SAFETY SCIENCE Monitor

Special Edition 1999

Safety in Action
25-28 February 1998

Safety Management
Article 5

VOL 3

RELATIVE RANKING AS AN INSTRUMENT IN RISK EVALUATION

A.W. ZWAARD
Gorlaeus Laboratories, Leiden University
PO Box 9502, 2300 RA Leiden, The Netherlands

L.H.J. GOOSSENS
Safety Science Group, Delft University of Technology
Kanaalweg 2B, 2628 EB Delft, The Netherlands

Introduction

In 1994 the Dutch Working Conditions Law was changed on several important aspects, caused partly by the need to implement the risk assessment requirements of the European Community. According to the adjusted national law, every employer should identify and assess all work related hazards in his company.

The safety and health policy of an enterprise should be based on a risk inventory and evaluation. A common sense approach should prevail, which is also directed at taking structural measures. Simple problems, especially in small enterprises, do not require complex, time consuming methods according to the legislator. The new legal requirements have led to a renewed interest in older, existing methods and instruments to identify and evaluate risks.

Risk

Risk is defined as a set of triplets, each triplet being the combination of scenario (a sequence of events), effect and probability.

Risk thus contains three elements:

1. What can happen (go wrong) and what are the consequences of this? *(scenario)*
2. How severe is the outcome? *(effect)*
3. What is the probability that it happens? *(probability)*

In this approach a hazard must be seen as a combination of a scenario and an effect while risk also includes the probability. Hazards thus describe the possible outcomes of a situation, irrespective of the probability. An inventory of hazards is impossible without - consciously or not- identifying (inventing) scenarios.

This description of risk and hazard is applicable to both short term (direct) effects and long term (delayed) effects. There is no essential difference between a scenario describing the walking on a slippery floor, causing a worker to fall and hurt his head and a scenario describing exposure to a carcinogenic substance followed by a fatal cancer after several years.

Often hazard is described as an intrinsic property of a situation, equipment or substance to cause adverse effects. To avoid confusion it is, however, better to use the expression for characteristics of activities, situations, operations or work and *not* for characteristics of substances, agents or machinery. A hazard is meaningless without a scenario and in scenarios people (workers) and their surrounding play an essential role.

Risk management

Performing a risk inventory and evaluation, however important, is no goal in itself. It should be part of the policy of an enterprise, aimed at improvements of working conditions and decrease of absenteeism. Performing a risk evaluation is the basis for several other activities such as writing an annual report on working conditions, setting up a program of education and training and counselling of sick workers.

To successfully implement such a policy, a systematic approach is necessary. The approach followed here is the so called Risk Management process; risk inventory and evaluation are merely two steps in this process.

In the first step of the Risk Management process goals and starting points are formulated. Subsequently the risks are identified and evaluated followed by the generation of solutions and measures to monitor. In the next step these measures are combined into an action plan. The implementation of this program is a subsequent step followed by an evaluation of the results which shows if the measures have actually led to improvements. If necessary goals are adjusted and the cyclic process starts again.

The Risk Management process can be considered as a leitmotif in a management system; risk inventory and evaluation play a central role in this process. Although the principles and jargon of Risk Management are part of daily practice in big companies, the same principles apply to smaller undertakings. In these firms the attitude of the employer is decisive. Only if the employer pays great interest to the management of risks will a basis for success exist.

Evaluation of risks

The step from risk inventory to risk evaluation is only a small one. Roughly speaking, the inventory deals with hazards while the evaluation focuses on risks. This means that in the evaluation both the effects **and** the probabilities should be considered. For industrial hygienists this can be translated to: hazards **and** exposure.

After the risk inventory a general picture has emerged of hazardous work situations and sources that may cause exposure. In order to determine whether these hazards actually lead to risks, the probabilities or exposures (time, frequency) have to be investigated.

In order to make the step from hazards to risks, it may be necessary to know how exposure and effects are related. Dose effect and dose response relationships give this information. If these relationships are known, the probability of the effect simply follows from the exposure. Legal standards and limit values are often based on these relationships. In fact, by comparing a situation with standards use is made of a (government made) risk evaluation.

Most standards are not phrased in terms of a level of risk as such. They give limits of, for example, noise levels, concentrations of toxic substances or even safety devices.

Besides exposure and the related probability of adverse effects, the number of exposed employees is an important element in evaluating the risks. An estimate of the number of workers handling specific hazardous substances or working with dangerous equipment is thus useful. Also the number of employees that may be exposed to, for example, elevated sound levels or micro organisms and the number of workers using lasers or X ray machines is useful.

The evaluation of risks should lead to a ranking of risks. Some instruments are unsuitable for this, for example an inspection using merely a checklist. When simple checklists are used, it is thus necessary to make additionally use of a method to judge the risks. This is possible for example with simple so called Relative Ranking methods.

The advantage of these methods lies in their simplicity. However, knowledge and experience is necessary in order to assign values to the parameters used. Therefore the advice is to apply the methods with a team of people having different backgrounds.

At this stage one should be careful when different methods of risk assessment are used together. The meaning of "risk" as a numerical value may differ between methods and may include other aspects which is not always directly clear from the figures only.

Risk evaluation includes two distinct aspects. The first aspect was described above as the weighing of the ("objective") risk. In this respect use is made of standards, codes of practice, information from literature and rules of thumb.

The second aspect is to assign a value to the risk. In order to judge risks additional features may be considered besides effects, probabilities and standards. Depending on the approach used the following aspects may be relevant:

- the magnitude of the population at risk;
- the possibility to detect and avoid the hazard;
- the perception of risk by all stakeholders.

Financial costs in technical and operational feasibility are not yet dealt with in this stage. These aspects have nothing to do with risks but are related to measures and should be considered in a later phase of the Risk Management process.

Methods

In most cases a risk assessment takes place by first identifying the existing risks using a checklist followed by an evaluation of the risks based on a relative ranking method.

Inspections and audits

Inspections and audits are methods to measure an organisation's safety and health performance. This may take place by a combination of several activities:

- a workplace visit, using for example a checklist, like in "classical" safety inspections;
- interviewing workers, using for example a questionnaire;
- investigating documents and procedures, like in a safety audit.

Roughly speaking, inspections focus on technical and physical aspects, while audits judge the organisational aspects of the work. The broader methods (investigating safety, health and well being) consist essentially of a closed checklist and a protocol. In the Netherlands a wide variety of methods are used.

Relative Ranking

Relative Ranking is a collective term for a number of approaches in which the risks or hazards of situations are compared in a rough way. The expression Relative Ranking does not refer to one specific method but rather to an analysis strategy or philosophy. Essentially, Relative Ranking is based on a comparison of risk characteristics, resulting in numerical values considered indicative for hazardous situations. Such characteristics are (combinations of) measurable quantities or they may be based on the likelihood and severity of possible accidents. They can be based on very different risk definitions.

The basis of many Relative Ranking methods is the concept of risk as a combination of scenario, effect and probability. A Relative Ranking method always leads to a ranking of risks. In most cases this takes place by assigning scores to effect and probability giving the method a semi quantitative character.

In most of the Relative Ranking methods risks are expressed as numerical values that have no absolute but only a relative meaning. The quality of the risk evaluation is moreover determined by the reliability of the data used. The advantage of the methods lies in their easy applicability and in the fact that they clarify the starting points and enable a discussion on the assumptions used.

An example

In several popular Relative Ranking methods risk is essentially considered as probability times effect and a risk score is calculated as the product of three parameters corresponding, respectively, with likelihood, exposure and possible consequences. The exposure parameter indicates how often a specific hazardous situation takes place. This may be exposure to a hazardous substance or operating a dangerous piece of equipment. The likelihood parameter indicates how likely it is, given the selected hazardous situation, that the effect occurs. To judge the variables the following tables can be used.

Likelihood	
0.1	virtually impossible
0.2	practically impossible
0.5	conceivable but very unlikely
1	only remotely possible
3	unusual but possible
6	quite possible
10	might well be expected

Exposure	
0.5	very rare (< yearly)
1	rare (yearly)
2	unusual (monthly)
3	occasional (weekly)
6	frequent (daily)
10	continuous

Possible Consequence	
1	noticeable (e.g. minor first aid accident)
3	important (sickness absence)
7	serious (irreversible injury)
15	very serious (fatality)
40	disaster (few fatalities)

The risk score is calculated as the product (Likelihood) x (Exposure) x (Possible Consequence). The aspect of hazard avoidance can be introduced by lowering the risk score with a fixed value for situations in which an effective avoidance of the hazard is possible. For toxic substances a relatively low odour threshold may be a reason for this.

Pitfalls

Since the new obligation to evaluate risks came to force a renewed interest in Relative Ranking approaches has occurred. In fact the methods are now used widely, both by experts and workers.

Generally when the ranking method is applied by different users, differences in risk scores result. These can be diminished in a discussion between the users. Several differences can be traced back to a limited number of pitfalls. The most common ones are:

- *insufficient specification of scenarios.*

This pitfall can be omitted by specifying beforehand the scenario considered with some key words.

- *inconsequent "cutting" of scenarios.*

By separating probability into exposure and likelihood it should be stressed that both parameters are coupled.

- *incorrect treatment of the number of exposed workers.*

The number of exposed workers can be taken into consideration in the chosen value for exposure or in that for likelihood (but not in both). Alternatively, the number of exposed workers can be given separately and the risk score calculated for one worker.

- *incorrect interpretation of the descriptions of likelihood.*

Careful description of key words and terminology of the subjective scales (e.g. "remotely possible" and "unlikely") is important. It is often useful to use percentages instead (e.g. "virtually impossible" means one in a million; "might well be expected" means fifty-fifty) to avoid confusion

- *insufficient use of available information.*

Information on the frequency of certain outcomes (accidents) in the past may be used to avoid unreliable results.

Performing a risk assessment is possible using checklists and a simple Relative Ranking instrument. Our experience shows that this makes it possible to assign priorities to measures, even in small enterprises. It is, however, necessary to be aware of some pitfalls. The influence of misunderstandings can further be minimized by application of a clear procedure by a small team of people having sufficient knowledge and experience.