

Performance Implications of Safety Training

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Abstract. Safety management practices aim to improve working conditions and safety performance. Safety training can positively affect employees' safety knowledge, safety motivation, safety compliance and safety participation, which are the main factors of safety performance. Several models for evaluating safety training effectiveness have been suggested. The aim of this paper is to study how employees' safety performance can improve after safety training intervention. The effects on safety performance were studied in two units of a case company based on a questionnaire and selected indicators. A descriptive analysis was performed with the data gathered. Based on the survey (n=45), some improvements in safety knowledge, attitudes, behavior and safety performance can be found. Indicator data also show a positive trend during the studied period. The amount of preventive actions has increased, and the number of injuries has decreased. This study contributes to the current knowledge on evaluating the performance implications of safety training.

Keywords: Occupational Safety and Health · Safety Training · Safety Performance · Performance Measurement

1 Introduction

Safety management practices aim to improve working conditions at the workplace and positively influence employees' attitudes and behaviors with regards to safety, thereby improving safety performance [1]. Safety performance is typically defined as actions and behaviors adopted to promote health and safety or to reduce safety events, such as accidents, at work [2-4]. Safety training interventions are one of the most important safety management practices. Safety training can positively affect employees' safety knowledge, safety motivation, safety compliance and safety participation, which are commonly considered the main factors of safety performance [1, 5-7]. Moreover, appropriate safety training may improve safety culture [8]. However, the training outcomes may be reduced over time [9]. Evaluation of safety training effectiveness is crucial to deliver continuous and adequate training to improve safety performance [9-11].

Safety performance is typically measured by both lagging and leading indicators, and their use should be balanced [4, 12-15]. Lagging indicators typically include the number or frequency of occupational fatalities, injuries and illnesses. Lagging indicators typically include the number of preventative measures carried out to improve safety, such as safety walks, discussions or audits and related corrective actions.

Several models for evaluating safety training effectiveness have been suggested [9-11, 16]. These models typically address safety knowledge, safety attitudes and beliefs, safety behavior and health. In our previous study [16], a model and related questionnaire was designed for this purpose. The model was evaluated and determined to be suitable for its purpose, as it is comprehensive and compiles the major objectives for effective safety training and reveals differences between different perspectives on safety performance [16]. However, there is still a need to apply and empirically test the instruments designed for evaluating the performance implications of safety training. This study provides more specific understanding on how training affects the different elements of safety performance.

Safety performance indicators could be better utilized in evaluating the effectiveness of safety training [16]. Studies combining different forms of measurement information (e.g. questionnaire and safety statistics) in the analysis are needed to gain more comprehensive knowledge on the performance implications of safety training [9, 16]. The aim of this paper is to study how employees' safety performance can improve during a six-month period after a safety training intervention in two units of the case company. The effects on safety performance were studied based on a questionnaire and selected leading and lagging indicators.

2 Materials and Methods

The safety training was carried in two units (unit 1 and unit 2) of a large company providing support services for facilities management. It consisted of participatory classroom lessons, with practical examples and discussions moderated by an expert. The training aimed to change employees' behavior and support the development of safety culture. The whole work team, including the supervisors, participated in one training session of four hours. The training sessions were arranged during November and December 2019, and the total number of participants was 300.

The effects on safety performance were studied based on a questionnaire [16] and selected indicators for safety performance. The questionnaire was carried out during February 2020 (two to four months after the training sessions). It consisted of 48 questions (43 Likert-scaled questions and 5 open questions). Forty-five responses from two units were received, 51% from unit 1 and 49% from unit 2. Most of the respondents were males (93%) and had more than one year of work experience in the company in question (96%). Three of the respondents (7%) were supervisors, and 42 (93%) were employees. The respondents evaluated the effects of the safety training with relation to the four themes: 1) safety knowledge, 2) safety attitudes, beliefs and motivation, 3) safety behavior and 4) safety performance [16].

Safety performance indicator data (leading and lagging indicators) were gathered before and six months after the training to complement the survey data. Leading indicators included the number of preventive actions taken, namely, safety observations, safety walks, safety moments, workplace risk assessments and machine risk assessments. Lagging indicators included the number of lost time accidents (LTA) and total recordable injuries (TRI). Descriptive analysis of the gathered data was carried out, and the performance implications of safety training were evaluated. The results and

performance implications of the training intervention were reviewed with the company safety representative to interpret the results.

3 Results

Based on the questionnaire, most of the respondents (73%) agreed that safety training has positive effects on occupational safety by decreasing the number of occupational injuries (mean 3.78). Similarly, most of the respondents (68%) agreed that the training improves the workplace climate (mean 3.75). The respondents stated that the training caused them to better plan work and observe risks before starting the job, become more aware of the consequences of an occupational injury and understand the wider picture. The summary of the results is shown in Table 1.

Table 1. Summary of the survey results (n=45).

Perspective	Sections	No. of questions	Mean
Safety knowledge	Working environment	4	3.66
	Ability to work safely	4	3.74
Safety attitude, beliefs and motivation	Understanding the significance of safety	5	3.80
	Risk perception	4	3.72
	Safety motivation	3	3.95
Safety behavior	Adhesion to the instructions	4	3.62
	Feedback	3	3.39
	Active safety participation	5	3.52
Safety performance	Effects on occupational injuries	1	3.78
	Effects on workplace climate	1	3.75
	Supervisory performance	4	3.76
	Employee performance	5	3.81

1 = disagree, 2 = partly disagree, 3 = neither agree nor disagree, 4 = partly agree, 5 = agree

Most of the respondents (70%) felt that the training improved their *safety knowledge* and ability to work safely in different kind of situations (mean 3.70), for example, to observe the working environment and acknowledge hazards. Most of the respondents (67%) perceived that the training had positive effects on their *safety attitude, beliefs and motivation* (mean 3.81). Interestingly, the training seemed to have the greatest effect on the employees' safety motivation (mean 3.95), such as striving for a high level of safety, working safely and caring for each other. The respondents perceived that after the training safety issues are discussed more often and safety problems are tackled more actively.

The training also had some positive effects on *safety behavior* (mean 3.52). About half of the respondents (53%) agreed that after the training they more actively follow safety instructions, get and give safety feedback and participate in safety development. It is noteworthy that there is room for development, especially in giving positive feedback about working safely and paying attention to physical ergonomics. Most of the respondents (69%) perceived the safety climate as quite positive (mean 3.79). For example, the majority of the respondents stated that they take their fellow workers' safety

suggestions seriously (mean 3.88) and can discuss safety matters openly (mean 4.14). Moreover, they reported that supervisors ensure that every employee can influence his or her own occupational safety (mean 3.91) and encourage employees to always follow the safety instructions (mean 3.77).

There were some differences between the results of the two units. In unit 1, the effects of the training were perceived as overall more positive than in unit 2 (approximately 0.1–0.6% difference per question). However, supervisor performance was evaluated the same or slightly more positive in unit 2 (0.2–0.3% difference in two question). Employee performance was perceived more positively in unit 1 than in unit 2 (0.1–0.4% difference per question).

The safety performance indicator data were gathered during six months after the training (January 2020 – June 2020), and a five-month moving average was calculated (Fig. 1 and Fig. 2). The number of preventive actions taken slightly increased during the period in the whole data set and in both units, especially safety walks, workplace risk assessment and safety observations. The LTA rate decreased in the whole data set and in both units (30% in unit 1 and 27% in unit 2). The TRI rate decreased in the whole data set but decreased by 30% in unit 1 and increased by 25% in unit 2.

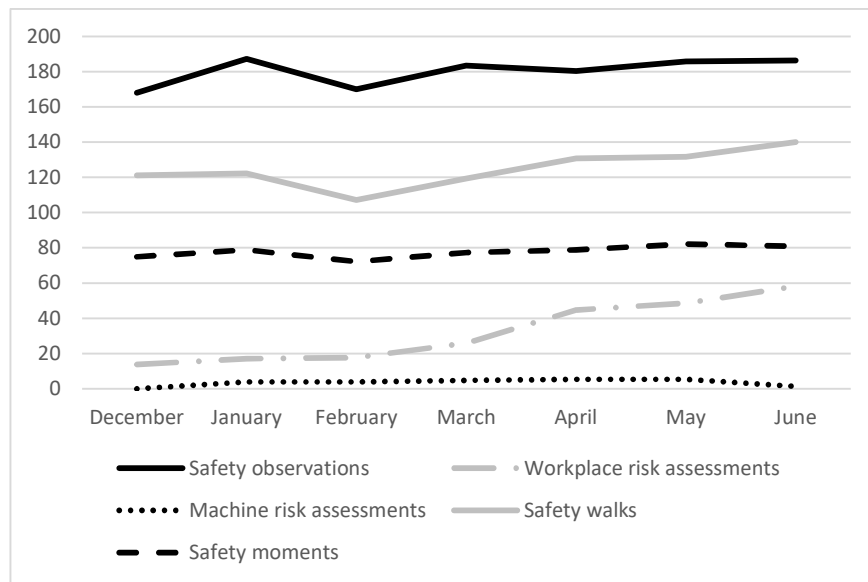


Fig. 1. Five-month moving average of monthly preventive actions taken (number).

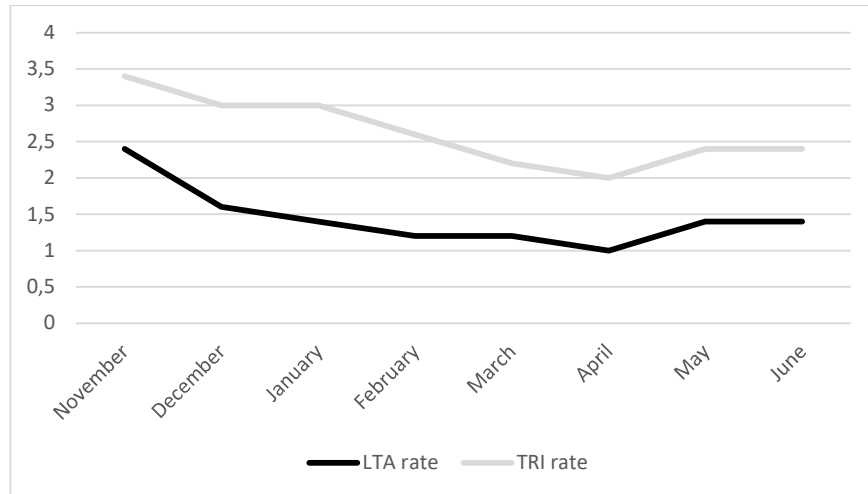


Fig. 2. Five-month moving average of Lost Time Accident (LTA) rate and Total Recordable Injury (TRI) rate (number).

Based on the review by the company representative, the participants evaluated the quality of the training positively. Some effects on safety knowledge, attitudes, beliefs and motivation were perceived after the training, but they were not expected to have an immediate effect on safety behavior or safety performance.

4 Discussion

Based on the survey results, some improvements in safety knowledge, attitudes, behavior and safety performance can be found. The results reinforced the view that training will not affect safety behavior instantly [9,11]. However, some direct effects can be found, for example, with regard to following the safety instructions. Nevertheless, safety training remains inadequate if it does not support behavioral changes [9,16].

Indicator data also show a positive trend in safety performance during the studied period. The amount of preventive actions has considerably increased while the number of injuries has decreased. More active reporting of and participation in safety issues may indicate behavioral changes after the training. The safety performance indicator data indicated even more positive development than the company representative expected.

The safety performance indicator data are not fully comparable between 2019 and 2020 due the exceptional COVID-19 epidemic situation during 2020. The employees of the company in question typically cannot do remote work since they carry out facility services at customer premises. Hence, the focus of safety work has been on sheltering from coronavirus and preventing it from spreading in the workplace during spring 2020. To manage this challenge, a moving average was used to smoothen the data and decrease the impact of random, uncontrollable factors. However, the indicator data should

be followed for a longer period to confirm the effects. In the future, a second survey round could be carried out to study the permanence of the effects.

Most of the respondents were employees, and hence the survey results may be biased toward more positive evaluation of employee performance than supervisory performance. It is noteworthy that the dispersion of supervisory performance was relatively high. This indicates differences between the supervisors, for example, in how they encourage employees to work safely. Moreover, the differences in indicator data between the units may also indicate differences between the supervisors.

There were some differences in the survey results between the two units. In unit 1, safety training was perceived more positively than in unit 2, even though both units perceived the training as advantageous. The safety performance indicator level was significantly better in unit 1 than in unit 2. In unit 1, the respondents were more critical of the supervision. This may indicate differences in supervision, willingness to accept training or how well the training meets the current situation in the unit. Thus, the same kind of training might not be suitable for every unit, and the training should be tailored based on the participants' needs.

This study contributes to the current knowledge on evaluating the performance implications of safety training. Specifically, it advances the understanding of how safety training creates benefits. The results of the study can be utilized in planning adequate interventions and related measurements to improve safety. In addition, the study presents an approach for evaluating the impacts of safety training, which may be followed in other case contexts. This approach can be seen as a tool for safety managers in recurring analyses of safety-related training.

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References

1. Vinodkumar, M.N., Bhasi, M.: Safety management practices and safety behaviour: Assessing the mediating role of safety knowledge and motivation. *Accident Analysis and Prevention* 42, 2082--2093 (2010)
2. Burke, M.J., Sarpy, S.A., Tesluk, P.E., Smith-Crowe, K.: General safety performance: a test of a grounded theoretical model. *Personnel Psychology* 55, 429--457 (2002)
3. Burke, M.J., Sloane, M., Signal, S.M.: Workplace safety: a multilevel, interdisciplinary perspective. *Research in Personnel and Human Resources Management* 29, 1--47 (2010)
4. Hale, A., Guldenmund, F., van Loenhout, P., Oh, J.: Evaluating safety management and culture interventions to improve safety: Effective intervention strategies. *Safety Science* 48, 8, 1026--1035 (2010)
5. Hinze, J., Gambatese, J.: Factors that influence safety performance of specialty contractors. *Journal of Construction Engineering and Management* 129, 2, 159--164 (2003)
6. Wu, T.-C., Chen, C.-H., Li, C.-C.: A correlation among safety leadership, safety climate and safety performance. *Journal of Loss Prevention in the Process Industries* 21, 3, 307--318 (2008)

7. Neal, A., Griffin, M.A., Hart, P.M.: The impact of organizational climate on safety climate and individual behavior. *Safety Science* 34, 1, 99--109 (2000)
8. Bahn, S.: Moving from contractor to owner operator: impact on safety culture: a case study. *Employee Relations* 35, 2, 157--172 (2013)
9. Ricci, F., Chiesi, A., Bisio, C., Panari, C., Pelosi, A.: Effectiveness of occupational health and safety training. A systematic review with meta-analysis. *Journal of Workplace Learning* 28, 6, 355--377 (2016)
10. Burke, M.J., Sarpy, S.A., Smith-Crowee, K., Chan-Serafin, S., Salvador, R.O., Islam, G.: Relative effectiveness of worker safety and health training methods. *American Journal of Public Health* 96, 2, 315--324 (2006)
11. Robson, S., Stephenson, C.M., Schulte, P.A., Amick, B.C., III., Irvin, E.L., Eggerth, D.E., Chan, S., Bielecky, A.R., Wang, A.M., Heidotting, T.L., Peters, R.H., Clarke, J.A., Cullen, K., Rotunda, C.J., Grubb, P.L.: A systematic review of the effectiveness of occupational health and safety training. *Scandinavian Journal of Work, Environment and Health* 38, 3, 193--208 (2012)
12. Hinze, J., Thurman, S., Wehle, A.: Leading indicators of construction safety performance. *Safety Science* 51, 1, 23--28 (2013)
13. Reiman, T., Pietikäinen, E.: Leading indicators of system safety – Monitoring and driving the organizational safety potential. *Safety Science* 45, 3, 329--353 (2012)
14. Blair, E., O'Toole, M.: Leading measures: Enhancing safety climate and driving safety performance. *Professional Safety* 55, 08, 29--34 (2010)
15. Koivupalo, M., Reiman, A.: Health and safety performance indicators in global steel company. *Safety Science Monitor* 2, 2, 1--17 (2017)
16. Tappura, S., Jääskeläinen, A.: Measuring the Outcomes of Safety Training. In: Karwowski W., Ahram T., Etinger D., Tanković N., Taiar R. (eds.) *Human Systems Engineering and Design III. IHSED 2020. Advances in Intelligent Systems and Computing*, vol 1269, pp. 265-270. Springer, Cham (2020)