

Measurement methodology for the effects of accident prevention programs

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Before the effects of accident prevention programs can be evaluated, complementary measures are needed in addition to accident statistics. Safety may, can, and should be analyzed on various behavioral levels, ie, with respect to (i) management goals and strategies concerning safety (safety climate questionnaires, reports, discussions, meetings, safety directives, etc), (ii) the actions and performance of workers, eg, physical movements, decision making, perceptions, and the processing of information (observation methods, video recording, etc), (iii) the behavior of workers, eg, use of safety equipment, maintenance of safe gangways, storage of equipment in proper places, use of proper tools (check lists, questionnaires, etc), and (iv) accidents (reports, statistics, etc).

The first three of these measures reflect the actual changes in behavior of various personnel groups. The second and third concern changes in workers' behavior, the first one shows changes in management's behavior and organizational practices, and the last one gives the long-term effects or consequences of actions.

The three first criteria are perhaps more relevant than accident data in the evaluation of accident prevention effectiveness on a short-term basis and in the evaluation of changes towards positive safety performance.

Safety management

Safety management and practices may be evaluated from the responses of workers about their perceptions concerning organizational practices. These perceptions may be conceptualized as the safety climate of the organization.

The safety climate is one indicator of the operation of the workplace. It can be defined as perceptions which are shared by the workers and which concern the quality and actualization of safety-relevant activities and practices within the company. These activities can be divided into the following four groups: (i) education and training, (ii) preventive activities, (iii) daily routines, (iv) housekeeping.

It has been found that the perceptions of these activities relate to the accident rate of the company (9).

This result is especially valid in companies with traditional industrial management and safety organizations.

In occupations in which the employees do their work mainly alone, without the direct control of supervisors (such as loggers), safety management has mainly an indirect effect on worker performance.

Safety climate perceptions can be used as an indicator of any change in organizational safety activities. If safety measures are aimed at improving organizational or management practices, the methods of evaluating changes should operate at the same level.

Preventive actions to improve organizational practices should be such that they can be perceived or experienced by the workers. Improvements in safety training or inspection systems are examples of such activities, whereas improvements in accident reporting or other safety-related reporting activities may not be reflected in worker evaluations. Safety climate measures should thus be restricted to those preventive measures that are targeted towards improving visible management practices.

Questionnaires are often used to collect data for these measurements. Usually verbal quantifiers are used in the questionnaires. A typical verbal scale is "always," "often," "occasionally," "seldom," "never." However, one should be cautious with pure verbal scales and use numerical quantifiers together with verbal ones, if possible (1).

Behavior and performance

The success of behavior modification programs must be evaluated with criteria which are directly related to observations of worker behavior and its consequences (3, 5, 10).

Another measure for evaluating worker behavior is behavior sampling. It is based on random observations of actions or behavior. A relevant and accurate description of the behavior can be obtained with carefully designed observation schedules. Behavior sampling may be used to determine the amount of changes in behavior over time (11).

Various techniques analyzing human reliability have been developed for describing human performance and error liability. Because human reliability techniques mainly concern human action and performance measurements, as well as perception and decision-making

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processes in relation to the demands of tasks, these techniques could also be used for analyzing the effects of prevention programs at the action or performance level.

Safety in some professions, especially in heavy manual work like logging, is based on work skill, eg, the extent to which the worker behaves according to work instructions. Measuring work skill gives information on the parts of the work phase that should be trained and also on safety at work. Some trials have been carried out to measure the work skills of loggers (6). It was clearly seen that a high level of work skill among loggers associated positively with fewer accidents; the seriousness of the accidents also decreased with increased skill. This method gives some possibilities to evaluate the effects of training. The same evaluation of work skill undertaken by different people requires clear criteria. In some occupations the evaluation can be done through an examination of the result of the work, whereas in some occupations it is more useful to observe the work process.

Accident reports and statistics

At the final level, safety can be analyzed on the basis of accident reports and statistics. The frequency, seriousness, and type of accident can be measured with the help of statistics. The type of accident may be classified in various ways. One basis for the classification can be the harmful energy causing the injury. The energy can be inherent in the injured person, eg, falling down, or in the object causing the injury, eg, a moving vehicle, or it can be the result of interaction between the injured person and the object, eg, a person lifting a burden.

Accident reports and statistics usually form the basis for the evaluation of the final effects of safety programs. There are nevertheless some limitations for using accident analyses. First, an accident is always a stochastic event. The consequences of an accident may vary even though the type of accident is the same. One solution for this problem is to evaluate the potential damage of the accidents and to study also near-accidents. Second, the registration and investigation of accidents may be imperfect and faulty and therefore cause the results to be unreliable. Third, if the number of accidents to be considered is great, their analysis is very laborious. The solution may be a computer and good software. Finally, the delay of the effect of a special safety measure may be long. In a Finnish plywood factory it took two years before the campaign to reduce strain seemed to have an effect on accident statistics.

In spite of these problems accident analysis is one of the most used methods for analyzing safety. A useful way to analyze and clarify the description of accident statistics is to use computerized graphics. Chain analysis is one example (2). It is suitable for analyzing groups of accidents which can be described with a limited number of variables containing a limited number of classes. The disadvantage of this method is that it does not give much information if the accidents cannot be described with the same variables.

In spite of their disadvantages, the described measuring methods seem to offer a fairly good combination for measuring the stage of safety in many cases, especially in before-after situations (4, 7, 8).

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