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NOTES

A Simple and Flexible Risk Assessment Method in the Work Environment

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The existing risk assessment models in the work environment (on the basis of Standard No. BS 8800:1996; British Standards Institution, 1996) contain the need to determine the probability of the occurrence and the severity of consequences of the influence of hazardous factors on the worker. The determination of the probabilities of the influence of hazards (noise, vibration, chemicals, etc.) is complicated.

The authors of this article have developed a simple risk assessment method that does not contain the probabilities. The method is based on a 2-step model that could be enlarged into a 6-step model.

The implementation possibilities of the model are presented. The existing norms in the work environment in Estonia were analysed and the safety level of a wood-processing factory was determined.

risk assessment   risk levels   safety analysis

1. INTRODUCTION

Risk assessment in the work environment has been a topic for Estonian researchers in occupational safety and health since 1996, when the European Union (EU) document Guidance of Risk Assessment at Work[1] became accessible. The Estonian Occupational Health and Safety Act (based on EU Council

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Directive No. 89/391/EEC), which demands risk assessment at every workplace, was adopted in Estonia in 1999. In this context the main problem for managers has been finding a suitable risk assessment method. Labour inspectors are not satisfied with the majority of risk assessments carried out by employers, but they cannot improve the situation, as they have no better proposals. Determination of the risk level has been regarded as the most difficult part in the whole risk assessment process.

2. RISK ASSESSMENT IN THE WORK ENVIRONMENT

For risk management in the work environment (British Standards Institution [BSI], 1996; European Commission, 1996) the following activities are recommended:

1. Find in the literature or on the Internet or compile a list of hazards. Among the hazards mechanical, physical, chemical, physiological, psychological, and so forth could be identified;
2. Present short information on each hazard;
3. Measure the hazards in the work environment. For this purpose the services of accredited measuring laboratories could be used or the hazards could also be measured by the employer with approved measuring equipment;
4. Assess the magnitude of the risk;
5. Rank the hazards by magnitude (start with the greatest risk), add the cost of reduction methods, a person responsible for the reduction methods, and a deadline for the reduction;
6. Complete implementation of the reduction methods;
7. New risk assessment (its frequency depends on how hazardous an activity is).

Compared with 1996, by the end of 1999 the situation in Estonian economy changed so that risk assessment in the office environment became as important as in industrial activities. As many as 80% of Estonian offices are supplied with computers and 50% of them have access to the Internet. Considering this situation in the Estonian labour market, a necessity for two different types of risk assessment methods arose, one for industrial activities and the other for office rooms. It would seem that the latter might be easier but in this field also different new hazards have arisen, such as electromagnetic fields from mobile phones, video displays, and other video equipment or odours from chemical materials used nowadays in offices, schools, or hotels (hostels) by cleaners.

Since 2000 the importance of industrial activities has increased again. Everybody involved (employers, the Centre of Occupational Health of Estonia, the National Labour Inspectorate of Estonia) uses their own version of Standard No. BS 8800:1996 (BSI, 1996). So, in the autumn of 2000 it became quite obvious that a new method, sufficiently simple and corresponding to the demands of different parties, would be highly needed.

Estonia has paid much attention to risk assessment peculiarities in a post-communist country (Tint, 1998, 2000; Tint & Saarela, 1994). Tallinn Technical University has also made various proposals for creating Estonia's own risk assessment terminology.

Employers can carry out risk assessment by themselves or with the help of occupational health services. Exposure limits are still the main key words for employers with regard to occupational health and safety (OHS). Therefore, a risk assessment method understandable for employers has to be connected with exposure limits of hazards in the work environment.

TABLE 1. Determination of Risk Level for Hazardous Chemicals in Workplace Air

Consequences →	**Slightly harmful**	**Harmful**	**Extremely harmful**
	uncomfortable, irritable feeling, overcoming illnesses	burning, skin diseases, long-lasting severe damage, permanent slight disorders	poisonings, occupational cancer, asthma, permanent severe damage, illnesses dangerous to health
Probability ↓ ↓	R20, 21, 36, 37, 38	R23, 24, 25, 33, 34, 40, 43, 48, 62, 63, 64	R26, 27, 35, 39, 41, 42, 45, 49, 60, 61, 65
Highly unlikely severe damage from <10% of the limits, others 10–50% of the limits	**Trivial risk** no risk reduction measures needed	**Tolerable risk** follow-up of risks	**Moderate risk** risk reduction measures needed
Unlikely severe damage from 10–50% of the limits, others 50–100% of the limits	**Tolerable risk** follow-up of risks	**Moderate risk** risk reduction measures needed	**Substantial risk** risk reduction measures inevitable
Likely severe damage from 50–100% of the limits, others over the limits	**Moderate risk** risk reduction measures needed	**Substantial risk** risk reduction measures inevitable	**Intolerable risk** risk reduction measures to be implemented at once

The existing risk assessment models (based on Standard No. BS 8800:1996; BSI, 1996) contain the need to determine the probability of the occurrence and the severity of consequences of the influence of hazardous factors on a worker. The determination of the probabilities is too complicated even for engineers of occupational health services, not to mention employers with different levels of education (including nontechnical education). Also some attempts have been made to connect risk level determination (based on Standard No. BS 8800:1996; BSI, 1996) with hazards originating from chemicals (Rantanen & Pääkkönen, 1999). The results are presented in Table 1 (Rantanen & Pääkkönen, 1999).

Table 1 contains risk phrases (R20, R21, R65, etc.). Those risk phrases (like R20: harmful in contact with skin) characterize the hazardous effect of chemicals on a worker's health in EU (Council Directive 67/548/EEC) and Estonian legislation (Sotsiaalminister, 1998).

3. A SIMPLE AND FLEXIBLE RISK ASSESSMENT METHOD

The authors of this article have developed a simple risk assessment method that does not contain probabilities. The method is based on a two-step model that can be extended.

Figure 1 presents a simple and flexible risk assessment scheme for assessing the magnitude of risk.

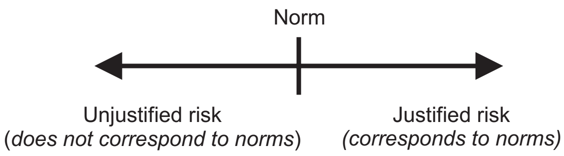

Figure 1. Two-step model.

The two-step model is clear, understandable, argumented, and simple for the user. The model has one boundary line (red on a coloured scheme), which is a stable, largely disseminated number such as a norm or a standard. The *yes—no* principle is used or *corresponds to norms—does not correspond to norms* or *justified—unjustified* risk. The model also suits small enterprises and those that do not have a complicated combination of hazards or have rather inexperienced personnel (also in occupational safety).

For a three-step model (version 1, Figure 2), one step is added to the right side, the boundary is a dotted line (green on a coloured scheme). In practice, such a scheme is rarely used. The scheme suits firms where the state of the work environment is comparatively good, the level of danger is not very high, and the enterprise has a desire and possibilities to improve working conditions.

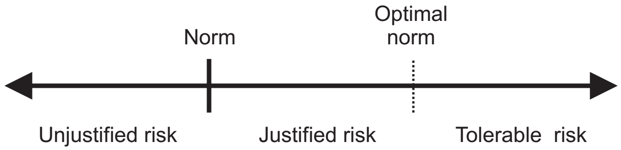

Figure 2. Three-step model (version 1).

Another version of the three-step model is also possible (Figure 3).

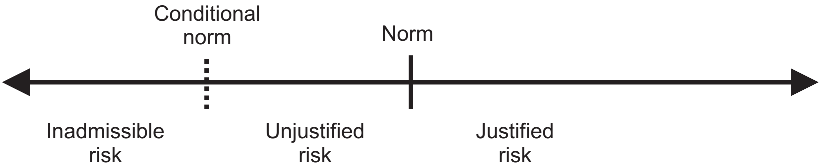

Figure 3. Three-step model (version 2).

In this case one step is added to the left side of the scheme. The boundary line is called conditional risk (a red dotted line): In practice it is not fixed. This line needs scientifically argumented statements (investigations) developed in co-operation by scientists in medicine, engineering, and economics.

Temporarily, in an emergency case, the boundary line can be fixed as a subjectively argumented agreement. This scheme suits enterprises that have a desire to improve working conditions, making them more satisfactory and less dangerous.

As to the content, the four-step model (Figure 4) is nothing more than the result of the summation of the previous schemes. So it is also simple and understandable for the user. The model suits medium-sized enterprises (but not only), where the situation of the work environment is irregular with many different hazards, therefore the level of hazards at the workplace varies to a large extent and the personnel, having relevant qualifications, are able to improve the work environment. The main target in this activity is the left side of the model, where the risk level is higher.

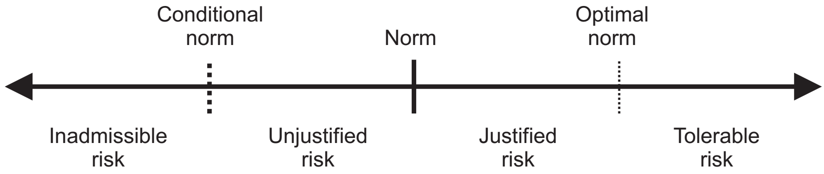

Figure 4. Four-step model.

The scheme in Figure 5 is a development of the previous schemes: An additional step is added to the four-step model on the left (worse) side of the scheme, the boundary line is a double dotted line (red on a coloured scheme).

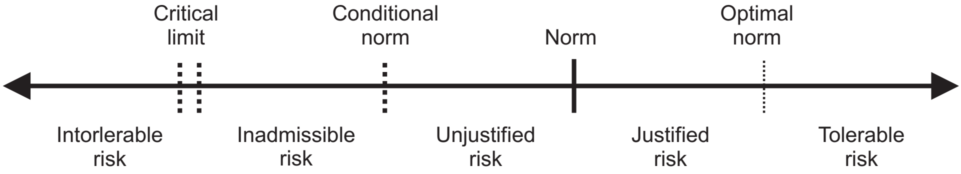

Figure 5. Five-step model.

This scheme is more complicated than the previous ones and it could seem that there is no need for it. The simpler (previous) schemes can be used. Some authors have an exaggerated need to use complicated multistage models only. If they are used then they could be used in big factories with a complicated mix of hazards and where the personnel are able to manage with one intricate scheme.

Finally, it is possible, but not particularly necessary, to add one stage to the right side of the five-step scheme and develop the six-step scheme (Figure 6), where the boundary line is a dotted double line (green) that fixes zero risk or negligible risk. In fact, we can speak of zero risk only when there are no hazards in the work environment.

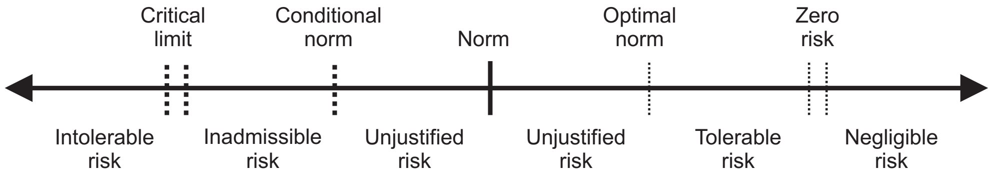

Figure 6. Six-step model.

To conclude, the flexible model presented here offers every enterprise an opportunity to choose a suitable and feasible scheme to introduce into practice.

4. AN ANALYSIS OF ESTONIAN NORMS FOR WORK ENVIRONMENT HAZARDS ON THE BASIS OF THE MODEL

The proposed simple and flexible risk assessment method can be used for assessing exposure limits for noise, microclimate, lighting, physiological hazards (manual loading) in the work environment, and for determining the safety level in enterprises. The use of the proposed method in the case of accidents (traumas), that is, for analysing hazards originating from machines (where it is not possible to set strict values such as exposure limits) can be carried out with Standard No. BS 8800:1996 (BSI, 1996) if the probabilities of accidents are determined on the basis of statistics.

Noise, vibration, unsatisfactory microclimate, and insufficient lighting are the main risk factors in the Estonian work environment (Tint, 1998). Exposure limits have been established in Estonia for noise and vibration, hazardous chemicals, electromagnetic radiation, and microclimate in the work environment. The limits for microclimate in the work environment were worked out in 1995. The limits for lighting have also been worked out (on the basis of Standard No. DIN 5035-6:1990; Deutsches Institut für Normung [DIN], 1990), but they have not been established yet.

The existing norms (exposure limits) in the work environment can be analysed with the use of the presented simple and flexible risk assessment method. For example, norms for microclimate give limits on two levels: normal and optimal air temperature, humidity, and velocity.

The norms for noise set only maximum values (85 dBA). It is also possible to decide how strict the exposure limits are and how much they demand from the employer.

The proposals for the lighting norms in the work environment (on the basis of Standard No. DIN 5035-6:1990; DIN, 1990) demand optimal conditions in the work environment, which is a step forward and an improvement for workers from the standpoint of their health than the lighting norms during Soviet times. Compliance with these norms is positive also for ageing people considering the fact that the demands for lighting rise during the lifetime. If in classrooms 300 lx is enough, then at schools at a higher level, for people over 20, 500 lx is necessary for comfort and for ergonomically well-organized work.

The chemical exposure limits in Estonia give two different numbers: 8-hr mean concentration in workplace air and 15-min short-term limit. The norms also identify three levels of hazard: harmful, toxic, and very toxic. All these things can be put into a simple risk assessment method for better understanding of the questions of risk in the work environment.

5. AN ANALYSIS OF WORKING CONDITIONS IN THE WOOD-PROCESSING INDUSTRY

The work environment in a large wood-processing firm (1,000 workers), in a medium-sized town in Estonia, was analysed. A list of hazards was compiled before the investigation by the firm's work environment specialist. The person had worked in this factory for over 20 years.

The main risk factors in that kind of industry are tools and equipment, also heavy physical load (moving wheelbarrows), noise, wood dust, and, in some places, odours of chemicals (mostly formaldehyde) originating from polishes.

Hazards were measured in the department where polishing and varnishing took place. The following results were obtained: temperature of the air—19.8 °C; air humidity—42.0%; lighting (overall)—300 lx; wood dust concentration, overall in the department—~1.5 mg/m^3, near the machines—10 mg/m^3; noise—98–101.2 dB; concentration of formaldehyde (as a component of phenol-formaldehyde varnish), 8-hr mean—0.5 mg/m^3.

Vibration caused by wood-processing equipment was not measured, but this has to be done, because the hazard of vibration disease is rather high (vibration disease is one of the two most frequent occupational diseases alongside physical overload disease in Estonia).

From the point of view the possibility of accidents or traumas originating from machines it was declared that one protective metallic covering component had been removed and afterwards substituted by cardboard for protection against cut injuries of fingers. That type of accident predominates in the Estonian range of work traumas nowadays (about 500 cut injury traumas of fingers a year, including amputations).

On the basis of the measurements and observations in the department the following conclusions were made: The microclimate in the wood-processing department was rather good (considering that there was room for improvement by increasing air humidity). The safety of machines had to be taken into consideration when buying new equipment. Experience shows that even machines with a CE-mark can be sources of traumas. Noise exceeded the limits (85 dB) in every workplace, but breaks were taken and earmuffs were used. So the total amount of noise during an 8-hr workday did not exceed the permissible level (dose: 85 dB × 8 hrs). The phenol-formaldehyde varnish is a source of allergic reactions in workers. The risk phrases for this compound are R23/24/25, R34, R40, and R43. The exposure limits (0.6 mg/m^3) were not exceeded.

The five-stage simple and flexible risk assessment model was used to assess the working conditions (Figure 7).

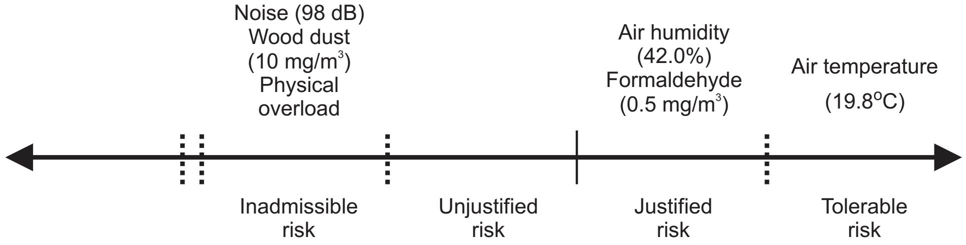

Figure 7. Assessment of working conditions using a simple risk assessment method in the wood-processing industry.

6. CONCLUSIONS

A simple and flexible risk assessment method (beginning with a two-stage model that can be extended into a six-stage model) has been worked out and the implementation possibilities have been presented. It is necessary to increase the employers' interest in using the method and in analysing the work environment to implement improvements.

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