

Feedback, Injuries, and Cost Reduction

Cumulative Feedback Sessions

For both phases combined, the cumulative number of feedback sessions over the previous 13 months and the worker-hours between injuries were positively and significantly correlated ($r = 0.46$, $p = .011$, $n = 30$), indicating that as more feedback sessions were conducted within a phase, the more work was performed without injuries. This correlation persisted at approximately the same magnitude when each phase was analyzed separately (Phase 1: $r = .39$, $p = .22$, $n = 12$; Phase 2: $r = .48$, $p = .043$, $n = 18$), although the relation was not significant for Phase 1, which had only 12 data points. The correlation also persisted significantly or nearly significantly for various transformations and adjustments to the data, including using the log transformation of worker-hours between injuries (reduces effects of outliers) ($r = .36$, $p = .052$), adjusting the cumulative feedback sessions by the worker-hours in each month ($r = .52$, $p = .0029$), and using monthly injury rate rather than worker-hours between injuries ($r = -.35$, $p = .060$, $n = 31$).

Feedback Session Rates

To determine the time lag between feedback session rates and the resulting effect on injury rates, the correlation was calculated between the monthly injury rate and the monthly number of feedback sessions, lagging injury rates from 0 to 3 months. This analysis was performed for Phase 1 and 2 combined. A maximum and significant correlation of –0.376 was obtained with two months of lag ($n = 33$, $p = 0.030$). The more feedback conducted in a month, the lower the injury rate two months later. This relationship was considered robust because it was also observed when the feedback sessions per month were normalized by the number of worker-hours in the month ($r = -0.382$, $n = 33$, $p = 0.028$) and when the natural logarithm of the injury rate was used ($r = -0.397$, $n = 33$, $p = 0.024$).

Cost Reduction

Estimates of the cost savings associated with the CSA methodology were calculated using the formula found to fit the data best ($r = -0.447$, $n = 33$, $p = 0.0084$). Given that the average cost of an injury in the Station Services Department is $35,000, and that the annual cost of the CSA program is $127,000,[1] this formula can be used to predict not only the number of injuries per year for a given feedback rate, but also the cost effectiveness of the program.

The formula is plotted in Figure 1. It is predicted that a feedback rate of less than 40 per month will result in minimal reduction in injuries, and less than 63 feedback sessions per month results in a net cost to the department. However, as the feedback rate increases, a dramatic reduction in injuries is

[1] The CSA process at this site is largely a fixed labor cost per year irrespective of the number of feedback sessions.

predicted, and savings become substantial. The observed benefit continues until around 100 feedback sessions per month, thereafter return are diminished. In the data, all months where the number of feedback sessions per month exceeded 100 are associated with zero injuries two months later. The model predicts that at 100 feedback sessions per month the frequency of injuries is less than one per year, a 97 percent reduction, saving the department of 200 employees over $300,000 per year. These predictions are based on the injury and feedback data in the study described here; performance in a future implementation may differ. However, this analysis does suggest that CSA may be a cost-effective method for reducing injuries.

DISCUSSION

These findings provide some evidence that the CSA demonstration project implemented at Amtrak reduced injury rates there. Specifically, both the all-employee training and observation-feedback sessions are associated with a reduction in injuries. It is difficult to assess the relative contribution of the training vs. the feedback sessions on safety given these components were complementary parts of the same methodology. The training provides employees with a graphic understanding of desired safe behavior, and the observation-feedback sessions encourage their application of it. It should also be pointed out that any implemented corrective actions based on analysis of the observation-feedback data may have contributed to the observed reduction in injuries.

CONCLUSIONS

CSA seeks to improve peer-to-peer interactions concerning safety, enhance cooperation between management and labor in addressing safety issues, prevent injuries, and increase personal awareness and injury rates. The findings above suggest that CSA might be a promising strategy for safety improvement.

FUTURE DIRECTION AND ACTIVITIES

Further analysis is underway to learn more about the effectiveness of the CSA demonstration project. For example, the evaluation team is analyzing interview and focus group data collected at Amtrak. Also, another FRA-sponsored CSA demonstration project is in progress in an operating department on a Class I railroad. It will provide additional insight about the potential for CSA to improve safety in the railroad industry.

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CONTACT

Michael Coplen
Human Factors Program Manager
Federal Railroad Administration
Office of Research and Development
1120 Vermont Avenue NW - Mail Stop 20
Washington, DC 20590
(202) 493-6346
Michael.Coplen@dot.gov

Joyce Ranney and Michael Zuschlag
Operator Performance and Safety Analysis Division
Research and Innovative Technology Administration
Volpe National Transportation Systems Center
55 Broadway, DTS-79
Cambridge, MA 02142
(617) 494-3250
Ranney@volpe.dot.gov, Zuschlag@volpe.dot.gov

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