

# Measuring the Outcomes of Safety Training

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**Abstract.** Safety training has been identified as one of the most important safety management practices. Previous research has suggested several models for evaluating the effectiveness of safety training. Evaluation is crucial to implement evidence-based training interventions. However, the outcomes of safety training are difficult to demonstrate. Studies better specifying and measuring the outcomes of training are needed. The aim of this study was to design and test a model for evaluating the outcomes of safety training. The model addressed 1) safety knowledge, 2) safety attitudes, beliefs and motivation, 3) safety behavior and 4) safety performance. A survey (n=25) was used to measure the employees' perceptions after the safety training. Based on the results, some improvements in safety knowledge, attitudes, behavior and safety performance can be found. The model was found as suitable for its purpose. The results can be utilized in identifying factors related to the effectiveness of safety training.

**Keywords:** Occupational Health and Safety · 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 regard to safety, thereby improving safety performance [1]. Safety training has been identified as one of the most important safety management practices that predicts safety knowledge, safety motivation, safety compliance and safety participation which are key factors of safety performance [1,2,3,4]. Appropriate safety training could improve organizations' safety culture [5].

Previous research has suggested models for evaluating safety training effectiveness. These models address several themes, such as safety knowledge, safety attitudes and beliefs, safety behavior and health [6,7,8]. Based on the Ricci et al. [8] meta-analysis, the most effective training in terms of improving safety knowledge and attitudes are the individual self-learning modality, supplied by learning sessions no longer than 1 h and not compulsory for the worker. The best effects on increasing safety behaviors were obtained by behavioral, not compulsory training led by a researcher or an expert, individually supplied and for a longer duration. On the whole, the effectiveness was higher in voluntary learning conditions.

According to Ricci et al. [8], a questionnaire is the most common method for evaluating the effectiveness of safety training. However, the most significant measures of

efficacy are practical tests and questionnaires (administered immediately after the intervention) for knowledge training and only practical tests (in a follow-up time from immediately until three months) for attitudes training. The most significant measures were obtained by questionnaires, administered up to three months after the intervention.

Evaluation is crucial to implement evidence-based training interventions and improving the content and focus of training [8]. Previous studies [7,8] highlight a strong support for the effectiveness of training on worker safety attitudes and beliefs and, to a lesser extent, on worker's knowledge. Further, safety training has found to have a medium effect on employee behavior and only minor effect on health. Different kinds of training are effective with regard to safety knowledge and attitudes than with regards to safe behavior [8]. Previous research suggests that classroom training does not reveal itself very effective [8]. More research is needed about the effectiveness of training, for example, applying different methods, in a small group, and regarding vulnerable employees [8]. Furthermore, training should be continuous since the training outcomes can be significantly reduced over three months [8].

Outcomes of safety training are difficult to demonstrate. There is a need for studies better specifying the outcomes of safety training and presenting and testing instruments for evaluating the outcomes of safety training.

Safety performance indicators could be better utilized in evaluating the safety training effectiveness. We investigate how the outcomes of safety training can be measured and whether safety training has positive effects on safety performance. Therefore, this paper presents a framework and method for measuring safety training outcomes and discusses the employees' perception on the effectiveness of training on safety performance.

## 2 Materials and Methods

This study designed and tested a model for evaluating the outcomes of safety training. Testing was carried out in a large company providing support services for facilities management. This study utilizes a design science approach in which the intention is to develop scientific knowledge and solve practical problems. The six main phases of design science process [9] can be found in Figure 1. This study follows the first four steps while deploying and maintaining are not in the scope. First, the scope of the model is defined. Second, the design and content of the model is designed based on earlier literature. Third, the model is tested with the potential users of the model.



**Fig. 1.** Main phases in constructing a maturity model [9].

The scope of the model was defined based on the company's needs to find out how effective is the specific training intervention. The aim of the training was to increase hazard awareness, promote employees' safe behavior and support the development of safety culture. A model and its content were designed based on the literature addressing safety knowledge, safety attitudes and beliefs, safety behavior and safety performance with regard to safety training effectiveness [6,7,8]. The model was reviewed by safety

experts of the case company and revised accordingly. Finally, the model was tested in a case company via paper survey.

Company-specific safety training was carried out as participatory classroom lessons with practical examples and discussions moderated by an expert. The whole work team including the supervisors participated in one training session. Training session were arranged during November and December 2019, and total amount of the participants was about 300.

A survey was used to measure the employees' perceptions after the safety training. The survey was carried out during February (2 to 4 months after the training sessions), and 25 responses were received. Only one respondent represented supervisor position. Around half of the employees had worked more than 5 years in their current position, and almost all had at least 1 years experiences in the position. The survey consisted of 48 questions; a Likert-scaled evaluation included 43 questions, and 5 open questions were asked. The respondents evaluated the effects of the safety training with relation to the four themes of the survey. Data was captured from the response sheets using Webropol survey tool. Descriptive analysis of the gathered data was carried out. The utilization of the model was evaluated.

### 3 Results

The model for measuring the outcomes of safety training was designed based on the existing literature on safety management and models related to the effectiveness of safety training. The literature-derived content was further revised by the safety experts in case company in order to capture realistic outcomes in the training in question. The model addressed: 1) safety knowledge, 2) safety attitudes, beliefs and motivation, 3) safety behavior and 4) safety performance (Table 1). The mean scores of the items are shown in Table 1.

**Table 1.** The contents of the model and the main results (n=25)

Perspective	Sections	No of questions	Mean
Safety knowledge	Working environment	4	3.73
	Ability to work safely	4	3.74
Safety attitude, beliefs and motivation	Understanding the significance of safety	5	3.82
	Risk perception	4	3.81
	Safety Motivation	3	4.01
Safety behavior	Adhesion to the instructions	4	3.76
	Feedback	3	3.53
	Active safety participation	5	3.64
Safety performance	Effects on occupational injuries	1	3.84
	Effects on workplace climate	1	3.80
	Supervisory performance	4	3.66
	Employee performance	5	3.86

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

Most of the respondents (80%) agreed that the safety training has positive effects on occupational safety by decreasing the number of occupational injuries (mean 3.84).

Similarly, most of the respondents (64%) agreed that the training improves the workplace climate (mean 3.80). Some of the respondents stated that the training stirs themselves to think risks before starting the job. Most of the respondents (74%) also felt that the training improved their safety knowledge and ability to work safely in different kind of situations (mean 3.73). Most of the respondents (70%) perceived that the training had positive effects on their safety attitude, beliefs and motivation (mean 3.88). Interestingly, the training seemed to have greatest effect on the safety motivation of the employees (mean 4.01), such as more active tackling of the problems and caring for each other. The training had also some positive effects on employee behavior (mean 3.65), such as more active use of personal protective equipment. Safety climate was perceived quite positive (mean 3.77), for example, the majority of the employees stated that they take the fellow workers' safety suggestions seriously (mean 4.04) and can discuss safety matters openly (mean 4.00). Moreover, supervisors ensure that every employee can influence his/her own occupational safety (mean 3.80) and encourage employees to work always according to the safety instructions (mean 3.76).

The case company representatives evaluated that the model is suitable for its purpose, as it is comprehensive and compiles the major objectives for the effective safety training. The testing demonstrated that it includes relevant criteria for evaluating training outcomes and reveals differences between different perspectives to safety performance. Evaluation can also be conducted with reasonable efforts by employees.

## 4 Discussion

Based on the results, some perceived improvements in safety knowledge, attitudes, behavior and safety performance can be found. According to Ricci et al. [8] meta-analysis, OHS training induced positive effects on employees' safety knowledge, attitudes and beliefs, but minor evidence of training effectiveness on employees' safe behavior and health. On the contrary, Robson et al. [7] found strong evidence of the effectiveness of training on employees' safe behaviors. However, changes in behavioral routines are difficult to self-evaluate. They could be better evaluated by, for example, observations in workplaces [8].

Training adult workers is often a challenge because they are all motivated in different ways, have different sets of experiences, different expectations and different sets of skills and knowledge [8]. Safe behavior depends not only on perception and knowledge but also on safety climate at the workplace [10,11]. Co-workers' orientation and social pressure may influence workers' intention to act in a safe way [8]. Nevertheless, safety training remains inadequate if it does not support behavioral changes.

This study focused on safety training aiming at behavioral and cultural changes. Raising safe behaviors is typically linked to in-depth and organization-wide interventions and not only to knowledge extension or occasional interventions [6,8]. Previous research [8] suggests that classroom training does not reveal itself very effective. Behavioral training and hands-on practice with greater effect on individual training and provided by experts may promote safe behavior. Moreover, training should be in-dept and continued in order to have lasting outcomes. More research is needed about the effectiveness of training, for example, applying different methods, in a small group, and regarding vulnerable employees.

The initial phase of the model testing shows positive results and implications. The model was found as suitable for its purpose. In a further study, safety performance indicator data will be gathered to complement the survey data and to evaluate whether different sources of information provide conforming message. In the future, a second survey round could be carried out to study the permanence of the effects. During the same period, the safety performance quantitative data could be examined to cross-check the effects.

The study has some limitations. The study used self-report measures which may affect the reliability of results. The use experiences of the new model are still limited. The number of respondents to the survey could have been higher. In the future, the model should be further tested with more companies in different kind of industries with regard to different kind of safety training interventions.

This study contributes to the identification of a training intervention that could be efficient in improving safety performance. The results of the study can be utilized in identifying and measuring the outcomes of training and planning adequate interventions to improve safety.

The resulting model will benefit both the research and practice of safety management. The researchers can utilize the model in survey research. The practitioners can utilize it in evaluating safety training interventions and their (cost-)effectiveness. This study also presents a model for evaluating safety training effectiveness which combines safety knowledge, safety attitudes, safety behavior and safety performance. These perspectives can be used in linking different indicators and data sources to the evaluation of safety training effectiveness. By capturing safety performance, the new model highlights the link between training effectiveness and safety performance. Moreover, the developed new framework may be utilized as a leading indicator of safety performance.

**Acknowledgments.** The authors sincerely appreciate the contributions of all the respondents who participated in the study. The authors gratefully acknowledge the research funding provided by the Finnish Work Environment Fund, participating companies, and Tampere University.

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