ISSN 1392 – 2785 Inzinerine Ekonomika-Engineering Economics, **2010, 21(5), 485-492**

Cost-Effectiveness of Safety Measures in Enterprises

Piia Tint, Õnnela Paas, Karin Reinhold

Tallinn University of Technology
Ehitajate 5, 19086 Tallinn, Estonia
e-mail: piia.tint@tseba.ttu.ee, onnela.pass@tvesi.ee, karinhold@tseba.ttu.ee

Safety auditing is a systematic method to evaluate the company's safety management system. The main task of auditing is to establish whether the correct types of safety methods are used and whether they are effectively implemented. The safety auditing in Estonian enterprises (on the basis of European Union legislation, Standards OHSAS 18001:1999 and BS 8800:1996) is only in the beginning stage. As the prerequisite to the paper the safety auditing in 12 medium- and small-scale enterprises in Estonia from 5 branches of industry (metal and wood processing, plastic, garment and printing) has been carried out. The modified Diekemper & Spartz (D&S) method has been used. The D&S method addresses 30 activities, divided into five activity areas: organization and administration; industrial hazard control; fire control and industrial hygiene; supervisory participation, motivation and training; accident investigation, statistics and reporting procedures. The maximum score was gained in the plastics industry: 62.9% and the minimum score in a printing industry: 40.9%. Economically developed enterprises have possibilities to pay also more attention to safety matters. The cost-effectiveness of the planned safety measures is calculated. The method considers the cost, the effectiveness and the uncertainty of the safety measure (Roed method). These three variables integrate the cost-effectiveness of a safety measure. The most cost-effective measures by investigated industries were: provide the workers with protective footwear in metal industry; the analysis of the spectrum of noise in printing industry; analysis of chemicals in the workrooms' air (risk analysis of chemicals) in plastic industry; the analysis of chemicals and medical examinations of workers in wood processing industry; advanced training of workers to prevent the injuries with fingers in garment industry. The safety policy and safety plan that set the framework for health and safety activities in enterprises are usually not available in written form in Estonian firms. In addition, there is a need for raising the awareness of workers in the field of occupational health and safety. Supervisory participation, motivation and training were the activities that received quite low scores. The recommendations to the employers were given: to improve the information of workers, motivation to use the personal protective equipment and to carry out continuing training of workers as well as the leaders in work safety and health.

Keywords**:** *safety management, OHSAS 18001, improvement of safety level, cost-effectiveness of safety measures.*

Introduction

The quality of life is very much depended on the work and living environment (Akranaviciute et al, 2007; Ruzevicius, 2009). The number of work accidents shows the level of safety culture in the enterprise. The economic losses due to accidents are the indicators to the employers where and how they have to invest to decrease the number of accidents. These data are not easily accessible from the State Sickness Fund in Estonia and they are publicly available only in recent years (Ministry, 2006). The outline reveals, that the increasing trend is shown among the people who receive compensation for damages related to occupational accidents and diseases (in 2003 – 1646 persons, in 2004 – 1745 persons and in 2006 – 2216 persons), but the costs for those damages has remained rather stable during 2003 and 2006 (34.5 million EEK) as well as the occupational accident benefit costs (21 million EEK). However, these data do not contain the indirect costs of accidents and diseases (the costs for hiring the substitute labour, training for the job, the lost or degraded production quality etc.).

Theoretical background

Safety culture (the indicator of a safety level) in enterprises is dependent on the employers' attitude to safety and health of workers (Arezes et al, 2003; Clarke, 2000; Järvis, 2009a, 2009b, 2009c; Paté-Cornell, 1994; Winder, 2007). Safety culture has different levels. In the first level, an organisation is not even interested in safety and has to make the first step to include safety as a necessary element into the management system of the enterprise. A subsequent level is one in which safety issues begin to acquire importance, often driven by both internal and external factors as a result of having many incidents. At this level, top management believes accidents to be caused by the stupidity and inattention of their employees. The next level involves the recognition that safety does need to be taken seriously. The term calculative is used to stress that safety is calculated; quantitative risk assessment techniques and overt cost-benefit analyses are used to justify safety and to measure the effectiveness of proposed measures. The upper level of safety culture is called as generative and involves a much more proactive approach to safety. It could be characterised with good practice in safety management (Cooper, 2002, 2004; Hudson, 1999; Morris, 1974; Nienaber et al, 2008; Reid, 2000).

In the present study the results of assessment the safety management system in 12 medium- and small-scale enterprises (from printing, mechanical, plastic, wood and

garment industries) in Estonia during 2002-2008 is presented. The methods of the analysis are described by Kuusisto (2000): Diekemper & Spartz (1970), Chase (Glendon, 1995) and others. Preventive safety measures were pointed out and the cost-effectiveness of these measures was calculated (Reinhold et al, 2009; Liu et al, 2000; Miller, 2000; Abrahamsen et al, 2009).

The occupational health and safety legislation in Estonia is mainly based on two documents: EU Council Directive No. 89/381/EEC and Standard No. BS 8800:1996 (BSI, 1996). According to the BS 8800:1996 a status review should compare the company's current arrangements with the applicable legal requirements, organization's current safety guidelines, best practices in the industry's branch and the existing recourses directed to safety activities. The Occupational Health and Safety Standard OHSAS 18001 was published in Estonian in 2006 and is implemented only in some of the enterprises, mainly with foreign origin. The implementation of the standard OHSAS 18001 improves the safety level at enterprises considerably and is associated with the improvement of all the management system of the enterprise (Zeng et al, 2010).

The research problem: the improvement of safety culture at an enterprise.

The research objective: to show that safety measures have to be assessed and implemented according to their importance and cost-effectiveness.

The scientific novelty: the cost-effectiveness of safety measures takes into account the uncertainty of the measures.

The research method: Modified Diekemper & Spartz method (Kuusisto, 2000) was used for the assessment the safety management system at an enterprise, and the Roed (2009) method was used for calculating the costs of safety measures in the present study.

Methodology

Safety auditing is a similar procedure to the auditing of quality and environmental management systems (Ruzevicius, 2009). Several methods have been developed for supporting safety auditing. These methods include questionnaires, interviews, observations and document reviews.

The safety management system at enterprises can be assessed through internal audits (carried out by the employer or safety personnel of the enterprise) and external audits (carried out by the officials of labour safety or certification bodies).

The original safety level assessment method in enterprises was worked out by Diekemper & Spartz (D&S) in 1970. The method used in the present study has been modified by Kuusisto (2000) considering the demands of the occupational health and safety management systems standard OHSAS 18001 (2007) and by the authors of the present paper taking into consideration the state of work safety and health in Estonia. The modified D&S method addresses 30 activities ((Kuusisto, 2000; Tint, 2010). These are divided into the following activity areas:

1. A* - organization and administration;
2. B* - industrial hazard control;
3. C* - fire control and industrial hygiene;
4. D* - supervisory participation, motivation and training;
5. E* - accident investigation, statistics and reporting procedures.

The assessment is carried out in four level system: level 1(poor); level 2 (fair); level 3 (good); level 4 (excellent).

The methods for calculating the costs of safety measures are limited (Abrahamsen et al, 2009; Aven, 2003; Miller, 2000; Philips et al, 2006; Roed et al, 2009; Skjong et al, 2004; Tam et al, 1998; Whynes, 2006). The method proposed by Roed was used in the present study as it takes into account the reliability of safety measures. The cost-effectiveness of safety measures could be calculated considering three factors: the expected cost of the measure C; the effect of safety measure Z (using Likert scale: 0...5) and the uncertainty of the measure N (0...1). The scale for expected cost (EEK) of the measures is divided as follows: very low cost- <5000; low cost- ≥5000 and <10.000; medium cost- ≥10000 and <50.000; high cost- ≥50.000. The problem of using these expected values is that the expected values are conditional and could produce poor predictions of the real outcomes. As a result, uncertainties need to be taken into account in addition to the expected values. High uncertainty may indicate that the expected risk reducing effect can give a poor prediction of the real risk reducing effect. For uncertainty dimension, three categories are used: 1) low uncertainty: the phenomena involved are well understood; the assumptions made are seen very reasonable; there is broad agreement among experts; 2) high uncertainty*:* the phenomena involved are not well understood; there is lack of agreement among experts; the assumptions made represent strong simplifications; 3) medium uncertainty*:* the phenomena involved are well understood, but the models used are too simple.

Results

The results of the assessment of a safety management system in printing, mechanical, textile, plastic and wood industry are given in Table 1. Case I-1 (Table 1) was carried out in a medium-size printing enterprise situated in a new building in Tallinn. The factory has invested a great deal to improve the status of premises. The company had no safety manager; the duties were directed to the personnel manager, who had the responsibility for environmental risks and security system's management as well. The main types of accidents occurred in the company were slips, pinching of fingers and back injuries. The other two companies carrying out the printing activities are small-scale and the work was carried out in old buildings (particularly Case I-3). The safety level scores are the lowest in Case I-3 (floor not cleaned during the workday, the raw material and finished products standing on the pathways for workers, the strong smell of printing chemicals etc.). The highest scores in the Case I-1 were given to part B - industrial hazard control (15.0: workers were equipped with personal protective equipment, good storage of materials, material handling- manual and automated etc.), the lowest one (9.3) was given to the part E (accident investigation). The E part was the lowest for all investigated companies as the near-accident investigation

was not performed in any of the companies. Part D obtained the score 11.4: safety training was carried out on a regular basis, but no written handouts or programme for internal audits were presented. In most cases, new employees were trained by senior workers. Case II (mechanical processing industry) was carried out in two medium scale factories producing two-wheeled trailers for passenger cars and other metal parts to machines. The welding process was the most hazardous activity in both factories. It was carried out in the poorest conditions in Case II-1(in the building made of silica brick, without ventilation). The number of accidents showed a decreasing trend in this factory. The workers were complaining on back injuries caused by lifting tasks. These injuries were typically caused by sharp pieces of sheet metal. The interest from the side of management was obvious. The highest scores in the Case II-1 (from 10.5 to 9.2) were given to the parts A to D. The lowest score was obtained for the part E: neither accident statistics nor near-accident investigation took place in the company. Vast attempts were taken by the management to improve the ventilation in welding activities, but some re-arrangements are still possible for cleaning the air in the breathing zone of workers. The respirators were used during the welding work. Case III (plastic industry) was carried out in a medium-scale company in the countryside, where it hired a lot of people with the lowest salary, but the people very satisfied to have at least the job. In the Case III-1 the factory was producing rubber products for car industry situated abroad (Germany). The quality control of these products (package rings included) needs very good eye-sight from workers. Therefore, only the girls at the age 18-25 years not wearing eye-glasses were hired to work in the control-rooms. The plastic firm only planned to send the workers to the medical examinations after the reviewing of the risk assessment results. The highest score in safety for this factory (12.5) was got in the part B (housekeeping, machine guarding etc.) as the machines where new, premises good as the factory itself is only 2 years old. The lowest score (6.7) was received in the part E as there were no accident cause analysis nor near-accident investigation organized in the factory. The other two plastic factories are situated in the capital of Estonia and equipped with better workrooms and the attention from the side of employers for the improvement of work conditions in the Case III-2 was very obvious. The risk analysis were ordered from external firms and some rehabilitation possibilities were offered for workers (like spa, massage). In the Case III-3 the workrooms were new, but the knowledge of workers on used chemicals was non-existent. The workers could not make difference between the alkalis and acids. This caused a serious accident (a worker inhaled accidentally vinegar acid and got an occupational disease). The Cases in the group IV were carried out in the wood processing industry, one of them was a medium-scale firm and two other firms were small-scale. There are a lot of hazards in wood processing industry: sharp tools and parts of machines, wood dust in the air of workrooms, wood parts on the floor, and noise from machines and ventilation system. In the Case IV-3 very much was invested in the ventilation system, particularly installing the local ventilation systems. The safety training of workers was carried out periodically (3 times a year) in all three companies. The air muffs and plugs were used properly. Garment industry (Cases V-1) is spread very widely in Estonia, but it is mostly owned by foreigners and therefore it is difficult to get into these factories. The air of the garment industry (Case V-1) was clean (the content of textile dust < 2mg/m^3). The workers were not keen on wearing air plugs, but all other personal protective equipment was worn correctly. The accidents in the Case V-1 were investigated in depth and corrective measures were effectively implemented. Applying job hazard analysis for the detailed work procedures in the companies showed, that in most cases, truck driving and welding were seen as special and potentially hazardous tasks. Training for specialized operations was given in all companies. None of the investigated companies had prepared a written safety policy. Safety communication between supervisors and employees was observed to be insufficient. In all companies management reviewed the accident reports, but it was unclear if the blue-collar workers received the information about the results of the investigation. The machine guards were in place and hazards seemed to be under control. Usually supervisory participation, motivation and training were the activities that received quite low scores in Estonian companies. The recommendations to the employers were given which included the improvement of information arrival for the workers, motivation to use the personal protective equipment and the consistent training of workers and leaders in work safety and health. The results of assessment of the assessment of safety system are given in Table 1.

The results of calculation of cost effectiveness of the investigated industries are given in the following form: expected cost /effectiveness of safety measure - uncertainty (C/Z-N). The data for the metal processing industry were obtained as follows (Figure 1):

1) Installation of a wall around the guillotine saw (C/Z-N): 20.000/4-0.5
2) Installation of raw materials and half-products properly, not on the walking area: 1000/3-0.5
3) To modernize washing rooms: 150.000/5-0.1
4) Re-arrangement of the local-ventilation equipment for welding activities: 40.000/2-0.8
5) Analysis of chemicals hazardousness by welding activities:10.000/4-0.1
6) Provide the workers with protective footwear: 40.000/4-0.8.

The most cost-effective of previously listed safety measures is No.6 as the uncertainty is very high (we do not exactly know how many hazardous situations may occur in the metal industry).

The data for the printing industry (Figure 2):

1) Analysis of the spectrum of noise: 3000/5-0.9
2) Selection of hearing protectors by the frequency of noise: 10.000/4-0.5
3) Re-arrangement of lighting for the newspapers' quality control: 10.000/3-0.8
4) Re-arrangement of manual lifting of loads (use the ideas of workers): 4000/3-0.5

5) Dry cleaning of the floor twice a day (instead of one): 500/1-0.9

6) Wet cleaning of the floor: 20.000/5-0.5.

The most cost-effective safety measure in printing industry is No. 1 as we do not know what the spectrum of noise from the printing machines is and therefore the selection of noise protectors is until now occasional. Noise is the most unpleasant hazard in the printing industry.

The results in the plastic industry (Figure 3) were as follows:

1) Analysis of chemicals in the workrooms' air (risk analysis of chemicals): 10.000/5-0.9

2) Separation of eateries from the industrial area with the wall and installation with the exhaust ventilation: 30.000/3-0.3

3) Installation of the local ventilation to every press machine: 300.000/4-0.7

4) Regulation of the ventilation (prevention of draught in the floor region): 500/4-0.7

5) Medical examination every year (as the monotonous work may cause musculoskeletal disorders): 300 per worker; 30.000 per 100 workers/3-0.7

6) Information, training and knowledge management of workers for finishing the eating at workplaces (by the press-machines): 2.000/5-0.9.

The most cost-effective measure in plastic industry is measure No. 1 (the analysis of chemicals in the workroom's air).

In the wood processing industry (Figure 4) the results were obtained as follows:

1) Training of workers on health risks: 5.000/4-0.9

2) Wet cleaning of the room two times per day: 10.000 per year/3-0.9

3) Installation of the local ventilation so that there will not be wood dust in the inhalation zone of the worker: 100.000/4-0.7

4) To modernize the washing rooms: 60.000/3-0.8.

5) Medical examinations possibility every year: 300 EEK per worker, 30.000 EEK per 100 workers/3-0.8

6) Analysis of chemicals used for wood treating from the side of health hazardousness: 10.000/4-0.8.

The most cost-effective measures in wood processing industry are measures No.5 and 6- analysis of chemicals and medical examinations of workers.

In the garment industry (Figure 5) the scores were as follows:

1) Advanced training of workers to prevent the injuries with fingers: 5000/5-0.8

2) To modernize the washing rooms: 30.000/3-0.5

3) Improvement of microclimate of workrooms in summer (too hot): supplementary ventilation: 60.000/3-0.5

4) Two times a day the wet cleaning of floor: 10.000/3-0.5

5) Medical examination every year for prevention of physical overload traumas (compulsory position): 300 per worker, 30.000 per 100 workers/3-0.8

6) Supplementary training of workers for use of hearing protectors and proper footwear, chosen by the workers themselves: 1.000 per worker, 50.000 per 50 workers /4-0.5.

The most cost-effective safety measure in garment industry is No.1- advanced training of workers to prevent the injuries with fingers.

The uncertainty of the measure is higher if we do not exactly know what effect of safety measure will be. The example: the wet cleaning of the floor in printing industry is more effective than dry cleaning as the latter may only circulate dust in the room.

Table 1

Results of auditing of safety system in Estonian enterprises

Category	**A***	**B***	**C***	**D***	**E***	Total score[0]	Likert scale, 0.....5
Printing industry, I							
Case I-1, 162 workers	12.7	15.0	11.0	11.4	9.3	59.4	3.96
Case I-2, 24 workers	7.8	12.5	11.0	11.4	9.3	52.0	3.60
Case I-3, 30 workers	5.0	10.0	10.0	9.2	6.7	40.9	3.05
Mechanical industry, II							
Case II -1, 136 workers	10.5	10.0	10.0	9.2	6.7	46.4	3.32
Case II-2, 360 workers	12.7	12.5	11.0	9.2	9.3	54.7	3.74
Plastics industry, III							
Case III-1, 160 workers	8.9	12.5	10.0	11.4	6.7	49.5	3.48
Case III-2, 10 workers	13.2	15.0	14.0	11.4	9.3	62.9	4.15
Case III-3, 19 workers	7.8	12.5	12.0	9.2	6.7	48.2	3.41
Wood processing industry, IV							
Case IV-1, 300 workers	7.8	10.0	10.0	11.4	6.7	45.9	3.30
Case IV-2, 23 workers	8.9	10.0	10.0	9.2	9.3	47.4	3.37
Case IV-3, 15 workers	10.5	12.5	12.5	11.4	9.3	55.7	3.79
Textile industry, V							
Case V-1, 160 workers	13.2	15.0	14.0	9.2	9.3	60.7	4.04

[0] *Maximum score in each area (A, B, C, D, E) is 20. Maximum total score is 100.*

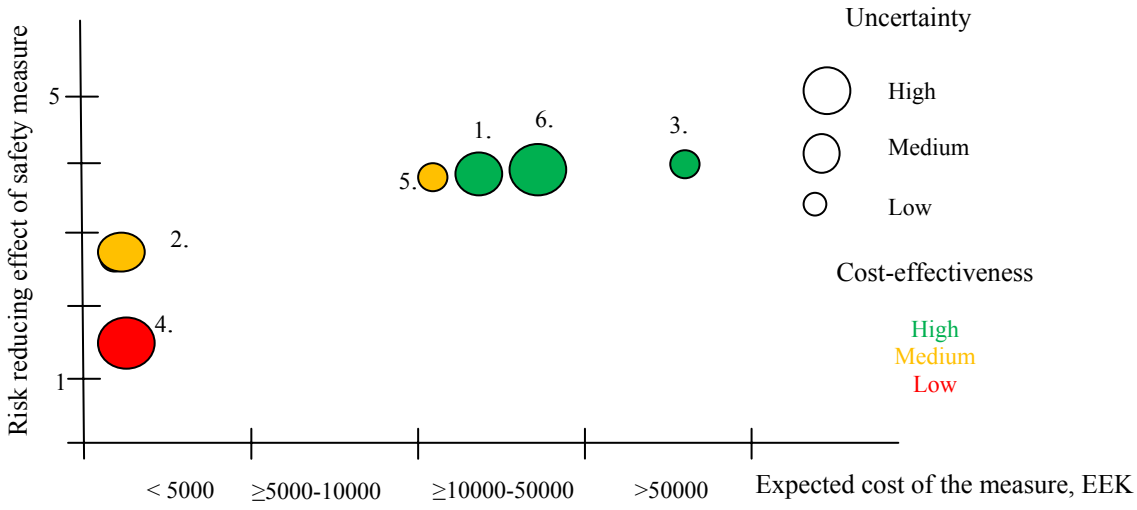

Figure 1. Cost-effectiveness of safety measures in metal processing industry

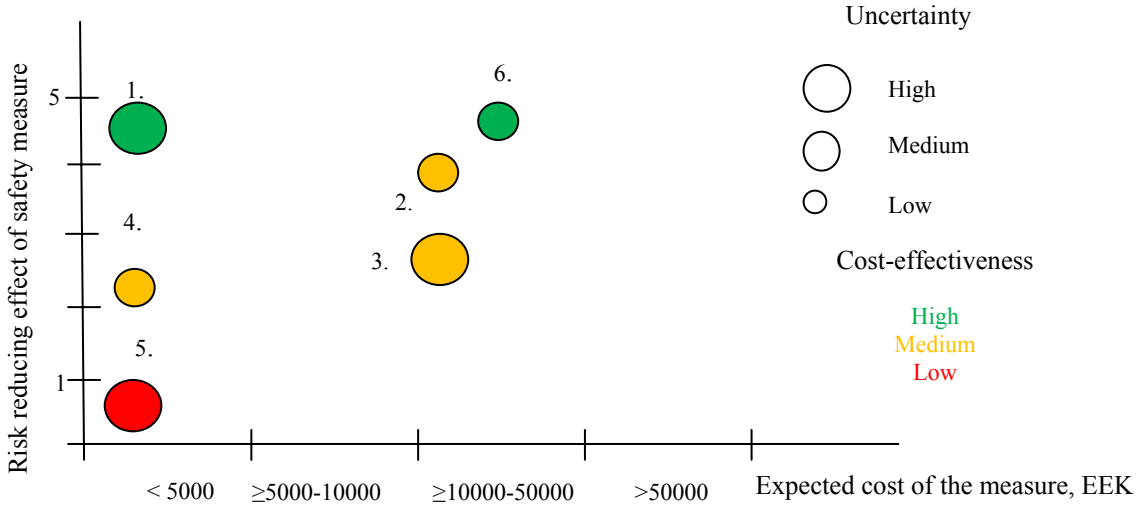

Figure 2. Cost-effectiveness of safety measures in printing industry

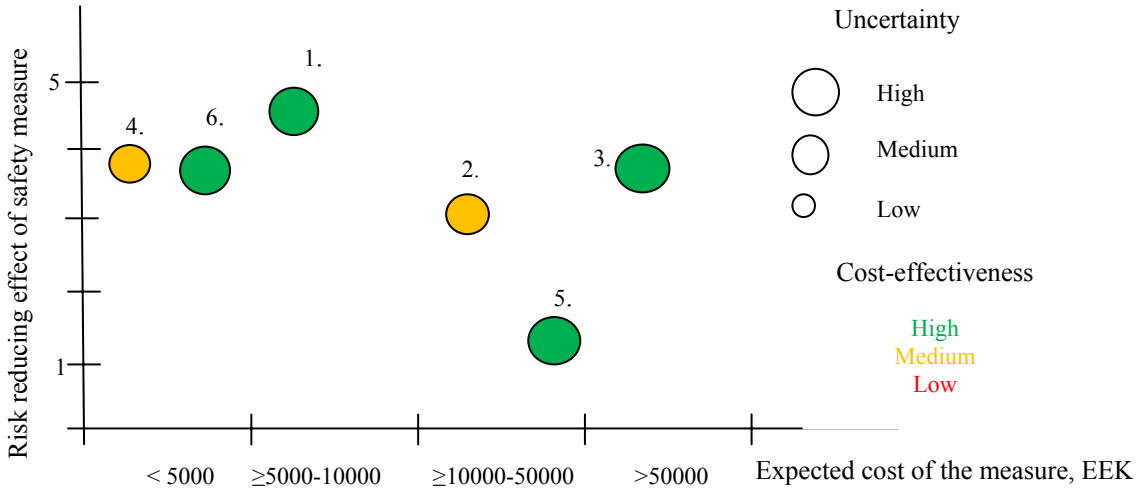

Figure 3. Cost-effectiveness of safety measures in plastics industry

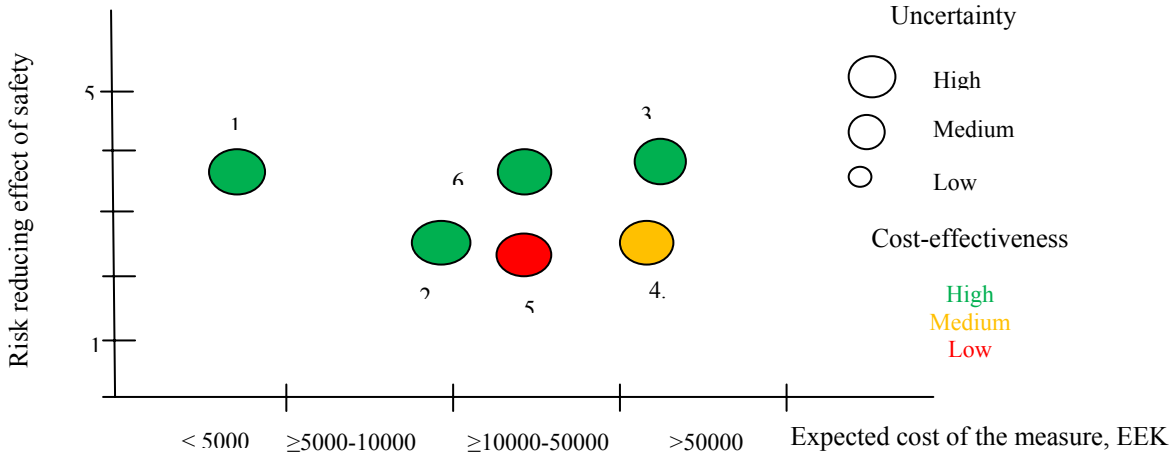

Figure 4. Cost-effectiveness of safety measures in wood processing industry

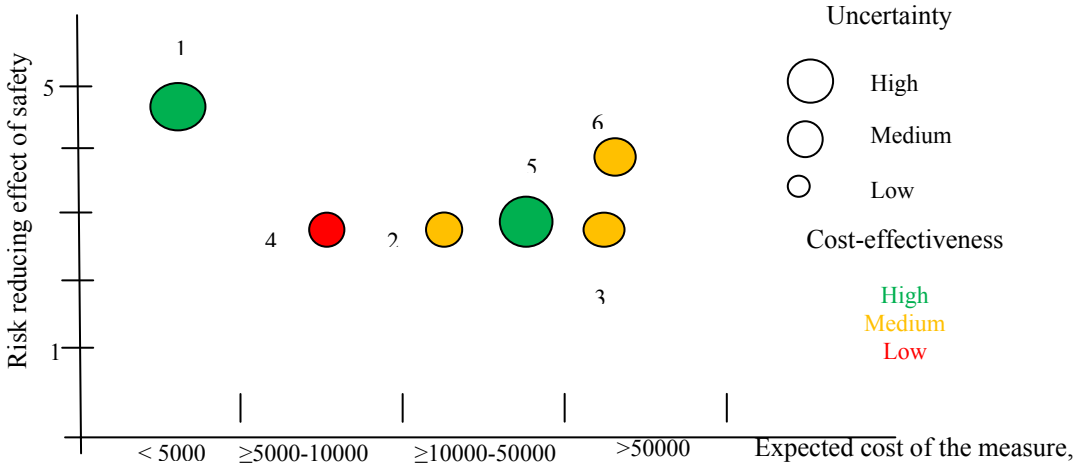

Figure 5. Cost-effectiveness of safety measures in garment industry

Conclusions

The investigation was carried out in 12 Estonian enterprises (metal and wood processing, printing, plastic and garment industries); the safety system used in these enterprises was assessed, the risk prevention measures were determined and the cost-effectiveness of these safety measures was calculated. The safety culture is very much dependent on the safety management in enterprises, the involvement of top managers in safety and health. The cooperation between the top management, work environment specialist, occupational health doctors and workers is also very important. Big enterprises have more possibilities to invest into safety and improve the safety level in the firm. Safety culture has different levels. In the first level, an organisation is not even interested in safety. A subsequent level is one in which safety issues begin to acquire importance. At this level, top management believes accidents to be caused by stupidity and inattention of their employees. The next level involves the recognition that safety does need to be taken seriously. The upper level of safety culture involves a much more proactive approach to safety. It could be characterised with good practice in safety management.

The cost-effectiveness of safety measures is dependent on the uncertainty of safety measure. If the measure concerns more than one worker then the uncertainty is higher, but the measure can be more cost-effective as it improves working conditions of more than one person. In wood processing industry the safety measures taken have all the uncertainties from medium or high, but for example to raise the frequency of a periodical medical examination from once in two years to once every year does not give the desired effect, so that kind of measure (No.5 in wood processing industry) is not cost-effective. There are other not cost-effective measures, like two times per day wet-cleaning of the floor in garment industry (measure No. 4). There is no dust over the exposure limit or even not dust smell in the air of the work environment. Organizing safety measures in enterprises, the manager is not allowed to look only on the cost of the measure, but has to assess also the

effectiveness of the measure and the number of workers who will benefit by the measure.

Safety policy and safety plan that set the framework for health and safety activities in enterprises are usually not available in a written form in Estonian firms. In addition, the information about hazards connected with used chemicals is often not available at workplaces and the workers are not trained to use the chemical safety cards. There is a need for raising the awareness of workers in the field of occupational health and safety by the compilation of relevant guidelines and fact sheets. Supervisory participation, motivation and training were the activities that received quite low scores. The recommendations for the employers were given: to improve the information of workers, motivation to use personal protective equipment and to carry out continuing training of workers as well as leaders in work safety and health.

References

Abrahamsen, E. B., & Aven, T. (2009). Communication of cost-effectiveness of safety measures by use of a new visualizing tool. *Reliability & Risk Analysis: Theory and Applications*, 2(4), 38-46.

Akranaviciute, D., & Ruzevicius, J. (2007). Quality of Life and its Components' Measurement. *Inzinerine Ekonomika-Engineering Economics*(2), 44-49.

Arezes, P., & Miguel, A. (2003). The role of safety culture in safety performance measurement. *Measuring Business Excellence, 7(4), 20-28.*

Aven, T., & Korte, J. (2003).On the use of cost/benefit analysis and expected utility theory to support decision-making. *Reliability Engineering and System Safety*, 79, 289-299.

British Standards Institution (BSI). (1996, 2004). *Guide to occupational health and safety management systems* (Standard No. BS 8800:1996), London.

Clarke, S. (2000). Safety Culture: underspecified and overrated. *International Journal of Management Reviews, 2(1), 185-198.*

Cooper, M. D. (2002). Safety Culture. A model for understanding & quantifying a difficult concept. *Professional Safety*, June, 30-36.

Cooper, M. D., & Phillips, R. A. (2004). Exploratory analysis of the safety climate and safety behaviour relationship. *Journal of Safety Research*, 35, 497-512.

Diekemper, R. F., & Spartz, D. A. (1970). A quantitative and qualitative measurement of industrial safety activities, *ASSE Journal*, Dec, 12-19.

Glendon, I. (1995). Safety auditing. *Journal of occupational health and safety- Australia and New Zealand* 11(6), 569-575.

Hudson, P. (1999). Safety culture – theory and practice. Presented at the workshop on "The human factor in system reliability – is human performance predictable?" Siena, Italy, 1-2 December 1999.

Järvis, M., & Tint, P. (2009a). Innovations at workplace: an evidence-based model for safety management. *Business: Theory and Practice,* 10(2), 150-158.

Järvis, M., & Tint, P. (2009b). The formation of a good safety culture at enterprise. *Journal of Business Economics and Management*, 10(2), 169-180.

Järvis, M., & Tint, P. (2009c). Employment, cultural differences and work safety: Estonia example. *Economics and Management,* 14, 567-574.

Kuusisto, A. (2000). *Safety management systems. Audit tools and reliability of auditing*. Publications 428; Espoo, Finland: VVT (Technical Research Centre of Finland).

Liu, L., Strawderman, R. L., Cowen, M. E., & Shih, Y. C. (2000). A flexible two-part random effects model for correlated medical costs. *Journal of Health Economics*, 29, 110-123.

Miller, P., Whynes, D., & Reid, A. (2000). An economic evaluation of occupational health. *Occupational Medicine*, 50(3), 159-163.

Morris, P. A. (1974). Decision analysis expert use. *Management Science, 20(9),* 1233.

Ministry of Social Affairs. (2006). *Social sector in numbers*. Tallinn, 47-54 (in Estonian).

Nienaber, H., & Roodt, G. (2008). Management and leadership: Buccaneering or science. *European Business review,* 20(1), 36-50.

Paté-Cornell, M. E. (1994). Quantitative safety goals for risk management of industrial facilities. *Structural Safety,* 13, 145-157.

Philips, Z., Whynes, D. K., & Avis, M. (2006). Testing the construct validity of willingness to pay valuations using objective information about risk and health benefit. *Health Economics,* 15(2), 195-204.

Reid, S. R. (2000). Acceptable risk criteria. *Progress in Structural Engineering and Materials*, 2, 254-262.

Reinhold, K., Tint, P.,Tuulik, V., & Saarik, S. (2008). Innovations at Workplace: Improvement of Ergonomics. *Inzinerine Ekonomika-Engineering Economics*(5), 85-94.

Roed, W. (2009). Evaluation of safety measures in road tunnels based on cost-effectiveness analysis. *Reliability,*

Risk and Safety: Theory and Applications- Bris, Guedes Soares & Martorell (eds.). Taylor & Francis Group, London, 993-998.

Ruzevicius, J. (2009). Environmental Management Systems and Tools Analysis. *Inzinerine Ekonomika-Engineering Economics*(4), 49-59.

Skjong, R., & Ronald, K. O. (2004). Criteria for cost effectiveness of safety measures. *Journal of Offshore Mechanics and Arctic Engineering*, 1, 129-134.

Tam, C., Fung, I. 1998. Effectiveness of safety management strategies on safety performance in Hong Kong. *Construction Management and Economics 16,* 49-55.

Whynes, D. K., Frew, E. J., & Wolstenholme, J. L. (2006). Willingness-to-pay and demand curves: a comparison of results obtained using different elicitation formats. *International Journal of Health Care Finance and Economics,* 5(4), 369-386.

Winder, C., & Makin, A. M. (2007). Problems in organisational management: A new category of hazards. *Risk, Reliability and Safety*. Aven & Vinnem (eds.). Taylor & Francis Group, London, 1293-1297.

Zeng, S. X., Tam, W. Y. T., Le, K. N. L. (2010). Towards Effectiveness of Integrated Management Systems for Enterprises. *Inzinerine Ekonomika-Engineering Economics,* 21(2), 171-179.

Piia Tint, Õnnela Paas, Karin Reinhold

Saugumo priemonių sąnaudų efektyvumas įmonėse

Santrauka

Buvo ištirta 12 Estijos įmonių (medžio ir metalo, apdirbimo, spausdinimo, plastmasių ir drabužių pramonės), įvertintos šių įmonių saugos sistemos, nustatytos rizikos išvengimo priemonės, apskaičiuotas šių saugumo priemonių sąnaudų efektyvumas. Saugumo kultūra labai priklauso nuo to, kaip įmonės organizuoja saugumą, ar vyriausieji vadybininkai įtraukiami į saugumo ir sveikatos apsaugos procesus. Labai svarbu bendradarbiauti vadybininkams, darbo aplinkos specialistams, sveikatos apsaugos gydytojams ir darbuotojams. Didelės įmonės turi daugiau galimybių investuoti į saugumą ir taip pagerinti firmos saugumo lygį. Saugumo kultūros lygiai yra įvairūs. Pirmame lygyje saugumu, nesidomima. Antrame lygyje saugumo problemos įgyja prasmę. Šiame lygyje vadovai tiki, kad nelaimingų atsitikimų gali įvykti dėl darbuotojų kvailumo ir neatidumo. Dar kitame lygyje suvokiama, kad saugumą reikia vertinti rimtai. Aukščiausiame saugumo kultūros lygyje reikalaujama ypač rimto požiūrio į priemones.

Tiriamose įmonėse darbuotojų buvo nuo 15 iki 360, t.y. buvo tiriamos smulkaus ir vidutinio verslo įmonės. Saugumo lygis šiose įmonėse skiriasi. Estijos sostinėje Taline esančios įmonės turi daugiau galimybių investuoti į darbo aplinką nei priemiesčio organizacijoms. Diekemperio ir Spartzo metodas buvo taikomas saugumo lygiui įmonėse nustatyti, o Roedo metodas padėjo nustatyti ir įvertinti saugumo priemonių sąnaudų efektyvumą.

Diekemperio ir Spartzo metodas apima 30 veiksnių, kurie suskirstyti į penkias veiklos sritis: A – organizacija ir administracija; B – pramonės rizikos kontrolė; C – gaisrų ir pramonės higienos kontrolė; D – vadovų dalyvavimas, motyvacija ir rengimas; E – nelaimingų atsitikimų tyrimas, statistikos ir ataskaitų procedūros. Veiksniai, kurie buvo įvertinti A srityje yra šie: politikos teiginiai, tiesioginis valdymas, saugumo instrukcijos, darbo vietų modeliavimas, avarijų ir nelaimių kontrolės planai, įmonės saugumo taisyklės, veiksmų numatymas, saugumo organizavimo struktūra, sveikatos apsauga. B srityje saugumo veiksniai buvo šie: žaliavų ir produktų sandėliavimas, technikos priežiūra, bendras darbo aplinkos saugumas, rankiniai įrankiai, rankinis ir automatinis medžiagų apdorojimas, asmeniniai saugumo įrenginiai. C srityje įvertinti šie veiksniai: cheminio pavojaus kontrolės atvejai, užsidegančių ir sprogstamųjų medžiagų sandėliavimas, pavojingų kvapų, dūmų ir dulkių kontrolė, odos pažeidimų ir ugnies kontrolės priemonės. D srityje esantys saugumo veiksniai šie: vadovų saugumo mokymas, naujų tarnautojų švietimas, darbo pavojų analizė, specialių operacijų mokymas, vidaus tikrinimo operacijos, saugumo užtikrinimas ir viešumas, tarnautojų / vadovų saugumo kontaktai. E srityje vertinami šie veiksniai: avarijų analizė, priežasčių tyrimas ir statistika, nelaimingų atsitikimų numatymas.

Tyrimas buvo vykdomas pagal keturių lygių sistemą: pirmas lygis (blogas), antras lygis (patenkinamas), trečias lygis (geras), ketvirtas lygis (puikus). Rezultatai pateikiami procentais, taip pat taikant Likerto sistemą (0...5). Rezultatai rodo, kad, jeigu įmonė valdoma pagal įstatymus ir ji rūpinasi savo darbuotojų gerove, tai saugumo kultūros lygis yra aukštesnis mažose įmonėse, kuriose nėra išsilavinusių darbuotojų sveikatos ir saugumo srityje, o darbo aplinkos gerinimo resursai yra mažesni. Maksimalus saugumo lygis – 100 proc., taikant Diekemperio ir Spartzo metodą. Saugumo lygis tiriamose įmonėse – 40,9 – 62,9, o remiantis Likerto skale (0...5), įvertinimas – 3,05 – 4,15. Taigi saugumo lygį laisvai galima kelti.

Saugumo priemonių efektyvumas (Roedo metodas) gali būti apskaičiuotas atsižvelgiant į tris veiksnius: tikėtini C lygio sąnaudų matavimai, saugumo priemonės, kurios įeina į Z lygį (taikant Likerto skalę 0...5), ir priemonės N netikrumas (0...1).

Galimų sąnaudų matavimų skalė yra ši: labai mažos sąnaudos – <5 000; mažos –≥5 000; vidutinės – ≥10 000 ir <50 000; didelės – ≥50 000.

Šių prognozuojamų reikšmių problema yra ta, kad tikėtini dydžiai yra sąlyginiai ir gali neteisingai prognozuoti tikrus rezultatus. Taigi neapibrėžtumai turi būti įvertinti kartu su tikėtinais rezultatais. Didelis netikrumas gali rodyti, kad galima rizika prognozuojama, jog tikra rizika sumažės.

Neapibrėžtumo dimensija apibrėžiama trimis kategorijomis:

1) žemu neapibrėžtumo lygiu: su tuo susiję reiškiniai gerai suprantami; prielaidos yra labai protingos; ekspertai labai sutaria;
2) aukštu neapibrėžtumo lygiu: su tuo susiję reiškiniai nėra gerai suprantami, ekspertai nesutaria; prielaidos yra labai supaprastintos;
3) vidutiniu neapibrėžtumu lygiu: reiškiniai yra gerai suprantami, bet taikomi modeliai yra labai paprasti.

Saugumo priemonių efektyvumo priemonės (Roedo metodas) priklauso nuo saugumo priemonių neapibrėžtumo. Jeigu priemonė susijusi su daugiau nei vienu darbuotoju, netikrumas yra didesnis, tačiau ji gali būti efektyvesnė, nes gerina daugiau nei vieno darbuotojo darbo sąlygas. Medžio apdirbimo pramonėje saugumo priemonės yra susijusios su visais neapibrėžtumo lygiais (nuo vidutinio iki aukščiausio). Tačiau tai, kad padaugėja medicininės apžiūros nuo vieno karto kas dveji metai iki vieno karto per metus, neteikia reikiamo efekto, todėl šios rūšies priemonė nėra efektyvi.

Yra ir kitų neefektyvių sąnaudų, pvz., drabužių pramonėje drėgnas grindų valymas du kartus per dieną. Nesijaučia net dulkių kvapo darbo aplinkoje. Organizuojant saugumo priemones įmonėse, vadybininkas negali vertinti tik priemonių sąnaudų, jis turi įvertinti priemonės efektyvumą ir darbuotojų skaičių, kurie gaus naudos iš tos priemonės.

Efektyviausios priemonės tiriamose įmonėse buvo šios: aprūpinti darbuotojus apsauginiu apavu metalo pramonėje, analizuoti triukšmo spektrą spausdinimo pramonėje, tirti chemikalus, tvyrančius darbo vietos ore, plastmasės pramonėje, analizuoti chemikalus, taip pat darbuotojų sveikatos būklę medžio apdirbimo pramonėje, mokyti darbuotojus, kaip išvengti sužeidimų drabužių pramonėje. Taikant saugumo priemonių efektyvumo įvertinimo metodą, gerai panaudotų saugumo priemonių sąnaudos tampa efektyvios, saugumas tampa patrauklesnis tiek vadybininkams, tiek darbo aplinkos specialistams, taip pat didėja valstybinių institucijų teisinė atsakomybė. Saugumo politika ir saugumo planai, kurie sudaro sveikatos ir saugumo veiksmų pagrindą, Estijos įmonėse raštu nėra pateikti. Be to, informacija apie pavojus, susijusius su chemikalais, dažnai nėra pasiekiama darbo vietose, o darbuotojai nėra informuojami, kaip pasinaudoti saugumo priemonėmis. Darbuotojams reikia gilinti žinias sveikatos ir saugumo srityse pateikiant reikiamus nurodymus ir faktus. Vadovavimas, motyvacija ir švietimas yra tos sritys, kurios buvo vertinamos prasčiausiai. Rekomendacijose buvo nurodoma, kaip gerinti darbuotojų informatyvumą, kelti motyvaciją naudojant asmeninius apsaugos įrenginius, taip pat šviesti darbuotojus ir kelti vadovų kvalifikaciją darbo ir sveikatos apsaugos srityje.

Raktažodžiai: *saugumo valdymas, OHSAS 18001, saugumo lygio gerinimas, saugumo priemonių sąnaudų efektyvumas.*

The article has been reviewed.

Received in February, 2010; accepted in December, 2010