

Improvement of Managers' Safety Knowledge through Scientifically Reasonable Interviews

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Abstract – The safety management system has been analysed in 16 Estonian enterprises using the MISHA method (Method for Industrial Safety and Health Activity Assessment). The factor analysis (principal component analysis and varimax with Kaiser analysis) has been implemented for the interpretation of the results on safety performance at the enterprises implementing OHSAS 18001 and the ones that do not implement OHSAS 18001. The division of the safety areas into four parts for a better understanding of the safety level and its improvement possibilities has been proven through the statistical analysis. The connections between the questions aimed to clarify the safety level and performance at the enterprises have been set based on the statistics. New learning package “training through the questionnaires” has been worked out in the current paper for the top and middle-level managers to improve their safety knowledge, where the MISHA questionnaire has been taken as the basis.

Keywords – Factor analysis, Kaiser normalization, learning through the questionnaires, safety management.

I. INTRODUCTION

The knowledge about the health and safety risks at the workplace is an urgent requirement for the top and middle-level managers. To deal with the hazards to health or to minimise the potential major accident risks, there is the need for the understanding of the key issues in the standards of health and safety risk management. It includes the understanding of legal requirements, good practice and the organisational and cultural issues, such as leadership and communication skills [1]. Since the mid-1980s, an intensive development of concepts and models of OHS management systems (OHS MSs) has been observed, including OHSAS 18001 [2], [3]. OHSAS 18001 provides detailed, but non-mandatory requirements for designing, implementation and conformity assessment of OHS MSs. The requirements in the standard are aimed at reducing the number of the work accidents, near misses and occupational diseases, and decreasing associated economic losses. A review of the literature on the OSH MS performance in enterprises [4], [5] shows that OHSAS 18001 itself will not improve the situation as the demands are too formal: too much paperwork and formal approach to numerous enterprises, presence of certification bodies and auditor teams and high price. Therefore, there is still a need for further research regarding the measurement properties of OHS management audits [6], [7]. It is also said that OSH MS auditors focus on checking the formal compliance of system procedures with relevant criteria rather than getting the core of technical issues, human factors, and the relationship between employees and employers, which

actually provide a foundation of actions for the benefit of OHS [8]. With regard to the OHS MS audits, Blewett [9] calls straight out the re-conceptualisation of their role, since the main focus should be on the development of healthy and safe working conditions, and not on auditing the system. Therefore, the above consideration leads to the conclusion that it is necessary [10] to search for the new solutions and arrangements that would improve the performance of OHS MSs. Podgorski [10] has worked out a questionnaire that includes OHS *policy* and workers' participation; *management*: responsibilities and accountability, delivering OSH training, evaluation and improvement of OSH training programmes, OHS MS documentation, communication; *planning and implementation*: OHS goals and improvement plans, risk assessment processes, implementation of risk control measures, management of changes, emergency preparedness and response, procurement, contracting; *evaluation*: performance monitoring and measurement, investigation of work-related accidents, diseases and incidents and their impact on OHS MS audit, management review; *action for improvement*: preventive and corrective action, continual improvement. The answers are given in per cents and numbers (for example: number of OHS improvements proposed by workers or percentage of periodically verified OHS requirements applied to purchase specifications. This method is possible to implement in a big enterprise corresponding to the presence of the respective labour force. Therefore, in this study the MISHA method is more suitable for SMEs [11]; for safety audits it is modified to be as a learning package for the improvement of the safety management knowledge in safety and health in the SMEs. The basis for the development of a modified questionnaire for the interview style learning package is the investigations carried out in 16 Estonian enterprises, 8 of which implement OHSAS 18001, and 8 enterprises do not implement it. The statistical verification of the results has been carried out [12], [13]. The review on the effectiveness of the OHS MS interventions is given in [14].

The aim of the current paper is to improve the safety knowledge of the managers and to develop the “training through the questionnaires” package”.

II. LEARNING FROM INTERVIEWS

The questionnaires compiled for the assessment of safety activities at enterprises can also be a tool for learning and getting more information about safety at enterprises [15], particularly, by the top and middle-level management. The

foremen and working environment specialists (WESs) are usually more competent in safety activities and improvement possibilities. The working environment representatives' (WER) knowledge in safety matters is variable. There are several possibilities to learn through questioning: for students [16], [17], in the safety area [18], [19], the effectiveness of safety training of workers with other methods [20].

There are different scales how to measure the activities in safety performance at enterprises. The 5-point scale with the following response alternatives is usually used: "do not know what internal control is" (=1), "not started" (=2), "under way" (=3), "almost finished" (=4), and "implemented internal control" (=5) [17]. The other questionnaire [17] regarding satisfaction with the activities and the physical and psychological work environment have indices phrased as statements and ranging from "do not agree" (=1) to "agree" (=7). The coping index ranges from "never" (=1) to "often" (=7). The scores of the indices are calculated by summing the scores of single items. A higher total score indicates a higher level of psychological demands, decision authority, social support, H&S (health and safety)-related management support [17]. The satisfaction with the WE is possible to assess with the questions like "How good do you think the work environment (WE) is?"

The evaluation of the results of the interviews is very important: it has to be simple, the analysis has to be understandable and the content has to reflect all sides of the safety performance at enterprises.

III. PRACTICAL PART

In 2014, 8 OHSAS 18001-certified organisations, (group OHSAS) and 8 non-certified organisations (group NOHSAS), Estonian enterprises from different branches of manufacturing, participated in 25 interviews with employers, middle-level safety personnel and with safety responsible persons. Altogether 55 questions presented by Kuusisto [11] were asked from each of the person interviewed. The MISHA method (scale 0–3) was used for assessment as the safety auditing method [11]. The expert-interviewer (the first author of the paper) carried out the interviews.

The MISHA method consists of the following safety areas:

- A. Organisation and administration
 - A1. Safety policy
 - A2. Safety activities in practice
 - A3. Personnel management
- B. Participation, communication, and training
 - B1. Participation
 - B2. Communication
 - B3. Personnel safety training
- C. Work Environment
 - C1. Physical work environment
 - C2. Psychological working conditions
 - C3. Hazard analysis procedures
- D. Follow-up
 - D1. Occupational accidents and illnesses
 - D2. Workability of the employees
 - D3. Social work environment.

Each area gives 25 % of the total, so a maximum total score (safety level) is 100. Each safety sub-area (like A1, A2 etc.) includes different numbers of questions (from 3 to 20) according to the MISHA method. Numerical results about the safety level in OHSAS and NOHSAS companies are given in [12], [13] and they differ strongly (they are much higher in OHSAS companies).

The correlation analysis of all the questions in the MISHA questionnaire has shown that the correlation between the components of the questionnaire is very strong or strong ($R < 0.8$). The only group that is not correlated to any other is D2. Groups B1 and C2 have moderate positive correlations with other groups. All the other groups are strongly correlated with each other at a significance level of 0.01.

Statistical analysis has been performed using IBM SPSS v. 22.0. Firstly, the correlation matrix has been generated for all the variables and the analysis shows a strong correlation between the components A1, A2... to the total score, except for D2 (workability of the employees). KMO and Barlett's test of sphericity produce the Kaiser-Meyer-Olkin measure of sampling adequacy (0.83) and the Barlett's test significance (Sig. = 000). Therefore, we should be confident that the sample size is adequate for the factor analysis. The best model fit possible has been achieved after reducing the proposed safety management system scale from 12 to 9 explanatory variables structured in two subscales. The items B1, B2, C2 have finally been eliminated.

Then SPSS extracts all factors with eigenvalues greater than 1, which leaves us with two factors. Factor 1 represents questions: safety policy, safety activities in practice, personnel management, personnel safety training, physical work environment, hazard analysis procedures, occupational accidents and illnesses, social work environment; Factor 2: workability of the employees. Factors are uncorrelated.

A. Only Enterprises Implementing OHSAS (OHSAS)

The best model fit has been achieved after reducing the proposed safety management system scale from 12 to 11 and structuring explanatory variables in four subscales. The item finally eliminated is B3 (Table I, a). In addition, the varimax rotation with Kaiser normalization to simplify the definition factors has been used (Table I, b). This analysis has proved that there are statistically four subscales (factors). Before rotation Factor 1 describes 36.4 % of variance, Factor 2 – 30.3 %; Factor 3 – 15.2 % and Factor 4 – 9.7 %. The rotation percentage of varimax rotation method: Factor 1 – 30.2 %, Factor 2 – 23.5 %, Factor 3 – 19.7 % and Factor 4 – 18.3 %.

B. Enterprises that do not Implement OHSAS (NOHSAS)

The best model fit has been achieved after reducing the proposed safety management system scale from 12 to 11 and structuring explanatory variables in four subscales. The item finally eliminated is B1. SPSS then extracts all factors with eigenvalues greater than 1, which leaves us with two factors. Factor 1 represents questions A1, A2, A3, B3, C1, C3, D1, D3 and Factor 2 represents D2. This analysis seems to reveal that the initial questionnaire in reality is composed of two

subscales (Table II, a). The Kaiser normalization has been used to simplify the definition of the factors (Table II, b).

The result of the correlation, Factor Analysis Principal Component method (including KMO Barlett's test (Keiser-Meyer-Olkin measure of sampling adequacy)) have shown that the questions give the real picture of the safety level at the enterprises, subdivided in one or another way, only the subareas (A1...D3) have to be present, in one or four

subsections. The exception is component D2 (workability of the employees), which is surprising as in Estonia there is a resolution on lifting of heavy loads and the surveillance by the National Labour Inspectorate in this field is rather strong. The reason might be in the character of the industrial activities in the investigated companies as part of the manual load and static posture is small; therefore, D2 is not important.

TABLE I
COMPONENT MATRIX (OHSAS)

Components	Factor 1	Factor 2	Factor 3	Factor 4
	A1, A2, A3, B1, C2, D2	C3, D1, D3, B2	C1, C2, D2	A3
A1: Safety policy	.924 ^a	.741 ^b	.646 ^b	
A2: Safety activities in practice	.775 ^a	.890 ^b		
A3: Personnel management	.758 ^a	.908 ^b		
C1: Physical work environment	.533 ^b		-.587 ^a	.814 ^b
C3: Hazard analysis procedures	.691 ^b	.744 ^a	.536 ^a	-.603 ^b
D1: Occupational accidents and illnesses	.937 ^b	.967 ^a		
D2: Workability of the employees	.569 ^a		.712 ^a / .959 ^b	
D3: Social work environment	.811 ^b	.761 ^a		
B1: Participation	.915 ^a		.698 ^b	
B2: Communication	.944 ^b	.934 ^a		
C2: Psychological working conditions	.714 ^a			.803 ^b

^aExtraction method: principal component analysis. ^bRotation method: varimax with Kaiser normalization.

TABLE II
COMPONENT MATRIX (NOHSAS)

Components	Factor 1	Factor 2
	A1, A2, A3, C1, C3, D1, D3	D2
A1: Safety policy	.875 ^a / .797 ^b	.535 ^a
A2: Safety activities in practice	.903 ^a / .916 ^b	
A3: Personnel management	.969 ^a / .933 ^b	
C1: Physical work environment	.956 ^a / .972 ^b	
C3: Hazard analysis procedures	.917 ^a / .950 ^b	
D1: Occupational accidents and illnesses	.933 ^a / .896 ^b	
D2: Workability of the employees		.908 ^{a,b}
D3: Social work environment	.914 ^a / .849 ^b	
B2: Communication	.868 ^a / .849 ^b	
C2: Psychological working conditions	.928 ^a / .854 ^b	
B3: Personnel safety training	.972 ^a / .982 ^b	

^aExtraction method: principal component analysis. ^bRotation method: varimax with Kaiser normalization.

IV. THE PROPOSED "TRAINING THROUGH THE QUESTIONNAIRES" PACKAGE

The interviews with the learning aims consist of the questionnaire that includes "whether" and "how" questions. In the first case, the answers are "yes" or "no"; alternatively the respondents have to answer how the questioned activity is organised. The possibilities are proposed in this case. The total result is qualitative. It is also possible to develop the questionnaire and answers to the quantitative result, so the different persons in the safety chain can compare their knowledge in OHS. The questionnaire has been validated in

two enterprises (one enterprise implementing OHSAS 18001 (OHSAS) and the other does not implement OHSAS 18001 (NOHSAS)) by 3 persons (the employer, the working environment specialist (WES) and the working environment representative (WER)). The feedback is good.

The example of the "training through the questionnaire" package:

Safety policy

1. Does the company have the written policy?

How do the personnel become aware of the policy?

How has the company's top management committed itself to the goals of the policy?

Content of the policy

2. Does the policy have the following elements?
 a) A description of the company's safety goals?
 b) the safety tasks and responsibilities: the distribution among the top management, line management, supervisors, WE specialists and WE representatives, OH personnel?

Participation in the preparation of the safety policy

3. Are the following personnel groups participating in the preparation of the safety policy? The top management, line management, employees, safety and health personnel?

Initial status review

4. What was the initial safety and health level at the company (on the basis of the risk assessments)?

Safety documents

5. Does the policy list the following documents: work instructions, instructions for safety training, instructions for training of new employees, instructions for duties of line managers and WE specialists, the programme for medical examinations of employees, co-operation with the occupational health services?

The revision of the safety policy: how often is the policy revised and who is responsible for revising the policy?

Is the safety policy linked to the company's quality and environmental policy?

Top management safety knowledge

6. Is the top management aware of:
 How well the company's premises and equipment meet the health and safety standards?
 Are health and safety (H&S) considered in designing the new workplaces?
 Are H&S considered when the new machines or equipment are purchased?
 Are the workers satisfied with the WE, motivated and feel themselves psychosocially good?
 What is the safety knowledge of the line management?
 Is the manager aware of the costs of accidents and occupational diseases?
 What trend do the insurance costs have?
 What is the cost-effectiveness of the safety measures?
 How is the OH provider selected? By the price or by the content?

The safety knowledge of the middle-level management

7. Are they aware about housekeeping standards?
 What is the machine safety standard?
 What is the standard for the safety of machines, work instruments?
 What is the quality of the personal protective equipment?
 What PPE is needed and used by the workers?
 What is the employees' risk behaviour (conscious risk taking)?
 How to find a specialist for internal or external safety audit?

Supervisor's safety knowledge

8. What is the housekeeping standard of the plant?
 What is the safety training plan at the company?
 What are the standards for safety of machines, instruments, tools?
 Are the workers using and taking care of their PPE?
 What are the measures during the fire and what are the fire risks?
 What is the employees' risk behaviour?

Safety manager (working environment specialist)

9. Is the safety manager hired on a full-time basis?
 What is the safety manager's training, education?
 Is the risk analysis carried out at the enterprise and what are the results?
 How to find external experts for the safety audit?
 Is the safety audit needed?
 What is the risky behaviour of workers?
 What is the content of safety training of workers?
 What is the housekeeping procedure at the plant?
 Is there a safety committee at the company?
 Is the plan for safety activities for a year by the months?
 Does the safety manager have enough means for safety improvement?
 Are there connections to the occupational health services (OH services)?
 Who is obliged to go to the medical examination?
 What is the basis for them?
 Is the personnel opinion asked when the PPE is obtained?
 Are the OH doctors familiar to the hazards in the work environment?
 Do they know how to measure the hazard level?

Working environment representative (WER)

10. How was the WER elected?
 Does the WER know all the workers he (she) is representing?
 Does the WER know the safety policy at the enterprise?
 Does the WER know the obligations of the top, middle-level, supervisor, safety manager?
 Does the WER have enough time for the activities in the H&S area? What is the safety and health education of the WER?
 What are the connections to the occupational health services (OH services)?

Personnel management

11. Who is participating in the selection of the personnel, whose work is hazardous?
 Are safety questions touched when selecting the top managers or when the middle-level managers and supervisors are hired?
 Is the age of the worker considered selecting the worker?

Participation

12. Is the supervisor carrying out periodical safety trainings?
 How often?
 Is the employer asking the opinion of the worker when the workplace is designed?
 Are the workers participating in the development of safety policy or re-design of the workplace?

Communication

13. Is the communication between the supervisor and the employee benevolent or peremptory?

Are the briefings organised for the workers?

Is the communication effectively organised from the employer up to the top manager?

What communication means are used?

Are the workers aware of how the accidents and incidents are recorded?

Are the new workers informed about the safety policy, the changes in the safety policy, how do they get known about the changes in the safety policy?

Are the workers informed about the hazards connected with the changes in the technology and equipment? Is there a system to collect the proposals of the workers in safety matters?

Are the workers encouraged to make proposals for improvements in safety?

Are the best proposals awarded?

Are there any safety campaigns organised by the company? How often?

Is the campaign material up-to-date? Is it possible to hire external experts for the campaign briefings?

Personnel training

14. Is there any training additional to the introductory training?

Is the experience of older (more experienced) workers used?

Who is collecting the material for the training purposes?

Where are the safety instructions available?

Are the workers acting according to the safety instructions?

Are the safety instructions renewed according to the changes in the legislation? Who is doing this?

Are the workers participating in the compilation of the training material?

How is the permission to the work with particularly hazardous work activities organised?

Physical work environment

15. Is the H&S legislation [20] taken into consideration designing the workplaces?

Are the workplace designers trained for considering health and safety aspects?

Do the designers consult with employees?

Are accident risks considered in the design of the workplaces and work processes?

Is ergonomics considered in the design of workplaces and work processes?

Chemical risks

16. Are the work environment measurements regularly carried out?

Are there prescriptions for the storage and handling of chemicals?

Are the containers labelled in Estonian and Russian?

Are the workers trained to use the chemicals?

Are the workers supplied with the personal protective equipment (PPE) and is their maintenance arranged?

Is there a system at the plant how to renew the Safety Cards?

Is the management aware of the substitution of more hazardous chemicals to less hazardous ones?

Handling of heavy loads and ergonomics

17. Is the handling of heavy physical loads eliminated by the automation or other means?

Has the company minimised the one-sided movements and one-sided postures?

Are the working postures ergonomically acceptable?

Is there monotonous and repetitive work?

Does the company have a system for rehabilitation from the work related physical overload diseases?

Noise

18. Are the areas where the exposure limit might be exceeded, clearly marked?

Does noise disturb the communication, observation, concentration?

Are the personnel equipped with suitable PPE? Is the maintenance of PPE organised?

Illuminance

19. Has the company ensured that the quality of the lighting of workplaces and work areas is suitable?

Have the reflection, dazzle, and contrast been considered in the planning of illumination?

Can senior workers increase the level of illumination in their workplace when necessary?

Microclimate

20. Is the temperature of the work environment appropriate for the nature of the work?

Is the ventilation approved by the workers?

Is it possible to change the ventilation during the seasons?

Is the humidity in the work environment air controlled?

Does the company provide the suitable clothing and breaks in cold climate conditions?

Accident hazards

21. Are the floors, tables, racks etc. clean?

Are the walkways in good condition, is their surface clean and free, are the walkways marked?

Are the walkways separated from the driveways?

Are the machines and equipment in good condition, are the safeguards in place?

Is the safety of motor vehicle traffic ensured?

Is the travelling between home and workplace provided?

Maintenance

22. Is the maintenance of machines and equipment at the adequate level?

Does the company have a maintenance programme for machines?

Is the regular cleaning of the plant area adequately organised?

Major accident hazards

23. Are the fire hazard activities under control?

Are the explosives and fire hazardous chemicals properly stored?

Is the extinguishing system controlled on a regular basis?

Are the emissions of the hazardous chemicals under control?
 Does the company have plans for the evacuation of personnel?
 Is the major hazard risk assessment carried out if needed by the nature of the technology?
 Is there a co-operation between the Fire Safety Board and the neighbouring houses organised?

Psychosocial work conditions

24. Is there part in the safety policy on the regulations and demands for the handling of psychosocial work conditions?
 Do the designers know the mental overload terminology and content?
 Are the questionnaires for the investigation of the psychosocial aspects of the work drawn up and used in every-day life?
 Are the results of the questionnaires presented to the top managers?
 Are the questionnaires anonymous?
 Working alone?
 Are relationships among the staff members investigated in these questionnaires?
 Is there a system for redesigning the workplace of a person who has difficulties in coping with the work?
 Are there persons working under extreme mental stress under special follow-up?

Workplace risk analysis

25. Is the risk analysis carried out according to the Occupational Health and Safety Act in Estonia?
 Is the risk analysis approved by the National Labour Inspectorate?
 Is the risk analysis renewed? How often?
 Is the risk analysis carried out by the internal personnel or is it bought as a service?
 Is the action plan renewed every year?
 Are the planned activities carried out?
 Is the top and middle-level management interested in the results of risk analysis?

The external OH services

26. How is the OH service provider chosen? By the price or by the content of analysis?
 Is the OH services provider interested in visiting the production area?
 Does the employer get the feedback from the OH service provider?

Occupational accidents and illnesses

27. Does the company make statistics on accident rates, and summaries on accident causes?
 Is the management informed of the every accident or disease based on work conditions?
 Are the incidents (near-accidents) recorded?
 Has the company defined who investigates the accidents?
 What are the activities to prevent similar accidents and how will the workers get acquainted with the accidents and diseases?

V. CONCLUSION

The current paper provides the statistics based on the safety audit results carried out by the MISHA method in 16 Estonian enterprises with 34 persons from the top, middle management and with the working environment specialists and working environment responsible personnel. The connections between the 4 safety and health indicative areas (through the questions) are presented and the correlations calculated. The statistics has shown that it is not necessary to divide the safety audit questions exactly into 4 areas, it is important that the questions are correctly elaborated and grouped. It is possible to learn through the interviews. An example interview is presented in the current study. The "training through the questionnaires" package has been developed and the safety knowledge of the managers should be improved using this package as a learning method.

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