THESIS ON ECONOMICS AND BUSINESS ADMINISTRATION H48

Development of the Safety Management System at Enterprises

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Declaration:

Hereby I declare that this doctoral thesis, my original investigation and achievement, submitted for the doctoral degree at Tallinn University of Technology, has not been presented for any academic degree.

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LIST OF ORIGINAL PUBLICATIONS

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III. **Õ. Paas**, K. Reinhold, P. Tint. Estimation of safety performance by MISHA method and the benefits of OHSAS 18001 implementation in Estonian manufacturing industry. *Agronomy Research*, 2015, 13 (3), 792-809.

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The author's contribution to the publications

Article I. In Article I the author participated in the experimental work (measurements in the work environment), the risk analysis and in the interpretation of the survey results.

Article II. In Article II the author conducted the experimental part (safety auditing in 18 enterprises) and the calculation of the cost effectiveness of safety measures, reviewed the scientific literature and legislative documents for writing the paper.

Article III. For Article III, the author carried out the interviews using the MISHA method in 16 Estonian enterprises, participated in the interpretation of the results, and writing the paper.

Article IV. For Article IV, the author interpreted the data and gave the scientific and safety connected meaning to the statistical analysis of real and formal safety components from 16 Estonian enterprises and took part in the writing the paper.

Article V. For Article V, the author presented the statistical data, and together with the second author worked out the model describing the different safety activity areas, the connections between the real and formal safety elements and took part in the writing of the paper.

Article VI. In Article VI, in co-operation with the other authors, the author provides the implementation of the PhD thesis results in the form of training method "learning through interviews".

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INTRODUCTION

Employer's awareness and appreciation of positive safety culture plays a substantial part in securing a healthy and safe workplace. Employees are more motivated and satisfied when they perceive the employer's input into their health promotion. On the other hand, employees' awareness cannot be underestimated either: the more educated the employees are, the more they want to have a role in reorganizations, strategy development or evaluation of work performance (Arghami et al., 2014; Inness et al., 2010; Koopmans et al., 2011).

A relationship has been found between high job dissatisfaction and frequent sick leave. The constructive dialog and conversation to solve the problems of occupational safety and health (OHS) in the company will promote healthy relations among the personnel (Aaviksoo et al., 2013; Clausen et al., 2014; Lesuffleur et al., 2014). The health management, which has no systematic background and lacks a general overview and targets, is short-sighted and will contribute little to the improvement of accident and sick leave figures for the companies. Workers' health and safety have become an increasingly important aspect in the industrial and commercial companies in Estonia. The workforce is ageing and there is a great shortage of high-quality workers (Järvis et al., 2014).

Some research results indicate that the enterprises with multiple locations possessing the similar safety principles may gain different results in safety performance according to location. Some locations that have managed to keep away from the accidents for a long period, had something markedly different from the average locations that occasionally had an accident. In those companies, a higher sense of awareness and attention to the employees' behaviour is present (Koivupalo et al., 2015; van Bellaer, 2014). Young people (15-25) represent a group that falls more into accidents during their first two years of professional experience in the company. Some countries prepare these young people to enter into the workforce by incorporating lessons in the OHS training programmes and by ensuring safe learning environments. In France, employees younger than 25 of age represent 11% of personnel and 20% of accidents (e.g. Documentation, 2014).

The quality of safety culture in a workplace has a strong influence on the level of injuries and accidents (Cooper, 2002; Järvis et al., 2014). The last three decades have seen a growing interest in the concept of safety culture, first in high-risk industries (Tammepuu, 2014; Wang, 2001; Wilpert and Itoigawa, 2002), large scale industries (Cooper and Phillips, 2004; Vecchio-Sadus and Griffiths, 2014) and in recent years also in small-scale enterprises (Kines et al, 2013; Sorensen et al., 2007). Organisations need to find the right balance between decrees, prescription, organisational learning and joint goal setting, as well as acknowledging the time that it is likely to take to achieve measurable and permanent change in the safety culture. Previously, OHS often reacted to emergencies of the new technologies, nowadays OHS is focusing on proactive activities to avoid and reduce risks (Robson and Bigelow, 2010). Global trends in the economic space for new OHS strategies are: use of new technologies, exposure to new and increasingly used hazardous substances, growing perception or importance of physical hazards, globalisation and

changing world of work and education, development of a service society, demographic change, increasing number/or severity of disasters, increasing unhealthy lifestyles (EU Strategic…, 2014).

Occupational health (Järvis and Tint, 2009; Kempinen and Kurppa, 2004; Kurppa et al., 2006) and safety (Reinhold and Tint, 2013) research is scarce in Estonia. There is a lack of empirical research identifying the specific dimensions of an adequate and effective safety management system (SMS) (Fernandez- Muniz et al., 2009; Santos-Reyes and Beard, 2002) and on the application of the occupational health management system (OHS MS) in manufacturing enterprises (Stolk et al., 2012).

Cooper (2002) emphasised that OHS auditing is more than a hazard identification exercise and should involve a comprehensive examination of the whole OHS MS itself. The existing OHS MSs and models do not assess the safety activities derived from the specific technical work environment conditions (Champoux and Brun, 2003; Makin and Winder, 2008; Saksvik and Quinlan, 2003). Only a few studies have analysed OHS MS, real and formal OHS situation in enterprises (Järvis, 2013) and have focused on the organisational consequences (Silva et. al., 2004). The shared responsibility is required to introduce safety behaviour where both managers and workers work to realise this together (Brown et al., 2000; Cooper, 2002; Fernández-Muniz et al., 2012b).

One of the most common ways to achieve good OHS status in the company is to establish a safety management system. The key elements of a SMS include: safety policy, procedures and rules, training, communication, incident reporting and analysis, safety audits and inspections, rewards and recognitions, employee engagement, safety meetings and committees, suggestions, concerns and discipline (Frazier et al., 2013). Further, SMSs include a process of regular overview, adaptation and updating of the system: a constant search for the best solutions. However, SMSs have received some criticism from researchers too, which involves mainly comments about high paperwork load, high costs for small and medium-sized enterprises (SMEs), focusing on management rather than on workforce participation (Hasle and Zwetsloot, 2011; Zwetsloot et al., 2013). An effective SMS should promote the achievement of an acceptable level of safety while balancing the distribution of resources between production and protection. In any manufacturing organisation, production and safety risks are strongly linked. According to James Reason (1997), when production increases, the safety risks may also increase if the necessary resources or process enhancements are not available.

Besides financial considerations human decisions and behaviours affect functioning of SMS considerably. According to Zwetsloot et al. (2007) safety management can be understood as a process of co-creation safety while top managers attitudes determine the basic values of OHS in the company, the middle managers actions are crucial because of their role as a connecting link between management and employees. Safety management is therefore nowadays a complex challenge wherein planning is complemented by resilience and *"managing the unexpected*".

The aim of this research is to elaborate the conceptual model for safety management system at enterprises that determines the key elements and their benefits in the system for sustainable and successive safety improvements.

In the view of absence of research on safety management problems, the **research question** of the current thesis is:

What characterises a safety management system in manufacturing enterprises, what are the essential key elements to be determined, and how can safety auditing as a research method be used in order to ensure the high level of safety performance?

Thesis motivation: the research is based on the safety level data from the examined Estonian enterprises, to describe to the employers the possibilities for the improvement of the safety means and knowledge through systematic and analytical approach and assessing entirety of OHS management system.

The research tasks are:

- to determine the most important health and safety risks in the Estonian manufacturing industry (Article I)
- to evaluate the available safety auditing methods and determine the most relevant for the manufacturing industry (Article II)
- to collect and analyse critically the data from the working environment through the safety auditing in Estonian enterprises (Article II)
- to conduct safety interviews in 16 industrial companies in order to find the gaps in safety activities and performance (Article III)
- to examine the outcomes of OHSAS 18001 for real safety performance (Article IV)
- to estimate safety performance by the MISHA method and the benefits of OHSAS 18001 implementation in Estonian manufacturing industry (Article V)
- to improve the leaderships' safety knowledge through the scientifically reasonable interviews (Article VI).

The contribution: the current research contributes to the elaboration of the conceptual model for safety management system in enterprises. The importance of the key elements, supported by OHSAS 18001 implementation is determined and the benefits to the improvement of safety level at enterprises are presented. The study demonstrates the suitability of safety auditing as the main method for the investigation of the state of safety management system in the enterprises and the suitability of the MISHA method for safety auditing. Moreover, it gives an indication to the areas in the safety management system that are not clearly visible while possessing OHSAS 18001 certification (e.g. the significance of psychosocial climate monitoring). The study enhances the current management knowledge about OHS activities and provides conceptual clarification of the role of the systematic discussion during the interviews for increasing their interest to OHS. The practical value of the thesis is related to the employees' knowledge improvement package - „learning through the questionnaires" based on the modified MISHA questionnaire.

The novelty of the research is the determination of the importance of the key elements in the conceptual model for safety management system created to reveal

the influence of OHSAS 18001 on the improvement of the safety level at enterprises.

The structure of the PhD thesis includes the introduction, theoretical framework, research methodology, the main result of the study and the conclusions.

Overview of the approval of research results

All the results from the current study have been published (or accepted for publishing) and presented by the authors at the international scientific conferences and doctoral seminars (PhD colloquia), following the acceptance of peer-reviewed submitted abstracts.

- The presentation covering "Risk assessment and measurement of hazards in Estonian enterprises" (Article I) took place in June 2009 in Lido, Venice, Institute Nationale Polytechnique de Toulouse: GPE-EPIC. 2nd International Congress on Green Engineering.
- The results of Article II ("Cost-effectiveness of safety measures in enterprises") were presented in HAZARDS XXI Conference: Process Safety and Environmental Protection in a Changing World in Manchester, UK, in May, 2009 and on the 19th International Symposium on Ecology and Safety in June, 2010 in Sunny Beach, Bulgaria.
- The results of Article III *("*"Estimation of safety performance by MISHA method and the benefits of OHSAS 18001 implementation in Estonian manufacturing industry") were presented by the author at the 6th Conference on Biosystems Engineering in Tartu, May 2015 and Article V *("*"OHSAS 18001 contribution to real and formal safety elements of safety management system in manufacturing companies: results of statistical analysis") will be presented at the 7th Conference on Biosystems Engineering in Tartu, May 2016.
- The results of Articles IV (*"*Voluntary safety systems in manufacturing industry – to what extent does OHSAS 18001 certification help?") and VI *("*"Learning through questioning in occupational health and safety") were presented by the author on the RTU 56th Annual Conference in Riga, Oct. 2015.

Abbreviations

General abbreviations and explanations:

OHS – occupational health and safety

OHS MS – occupational health and safety management system

RA – risk assessment

SMS – safety management system

MISHA – method for industrial safety and health activity assessment

D&S – a safety audit method originally developed by Diekemper & Spartz

SMEs – small and medium-sized enterprises

WE – work environment

WER – work environment representative

Formal safety element – acknowledged by the managers from the safety and legislation, which is documented, but not necessarily followed in practice

Real safety element – acknowledged by the managers from the real working conditions, which reflects also in behaviour and attitudes within an organisation

Combined safety element – acknowledged by the managers simplistically only as formal or real safety element, but in depth features real need to be implemented.

Abbreviations, connected with the denoted enterprises:

OHSAS – OHSAS 18001 certified companies

NOHSAS – companies which do not possess OHSAS 18001 certification

NOHSASL – locally established and owned companies which are not OHSAS 18001 certified

NOHSASC – organisations which belong to a larger corporation or concern but are not OHSAS 18001 certified.

1. THEORETICAL FRAMEWORK

A safety management system (SMS) is designed in order to deal with occupational health and safety (OHS) in a systematic way by the following activities: setting company's safety targets and objectives; designating roles and responsibilities for safety personnel; planning and performing the hazards mitigation; monitoring, measuring, and improving the on-going system and its effectiveness (Robson and Bigelow, 2010). Performance measurement is a key step in any management process and forms the basis of continual improvement (HSE, 2001). If the measurement is performed incorrectly, the effectiveness of the SMS is undermined and there is no reliable information to inform managers how well the health and safety risks are controlled. Various evaluation methods can be used to assess the different aspects of the SMS. The most commonly used methods are management reviews, measurement on safety performance through injury and accident statistics and safety audits.

Management reviews in OHS (OHSAS 18001) are conducted by the top management at suitable intervals to ensure the continuing effectiveness of the safety system. The management reviews contain: the objectives and policy of the company; customer and interested parties expectations and needs; requirements of OHSAS 18001.

Safety performance measurement through injury and statistics rates may be problematic due to under-reporting. An emphasis on injury, ill-health and accident rates decrease as a measure, particularly when related to reward systems, can lead to such events not being reported in order to "maintain" performance. Additionally, injury and accident statistics reflect the outcomes rather than the causes. Safety audit, on the other hand, is a tool of direct and comprehensive measure of the implementation and effectiveness of a company's SMS and covers all the aspects (Karapetrovic and Willborn, 2000). The primary purpose of measuring safety performance is to provide information on the progress and current status of the strategies, processes and activities used by an organisation to control risks to health and safety. The performance measurement system - auditing - must cover each element of the SMS as demonstrated in Fig. 1. For example, the measuring process should establish that a written health and safety policy statement exists, meets legal requirements and best practice, is up to date; and is being implemented effectively.

Recently, Fernández-Muniz et al. (2007) have determined the structure of safety performance, suggesting an effective SMS should contain six important sub factors: safety policy, incentives for employee participation, training, communication, planning, and control. The employee involvement was emphasised. Thus, additional research is needed in the following SMS areas: safety policy, procedures and rules, training, communication, incident reporting and analysis, safety audits and inspections, rewards and recognition, employee engagement, safety meetings/committees, suggestions/concerns and discipline (Bakker and Schaufeli, 2008; Frazier et al., 2013; Traumann et al., 2013a, b).

Several safety management related standards, directives, and regulations have been published after the 1990's. This progress has been noticeable especially in Europe. The BS 8800 (BSI, 1996) has become the first widely spread general safety

management standard. In 1999 the first version of OHSAS 18000 (OHS Assessment Series) was released. It was intended to help organisations to control OHS risks. Since its publication, OHSAS 18001 has gained considerable acceptance worldwide and has a revised version OHSAS 18001:2007 (OHSAS Project Group, 2007). The fundamental objective of this standard is to support and promote good practice in the area of OHS via systematic and structured management (Chang and Liang, 2009; Fernández-Muniz et al., 2012b). Additionally OHSAS 18001 certification enables the organization to demonstrate to the interested parties that the company has an adequate and functioning SMS; this increases the competitiveness in constantly changing economy market.

The OHSAS specification is applicable to any organisation that wishes to: establish an SMS to eliminate or minimise risk to employees and other interested parties who may be exposed to OHS risks associated with its activities; implement, maintain and continually improve an SMS; assure itself that the system complies with its stated OHS policy; and to demonstrate the compliance with this standard to the others, as environmental and quality management standards (OHSAS Project Group, 2007).

Several researchers have demonstrated that OHSAS 18001-certified organisations have an adequate and functioning SMS in order to control occupational hazards (Chang and Liang, 2009; Fernández-Muniz et al., 2012a) and have a stronger management commitment, better organised safety training, higher workers' involvement in safety, more efficient safety communication and feedback, explicit safety rules and procedures, fairer safety behaviour and reasoned safety promotion policies (Fernández-Muniz et al., 2012a; Santos et al., 2013; Vinodkumar and Bhasi, 2011). Abad et al. (2013) demonstrate that OHSAS 18001 can be seen as a strategic cost-control tool in order to create and maintain a safe working environment and through it, lower the rate of workplace accidents and interruptions in the production process.

Safety auditing is the main method for the assessment of a safety management system (Fig. 1). Auditing should establish how effective the following three components of the health and safety management in reality are:

- Management of organisation and arrangements;
- Identification and implementation of risk control measures;
- Workplace precautions and control measures (Robson et al., 2007).

Several auditing methods have been developed by different authors. A part of them is patented (Collision and Booth, 1993), the others are based on the legislation (Redinger and Levine, 1998; SafetyMap, 1995) or targeted to certain types of industries (Eisner and Leger, 1988; Pearse, 2002). In addition, methods for safety auditing in manufacturing (Diekemper and Spartz, 1970; Dyjack et al., 1998; Kuusisto, 2000) or sector specific (Bunn et al., 2001; LaMontagne et al., 2004) are available.

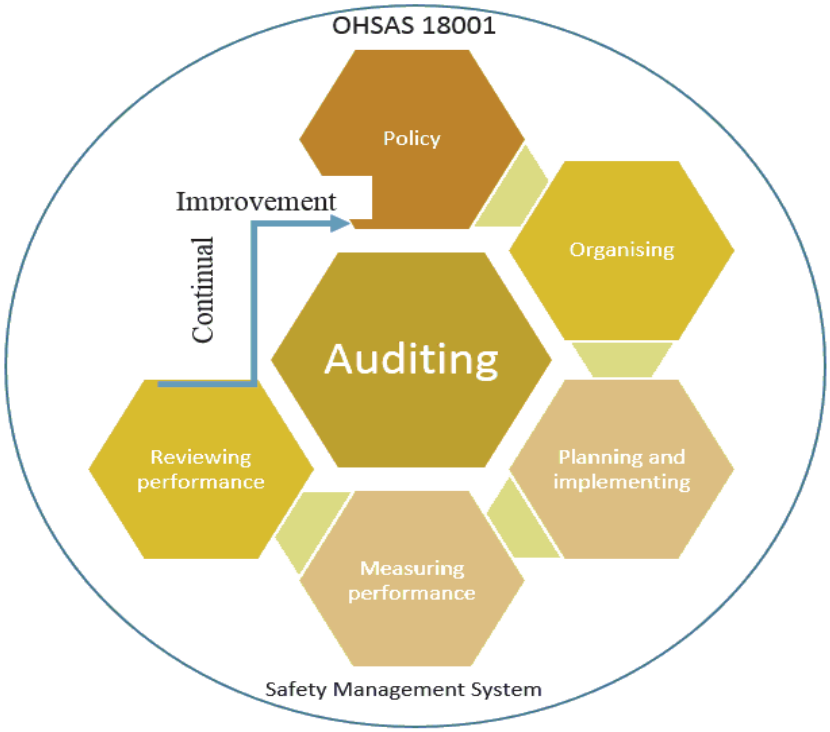


Figure 1. The safety auditing role in the whole safety management system (adopted from OHSAS 18001)

Following the analyses of the audit methods, author of the current study started with the D&S method (Diekemper and Spartz, 1970; Kempinen and Tint, 2006; Tint et al., 2010) which was used at the beginning of the investigation during 2007-2013. The MISHA, Method for Industrial Safety and Health Activity Assessment (Kuusisto, 2000), which covers essential safety key elements, was chosen for the further studies and scientific conclusions. The expert analysis proved that MISHA method is comprehensive and complies with high expectations for health and safety.

Safety audit as a term has been explained in EVS 18001 and BS 8800:2004.

Audit is a systematic, independent and documented process for obtaining audit evidence and evaluating it objectively to determine the extent to which audit criteria are fulfilled (EVS 18001).

According to HSE (Health and Safety Executive (UK)), a health and safety audit is a structured process of collecting independent information on efficiency, effectiveness and reliability on the total health and safety management system, and drawing up plans for corrective actions (BS 8800:2004).

The safety audit can be internal or external. Internal audit is conducted in-house as one of the possible tools to show the authorities that company's safety efforts are adequate and effective; external audit is performed by the trained expert from outside the organizations such as labour inspectors or personnel from certified bodies for auditing (Kuusisto, 2000).

The aim of the safety management systems is to manage the planning and implementation of a company's safety policy. A safety management system usually includes the setting and prioritising of safety goals and development of safety programmes. Other important parts are organisation, participation and communication.

The literature on OHS MSs often distinguishes mandatory OHS MSs from voluntary systems (Frick et al., 2000; Frick and Wren, 2000; Gallagher and Underhill, 2012).

Mandatory OHS MSs (Frick et al., 2000) arise from government legislation and dictate a limited set of core principles for the management of OHS to be implemented by employers. A good example of a mandatory OHS MS is Framework Directive 89/391/EEC (Directive, 1989), which defines employers' responsibilities in the management of OHS. It obliges employers to evaluate the risks to the health and safety of workers and to implement subsequent preventive measures and then to integrate those measures into all of the activities carried out by enterprises at all hierarchical levels. Finally, the Directive also requires that workers and their representatives are informed and consulted, and requires that employers either establish preventive services themselves or use external organisations to do so.

Voluntary OHS MSs are not state-regulated. These systems were first promoted by commercial organisations, large corporations and associations (e.g. industry associations). Voluntary OHS MSs have tended to be more complex than regulatory systems, and more formalised in terms of specifications. According to Frick and Wren (2000), the detailed specification of these systems helps ensure the good integration of OHS policy into the management processes of enterprises. Voluntary OHS MSs are generally in the form of standards or guidelines, providing requirements for certification or giving simple guidance on good management practice for OHS. These standards or guidelines are international (e.g. ILO-OSH 2001) (ILO, 2001), national (e.g. BS 8800 or OHSAS 18001:2007) (BSI, 1996; EVS 18001:2007), and sectoral (Drais et al., 2002; INRS, 2004).

OHSAS 18001 standard was developed in response to the demand for a recognisable OHS MS standard against which their management system can be assessed and verified. The standard was intentionally developed to be compatible with the ISO 9001 (Quality) and ISO 14001 (Environmental) management systems standards for easier integration of quality, environmental and occupational health and safety management systems by the organisations (Integrated…, 2015). Hamidi et al. (2012) argues over justifications to integrate quality, environment and OHS MSs. They see the main reason in reducing duplication and costs as these three systems share many similarities. They also conclude that integrated management system focuses on team work. OHSAS 18001 outlines requirements for an OHS management system, to enable an organisation to control its OHS risks and improve its performance. Like ISO 14001, it does not state performance criteria or dictate the design of a management system. All these three standards are directed to improve the competitiveness of the enterprise. Several authors have studied the impact of OHSAS 18001 on the improvement of the safety level at enterprises.

An effective OHSAS management system may contribute to the following aspects:

- provides a structured approach for managing OHS;
- establishes and maintains a strong commitment to OHS;
- provides organisational structures with clear and unequivocal roles and responsibilities;
- sets strong levels of trust and communication, existence of a continuously improving safety culture;
- reduces incident and accident levels with increased measures of performance (Chang and Liang, 2009; Sanchez-Toledo et al., 2009; Koivupalo et al., 2015).

Additionally some researchers have argued that OHS MS may favour a learning process, which contributes to improvements in health and safety activities (Rocha, 2010; Zwetsloot, 2000).

Due to the globalisation and constant competition in the world-wide market, organisations of all kinds are increasingly concerned with achieving and demonstrating sound OHS performance by controlling their OHS risks, consistent with their OHS policy and objectives (EVS 18001:2007; Hale, 2009; Torp et al., 2000). The standards covering OHS management are intended to provide organisations with the elements of an effective OHS management system that can be integrated with other management requirements and to help organisations to achieve OHS and economic objectives. It is intended to apply to all types and sizes of organisations and to accommodate diverse geographical, cultural and social conditions. The level of detail and complexity of the OHS management system, the extent of documentation and the resources devoted to it depend on a number of factors, such as the scope of the system, the size of an organisation and the nature of its activities, products and services, and the organisational culture.

OHSAS 18001 certification has been criticised for its tendency to increase the bureaucratisation of health and safety issues and therefore discourage genuine worker involvement. This may shift the focus from health and safety issues towards paperwork control, which may diminish the activities dealing with OHS problems (Kamp and Blansch, 2000; Nielsen, 2000).

Certification to OHSAS 18001 has been increasing rapidly for instance in Spain, particularly among SMEs. Spanish companies expect that the system can help the organisation to develop risk prevention activities in a structured and coordinated manner, integrated with all day-to-day activities and decisions (Sanchez-Toledo et al., 2009). According to Santos et al. (2013), the number of companies with the OHS MS certification Portugal is still very small but gradually growing. Companies possessing OHSAS 18001 see as the human capital as the main value which enables the maximum safety in an organisation. Another reason to implement OHSAS 18001 is to strengthen the organisations public image. According to a study (Vinodkumar and Bhasi, 2011) in India, the authors found out, while comparing perceived SMS practices and safety behaviours in management certified companies, that organizations with OHSAS 18001 certification have highest levels of the six safety

management elements (management commitment, safety training, workers' involvement, safety communication and feedback, safety rules and procedures and safety promotion policies) and safety behaviour. The results in Indian manufacturing companies showed that the level of mentioned six elements was significantly higher than those in ISO 9001 certified and non-certified organizations, showing the need for OHS MS certifications like OHSAS 18001. In Estonia, the manufacturing industry OHSAS 18001 certification has gained relatively little attention yet: in January 2014, 57 manufacturing companies possessed OHSAS 18001 certification among 178 certified Estonian companies. The majority of certified organizations are engaged in construction sector. According to Järvis (2013) only a minority of Estonian SMEs (0.2%) have established a voluntary OHS MS based on OHSAS 18001:2007.

A cost-effectiveness analysis is often used as the basis for the comparison between competing safety measures (Abrahamsen et al., 2009a, b). The cost-effectiveness indices such as the expected cost per expected number of lives saved are calculated. These indices are presented to the decision-makers, and seen in relation to the reference values, they form the basis for the assessment of the effectiveness of the safety measures. Quantitatively, the cost-effectiveness can be expressed as a cost-effectiveness ratio, the ratio of change in expected costs to the change effects (Aven and Korte, 2003; Abrahamsen et al., 2009a, b).

The methods for calculating the costs of safety measures are limited (Miller, 2000; Philips et al., 2006; Skjong and Ronald, 2004). In the evaluation of safety measures, a cost-effectiveness analysis is often adopted (Tam and Fung, 1998; Whynes et al., 2006). The decision on whether a safety measure should be implemented or not is by using an analysis to a large extent based on the calculated cost-effectiveness ratio. The ratios can be expressed either as a cost-effectiveness ratio, or as an effectiveness–cost ratio (Boardman et al., 2006).

This type of ratio (index) usually forms the basis for the communication of cost-effectiveness between analysts and other stakeholders. To improve the communication of the cost-effectiveness of safety measures between these two people groups, a cost-effectiveness uncertainty-diagram was presented by Abrahamsen et al. (2009a, b). The diagram reflects information about cost-effectiveness through three dimensions: uncertainty, expected cost and the expected lives saved. The cost-effectiveness-uncertainty-diagram reflects the three dimensions by showing the expected cost on the x-axis, the expected saved lives on the y-axis and the uncertainty through different bubble sizes. The cost-effectiveness of the safety measures is evaluated based on these three dimensions, and is presented by a colour (red, yellow, and green). Safety measures are classified into the cost-effectiveness-uncertainty-diagram on the basis of an understanding of the different dimensions described as follows: expected cost is the expected implementation cost of the safety measure; the expected number of lives saved is the number of saved lives if the safety measure is implemented; the expected number of lives saved is considered as the centre of gravity of the probability distribution of the number of lives saved. Uncertainty reflects the expected values' predictability of the real outcomes. High uncertainty in the cost-effectiveness- uncertainty-diagram may, for example, express that the assigned cost can give a poor prediction of the future cost.

The questionnaires compiled for the assessment of safety activities at enterprises can also be a tool for learning and getting more information about safety (TEAL, 2013) - particularly, by the top and middle-stage management. The line managers and working environment representatives (WER) are usually more competent in safety activities due to practical safety training and extensive theoretical training required by OHS regulation. There are several possibilities to learn through questioning: for young people (Edwards and Bowman, 1996; Billet, 2015), in the safety area (Government of Alberta, 2010; Torp and Moen, 2006) or other methods for safety training of workers proposed by the Law (OHS Act, 1999).

Different scales are available to measure the activities in safety performance at enterprises. A higher total score indicates a higher level of psychological demands, decision authority, social support, OHS-related management support (Billet, 2015).

Training has received much attention in the safety literature, and several comprehensive reviews have been published (Cohen and Colligan, 1998; Jonston et al., 1994; Wirth and Sigurdsson, 2008). The one-time and traditional trainings might not be official if there is no programme how to motivate the behaviour of the worker (Bell and Grushecky, 2006). Novel training tools are also available from authors abroad (Sinclair et al., 2003; Wallen and Mulloy, 2006) as well as domestic authors (Paas et al., 2015a, b). A new direction for training is blended learning (Stanca and Lacurezeanu, 2012), but it is suitable only for the leadership, not for the whole chain in command in the enterprise. Safety training and injury prevention are closely connected (Jonston et al., 1994; Bell and Grushecky, 2006). The human factor and worker's behaviour have to be considered (Dermol, 2013). The videos and interviews are useful in the safety learning process (Laberge et al., 2014). According to Jonnaert et al. (2007), the learners are no longer considered as passive receivers of knowledge, but they are acting subjects who have taken the place at the centre of the dynamic process of developing and constructing their own enacted identities and knowledge.

2. RESEARCH METHODOLOGY

2.1. Research design

The quantitative studies in safety research began with Heinrich (1941). The qualitative research was presented in the papers of Reason (1997) and Cooper (2002). Later studies of Fernández-Muniz et al. (2007, 2009, 2012a, b) have shown that both quantitative and qualitative studies are needed in the safety science research, particularly in improving the safety level at enterprises. The model centred approach is prevalent in the philosophy and in social sciences (Arbnor and Bjerke, 2008; Niglas, 2010).

The methodology of the current thesis is composed of a mixed methods approach, which is the best to represent the philosophical position of most of the investigators (Teddlie et al., 2009; Titov, 2015). The current research is descriptive and aims at describing and understanding of the SMS and particular safety audit role in manufacturing industry. The main method, used in the study, MISHA method (Kuusisto, 2000) allows both a qualitative and a quantitative approach (Given, 2008; Hunter and Leahey, 2008). It covers the whole area of safety management in questions and interviews with employers' and employees' representatives. It also includes the management reviews. At the same time, it educates the workers in safety work means and behaviour towards the use of safe work methods. The statistical analysis (Kern and Willcocks, 2000) was chosen as the tool to prove the results of audits by the MISHA method.

2.2. Sample

To identify hazards profile in manufacturing, 37 manufacturing enterprises (representing main manufacturing areas such as textile and clothing, printing, wood processing, mechanical, plastic industries and office areas) were investigated (Article I). The selection of enterprises was based on representation of the most common industrial sectors in Estonia. Companies were located in different locations in Estonia, however majority of them were situated in or around the capital and western part of the country with the highest density of production area. The initial data for the determination of the safety level were gathered.

The Diekemper and Spartz method was used for safety auditing in eight Estonian enterprises. The safety level up to 2010 was ascertained (Article II).

To select the industrial companies for the research by the MISHA method in 2014 (Article III), the database of the Estonian Association for Quality (2014) was used. In January 2014, 178 Estonian companies owned OHSAS 18001 certification. The scan showed that 32 % of the certified firms are engaged in the manufacturing sector. The investigator contacted each of these firms and explained briefly the purpose and the scope of the research. Finally eight companies (representing main manufacturing areas in Estonia such as printing, textile, metal, food industry etc.) agreed to participate which was enough to perform a qualitative study.

Table 1. Characterisation of enterprises investigated using the MISHA method (N=16)* (Article III)

Id. of the company	The activity area	Size, employees	OHSAS 18001 imple-mented	The persons interviewed: position, age
K (Int 1)	Textile industry	50 - 249	-	Production manager, 38
L (Int 2-4)	Plastic industry	50 - 249	+	Quality manager, 41 Safety manager, 62 WER, 25
M (Int 5)	Furniture industry	50 - 249	+	Personnel manager, 64
N (Int 6)	Heat industry	50 - 249	+	Quality and environment manager, 58
O (Int 7)	Printing industry	< 50	-	Production manager, 36
P (Int 8-9)	Metal industry	≥ 250	-	Safety manager, 35 Trade union representative, 60
Q (Int 10-12)	Elect-ronics industry	≥ 250	-	Quality manager, 36 Safety specialist, 42 WER, 53
R (Int 13-15)	Food industry	≥ 250	-	Safety specialist, 62 WER I, 34 WER II, 39
S (Int 16-18)	Elect-ronics industry	≥ 250	+	Quality manager, 59 Safety manager, 39 WER, 66
T (Int 19)	Metal industry	≥ 250	+	Safety manager, 64
U (Int 20)	Food industry	≥ 250	+	Safety manager, 37
V (Int 21)	Metal industry	< 50	-	Production manager, 36
W (Int 22)	Wood processing industry	≥ 250	+	Quality manager, 47
X (Int 23)	Food industry	≥ 250	+	Safety chief specialist, 68
Y (Int 24)	Glass industry	< 50	-	Production manager, 41
Z (Int 25)	Textile industry	≥ 250	-	Health and safety manager, 67

*Companies are listed and coded in chronological order;
Abbreviations: Id. – identification; Int – interview, WER – working environment representative.

The data collection was performed during 2014, when eight (OHSAS 18001-certified organisations, group I) + eight (non-certified organisations, group II) 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 were asked from each person interviewed (MISHA method). The enterprises are briefly characterised in Table 1; detailed characterisation is given in Article III (Table 1).

2.3. Research techniques and procedures

The methods used in the study are as follows:

1. In the measurements of work environment hazards (Article I) based on the standard methods presented in EVS-EN 15251:2007, EVS-EN 12464-1:2011, EVS-EN 15251:2007, the measuring devices for the measurements in the work environment proposed by the standards above were used.

2. During 2008 - 2013 the Diekemper & Spartz method (D&S) (Kuusisto, 2000) was used by the author for safety auditing in six Estonian enterprises. The D&S method was developed in the USA in 1970 to measure the quality and quantity of safety activities in individual companies. It consists of five safety activity areas: organization and administration, industrial hazard control, fire control and industrial hygiene, supervisory participation, motivation and training and accident investigation, statistics and reporting procedures.

3. From 2014, on the basis of the author's critical review of the existing auditing methods, the MISHA method (Kuusisto, 2000) as the most innovative was chosen for the current study to conduct semi-structural interviews. The MISHA method considers the following areas of industrial activities: A. organisation and administration (safety policy and safety activities in practice, personnel management); B. participation, communication, and training; C. work environment (physical work environment, psychological working conditions, hazard analysis procedures); D. follow-up (occupational accidents and illnesses, work ability of the employees, psychological work ability).

As compared to with the other methods used by the researchers (D&S, Goodyear Tire and Rubber Company audits etc.), the MISHA method enables more attention to be paid to different safety areas in more a emphasised mode, giving less attention to off-to-job safety.

Once data collection was completed, the author (and the interviewer) re-heard the records, and checked the coding strategy used for consistency and ensured that all questions had been answered. After that, the answers were discussed in each company to come to a good level of agreement about the results (Table 2, 3 and 4, Article III). Table 1 (Article III) presents the characteristics of the examined enterprises – the activity area, lifetime, size, the overall assessment of safety by an expert-interviewer, if OHSAS 18001 is implemented, and the persons interviewed (position and age).

4. The analyses were prepared using program *IBM SPSS Statistics 22.0 and R 2.15.2.* The following statistical methods were used: correlation, *BoxPlot, MANOVA,*

Factor Analysis Principal Component Analysis, Independent t-test for hypothesis (Frazier et al., 2013).

5. **Quantitative analysis** is presented in Articles I, II. In Article I the results of measurements of work environment conditions (in 19 enterprises and 18 office-rooms) and risk levels in clothing, printing, wood, mechanical, plastic and water purification and in offices are reported.

Article II reports the results of the safety audit by the D&S method in 12 enterprises and the cost-effectiveness of safety measures in five types of manufacturing (metal processing, printing, in plastics industry, in wood processing and garment industry) is calculated.

In Article III **quantitative** analysis of safety audits in 16 enterprises using the MISHA method is provided. The paper contains a comprehensive qualitative study which sheds light on the Estonian corporate safety policy and the system.

Article IV describes data of the statistical analysis between different subareas of safety.

Article V contains a **quantitative** analysis part as the correlative analysis of the safety audit data presented in Article III.

As a result of the study, the enterprises were divided into three sub-groups: locally-owned, corporated and enterprises where OHSAS 18001 is implemented. In Articles IV and V, the **qualitative** analysis cover the part of the connections between the formal and real safety and the possibilities to move from the formal safety to the real safety area.

Article VI presents the **qualitative** analysis of the MISHA questionnaire and the developed training package for the line management to learn through interviews.

More information on research techniques and the results of the investigations by the articles are presented in Table 2 (Appendix 8).

3. RESULTS

The results were derived from the on-site observations as well as from employee interviews and calculations by the MISHA method (Article III). According to the MISHA method, the total activity scores (Table 3) varied 73.94…93.33 for OHSAS 18001-certified organisations (group I) and 29.10…88.08 for non-certified organisations (group II). This demonstrates that normally the companies who have implemented OHSAS 18001 benefit from it in safety performance as the activity scores are considerably higher than those for non-certified companies. The activity scores of the study showed that OHSAS 18001 non-certified companies can be subdivided – four companies (P, Q, R and V) belonging to Nordic or global corporations (scores 79.80…88.08) and four companies (K, O, Y and Z) which are locally established and owned (scores 29.10…52.73). It shows that the safety management systems owned and run by the local businessmen may lack in several OHS activity areas. The reasons may lie in the lack of the resources, knowledge and skills, time while companies belonging to corporations are able to prioritise safety more. In the results among group I (OHSAS 18001 certified organisations), scores between locally owned businesses (companies L, M) and international corporations (N, S, T, U, W, X) do not differ.

Table 3. Activity rating according to framework elements calculated by the MISHA method (grey rows – OHSAS 18001-certified companies; white rows – without certification, local; rose rows- corporated, non-certified OHSAS 18001 companies; total score=100)

Identifi-cation	A: Organisation and administration	B: Training and motivation	C: Work environment	D: Follow up	Total activity score
K	31.88	57.58	60.00	44.44	46.67
L	85.02	68.69	74.07	42.59	73.94
M	85.51	78.79	75.56	61.11	78.79
N	92.75	87.88	80.00	66.67	85.45
O	24.64	33.33	35.56	22.22	29.09
P	86.96	96.97	90.00	69.44	87.88
Q	88.89	97.98	81.48	83.33	88.08
R	85.51	86.87	74.07	59.26	79.80
S	91.30	90.91	79.26	75.93	86.26
T	89.86	87.88	75.56	83.33	84.85
U	84.06	78.79	71.11	72.22	78.18
V	89.86	69.70	84.44	77.78	83.03
W	69.57	81.82	80.00	72.22	75.15
X	97.10	100.00	88.89	77.78	93.33
Y	31.88	54.55	57.78	16.67	41.82
Z	37.68	60.61	73.33	44.44	52.73

Looking at the results according to activity areas (Table 3), the following general conclusions can be drawn:

- The OHSAS 18001-certified organisations gained very high scores for element A (organisation and administration) which is mainly establishment of written documents (formal safety). Non-certified companies had low scores for element **A** when they are locally owned and high scores when they belong to a larger consolidated company.
- The differences for element **B** (training and motivation) are not as high as for element A, as training is strictly regulated by national legislation and therefore, each company, certified or non-certified, has to follow the requirements.
- Scores for element **C** (work environment) are high; - they vary slightly for the certified companies and are lower and vary more for the non-certified companies. The difference comes mainly from lack of dealing with psychological risk factors.
- Scores for element **D** (follow up) vary both for the certified and non-certified companies. It represents the real safety performance, registration and investigation of accidents and absenteeism as well as the measurements of workability of employees. As this is partially not regulated by legislation, the scores are diverse.

The hypotheses of this thesis research are set forward in the Article IV. The results are presented in Table 4. Two of the postulated hypotheses (H7 and H10) were not confirmed: no difference in psychosocial climate between OHSAS and NOHSASL companies was found, neither was there any higher appreciation on physical workability observed.

Hohnen and Hasle (2011) noticed the same shortcomings in their study, especially lack of concern with psychosocial work environment in an OHSAS company. Sampling adequacy was controlled by the Kaiser–Meyer–Olkin (KMO) measure. For these data, the KMO value is 0.83, the range indicated as large and there for the sample size is adequate for the factor analysis.

Table 4. Statistical analysis of the hypotheses (Article IV)

Hypotheses*		**Hotelling's T-square test statistic**	**P-value**
H1: OHSAS 18001 helps to disseminate the information at all levels of organisation.	OHSAS VS NOHSASL	11.128	0.008
H2: Written safety policy plays an important role in OHS management.	OHSAS VS NOHSASL	259.461	0.000
H3: OHSAS 18001 helps more effectively to organise OHS activities in the companies.	OHSAS VS NOHSASL	8.944	0.014
H4: OHSAS 18001 promotes the interaction between supervisors and employees.	OHSAS VS NOHSASL	5.132	0.047
H5: The employees are better trained in OHS at OHSAS 18011-certified companies.	OHSAS VS NOHSASL	23.3383	0.001
H6: OHSAS 18001 improves the development of the physical working conditions.	OHSAS VS NOHSASL	15.167	0.003
H7: There is a difference in psychosocial climate for OHSAS 18001 certified and non-certified organisations.	OHSAS VS NOHSASL	2.076	0.180
H8: Occupational health service activities are better organised in OHSAS 18001-certified organisations.	OHSAS VS NOHSASL	11.128	0.008
H9: OHSAS 18001 favours the registration and investigation of accidents, illnesses and near misses.	OHSAS VS NOHSASL	25.783	0.000
H10: Physical workability is appreciated higher in OHSAS 18001 certified organisations.	OHSAS VS NOHSASL	1.808	0.208
H11: Social work environment is regularly monitored in OHSAS 18001-certified organisations.	OHSAS VS NOHSASL	32.523	0.000

The explanation behind H7 may be that OHSAS 18001 does not emphasise psychosocial climate as one of its key elements. Most of the companies examined have little knowledge for dealing with psychosocial hazards. Hypothesis H10 is not supported while the study has revealed that physical workability irrespective of a company type is not assessed as there is generally no policy how to measure and deal with employees' workability.

3.1. Model of the influence of OHSAS 18001 on the improvement of safety level at enterprises

To determine the impact of OHSAS 18001 on formal and real safety performance, a statistical analysis was conducted. As a result, a conceptual model (Fig. 2) was created based on whether the safety element contributes to **formal, real or combined safety** (Fig. 2a, 2b, 2c, 2SUM, Article V).

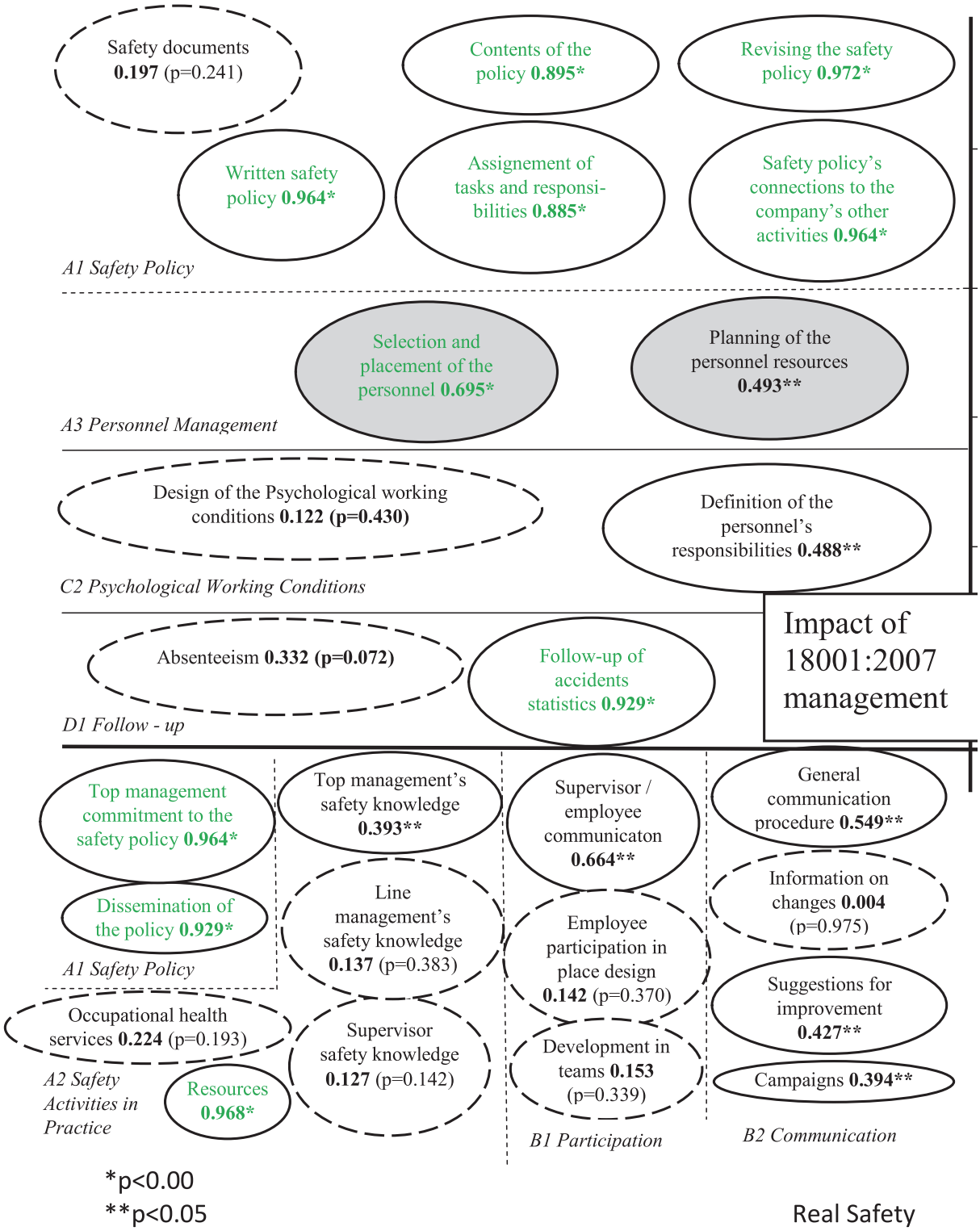
The highest impact of OHSAS 18001 (shown in Figure 2 with green color) on the safety elements is on the written safety policy, revising the safety policy, safety policy's connections to the company's other activities and follow-up of accidents statistics; contents of the policy, assignment of the tasks and responsibilities, selection and placement of the personnel, which all found in the **formal** safety area; top management commitment to the safety policy, dissemination of the policy, resources - from the **real** safety area; and participation in the preparation of the safety policy, workplace hazard analysis, assessment of the work environment - from the **combined** safety area. Thus, these components are dependent on the company type (OHSAS, NOHSASC, NOHSASL).

Three formal safety elements (shown in Fig. 2 with dotted line): safety documents, absenteeism and design of the psychological working conditions were not found dependent on the company type since no correlation was shown. All the other formal safety elements were found dependent on the company type (Fig. 3, Article V).

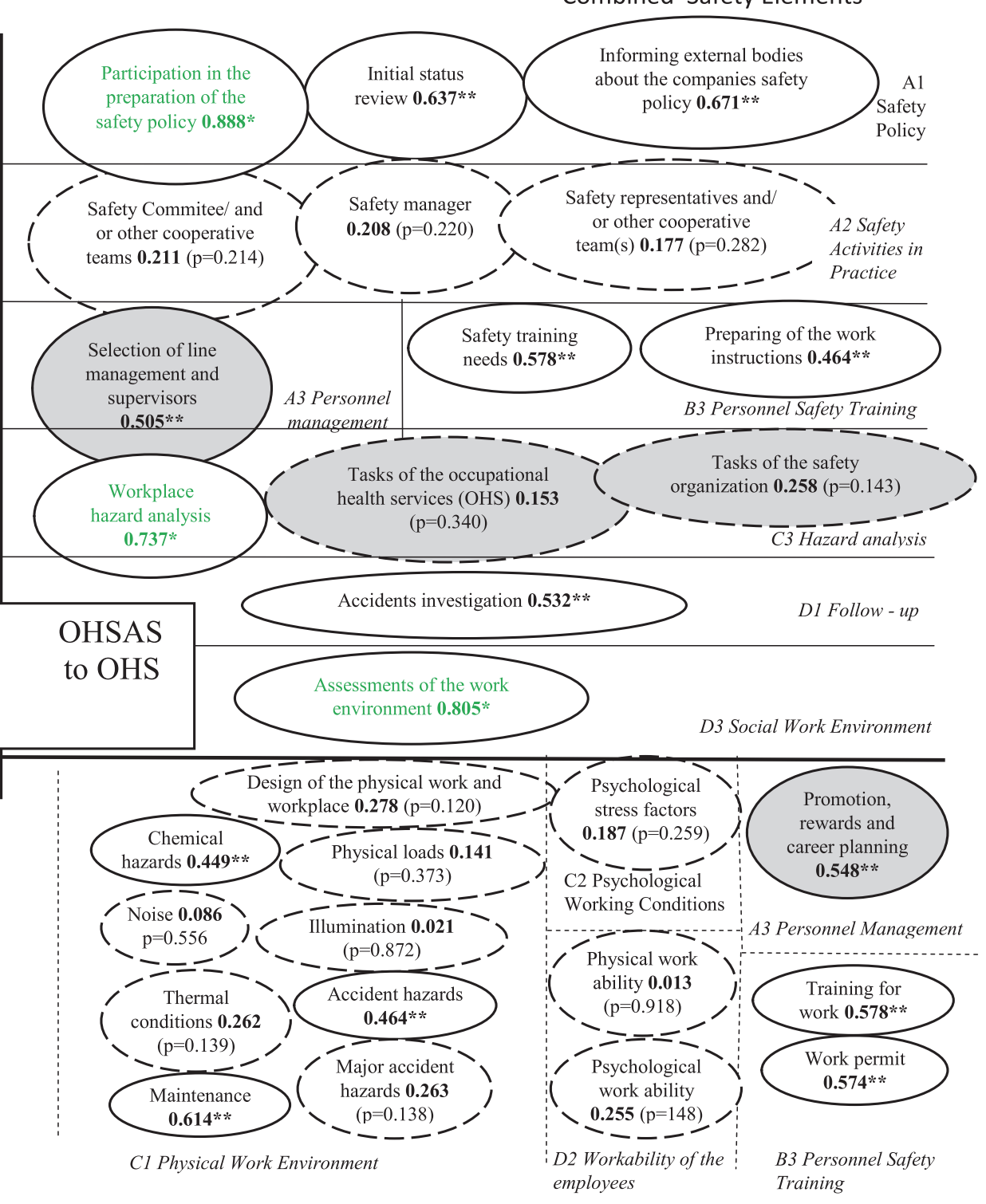
Implementation of OHSAS 18001 standard contributes only partly to real safety elements (Fig. 2 with green colour) such as top management commitment to the safety policy, dissemination of safety policy and resources. For many real safety elements (Fig. 4, Article V) strong demands from the corporations influence safety activities more than requirements derived from OHSAS 18001 standard, for example suggestions for improvements; general communication procedures; promotion, rewards and career planning and safety knowledge among supervisors, line managers and top managers.

The results (Fig. 2) indicate that all the elements form a safety policy that depends on the company type, while all the elements from safety activities in practice had no significance for the company type. From hazard analysis procedures, two elements – tasks of the occupational health services and tasks of the safety organisation did not correlate with the company type, while workplace hazard analysis was found dependent on the company type (Article V). Additionally elements from personnel safety training, accident investigation and assessment of the work environment showed significant difference. It is clear why OHSAS 18001 standard contributes to the participation in the preparation of the safety policy as it is reasonable to engage employees in the preparation stage in order to strengthen the relationship between employees' safety principles and employers' safety standards. Assessment of work environment was found strongly dependant on the company type although NOHSASC companies tend to assess the comprehensive risk and measure occupational hazards even more regularly than OHSAS companies, while NOHSASL companies hardly perform regular activities in this field. Interestingly, accident investigation is performed more actively by NOHSASC companies.

Figure 2. A conceptual model: OHSAS 18001 and the impact of the Formal Safety Elements



safety key elements in the scope of formal, real or combined safety



Obviously, the need to report and compare numeric results between subunits is a determinant factor. Clearly, elements from A2 (presence of safety manager, safety committee and safety representatives) are required by general OHS law, which irrespective of its type, every company has to follow.

Majority of safety documents are required by OHS legislation and therefore OHSAS 18001 plays an insignificant role in implementing basic safety documents. Absenteeism investigation is required by OHSAS 18001, however it is complicated to conduct it in practice due to restrictions in Estonian Personal Data Protection Act (2007), and therefore our study showed that all types of companies have difficulty with research about absenteeism.

Implemention of OHSAS 18001 contributes to higher **formal safety performance** – safety activities are systematically planned and it guarantees higher preconditions for the formal safety performance.

In the study of real safety elements, a statistically significant difference was found in **real safety performance** based on a company type (OHSAS, NOHSASL, NOHSASC) (Article V*)*. Among real safety elements statistical analysis showed numerous other safety factors that are independent of company type (Fig. 4, Article V). Other real safety elements were found dependant on the company type.

A statistically significant difference appeared in **combined safety performance** based on a company type (OHSAS, NOHSASL, NOHSASC).
Fig. 5 (Article V*)* presents the results of each real and formal safety element calculated by the MISHA method according to the company type.

The results indicate that all the elements form a safety policy dependent on the company type, while all the elements from safety activities in practice had no significance for the company type. From the hazard analysis procedures two elements – tasks of the occupational health services and tasks of the safety organisation were not correlation with the company type, while workplace hazard analysis was dependent on company type.

3.2. Connections between the Articles and fulfilment of the previous research gap

Articles I and II give the basis for further research (see Fig. 3). Risk assessment is the main tool from the year 1998 in Estonia that gives the information on the hazards in the enterprises. It is the basis for medical examinations of the employees as the law (OHS Act, 1998) imposes the risk assessment and the risk assessment quality, which are under surveillance of the National Labour Inspectorate officials. Risk assessment is a part of the safety management system.

Beginning from Article II the research is concentrated on the gap that prevails in the effectiveness of safety management system. Safety audit by the Diekemper and Spartz method was chosen to enable the comparison of the results in the Estonian enterprises with the results of audits in Finland and the US.

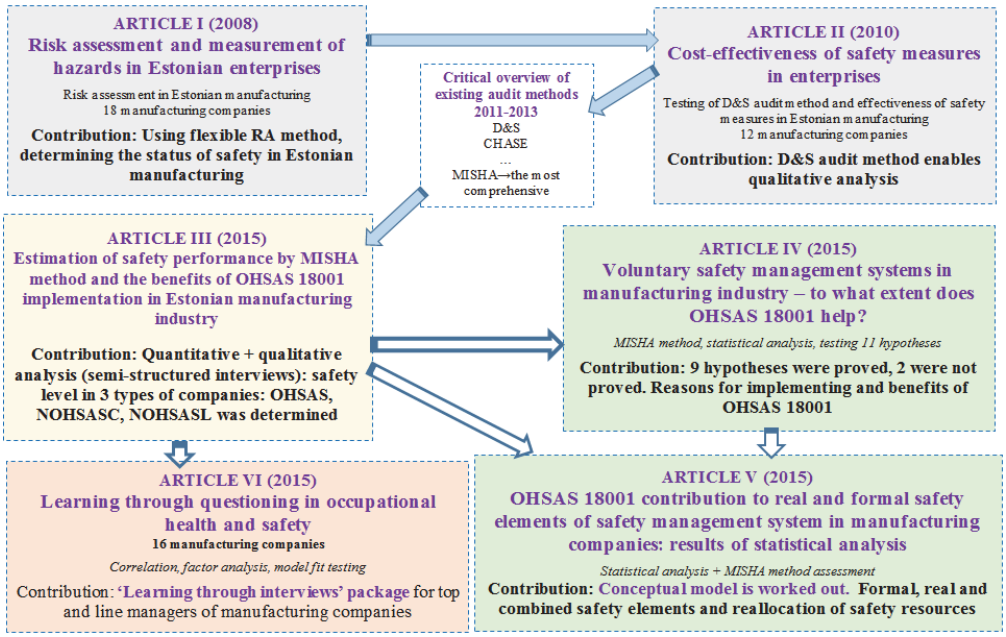


Figure 3. Contribution of the study, structured according to Articles I-VI.

Safety policy and safety plan in the investigated enterprises (in 2008) were not available in the written form. Supervisory participation, motivation and training were the activities that scored low (Article II).

After the critical observation of Articles I and II, the MISHA method was chosen for further research. Article III presents the data in two types of enterprises in Estonia: OHSAS 18001-certified organisations and non-OHSAS certified organisations. The first part in the second group of companies was locally-owned (NOHSASL), the other part - larger corporations (NOHSASC). The latter showed existence of better safety level in the enterprise.

The study (Articles IV and V) showed that safety needs commitment and systematic approach. The key elements of the safety management are safety policy, top managements' commitment to the safety policy, safety knowledge and training etc. If any of these key-elements is missing, it influences the whole result. The main important key-element is the safety policy, recommended in the written form. These results are in line with the earlier studies (Tint et al., 2010; Fernandez-Muniz et al., 2012a, b; Reinhold and Tint, 2013).

Articles IV and V present the statistical analysis of the use of MISHA method for the assessment of safety level at enterprises. The current study (on the basis of the audit results in Article III) supports different positive hypotheses (Article IV) on the OHSAS 18001 benefits: it favours accidents, illnesses and near misses registration; it supports regular monitoring of social work environment; contributes to more effective safety training etc. A study conducted in Finland (Koivupalo. et al, 2015) to examine OHS MS in a global steel company revealed that local OHS practices and tools varied significantly between sites and there was not any common practice or tool in use.

According to the results of the audits, we can conclude that in OHSAS companies OHS management functioned both in paper and in practice. However, in one or two cases, a doubt of window dressing and maintaining the system without practical value existed. A similar problem was encountered in a Danish study by Granerud and Rocha (2011). They demonstrated that five OHSAS 18001 certified manufacturing companies address health and safety issues in very different ways, including one manufacturer where the coupling took place and no legal requirements were complied. The study raises the question of the impartiality of the certification agencies. However, in conclusion, Granerud and Rocha (2011) state that OHSAS 18001 certification will not necessarily lead to higher levels of safety performance, and it is not an obstruction to more advanced or innovative practices.

The investigation of 16 manufacturing enterprises (Article V) in Estonia enabled the author to compose the **conceptual model** (Fig. 2) of the contribution of OHSAS 18001 to a company's safety activities. The results show that OHSAS 18001 certification facilitates company's commitment to health and safety activities. The connections between the four safety and health indicative areas (through the questionnaire) are presented and the correlations calculated (Article VI). The statistics showed that it is not necessary to divide the safety audit questions exactly to four areas, as correct elaboration and grouping of the questions is important. It is possible to learn through the interviews.

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" or "not applicable"; alternatively, the respondents have to answer descriptively. The total result of the questionnaire is qualitative. If needed, the questionnaire and answers can be developed to the quantitative result. In this case, the employees in the safety chain can compare their knowledge in OHS. The questionnaire was tested in two enterprises (one OHSAS and one NOHSAS) with 3 persons (the employer, safety manager and the working environment representative). The feedback helped to review questions and make minor corrections. The validation of the questionnaire remains for the future research.

The proposed version of the "training through the questionnaire" learning package based on statistical and qualitative interviews and the MISHA method is presented in Article VI.

3.3. Implications

The results of our study presented correlations between safety activity areas according to different company types. This promotes a better conception to understand how various safety activities are interconnected and explains how employers emphasising one specific safety element can smoothly influence positively other safety issues.

From the study we can conclude that safety level and performance depends largely on the safety management in enterprises, the involvement of top managers in safety and health. The cost-effectiveness of safety measures is dependent on the uncertainty of safety measures. If the uncertainty is higher (several workers are involved), the cost-effectiveness can be also higher as it improves the working conditions of more than one person.

Implementation of OHSAS 18001 creates a basis for a systematic work in the area of safety management. Other authors (Ma et al., 2001; Fernandez-Muniz et al., 2012a, b) have demonstrated that the implementation of OHSAS 18001 is merely the first step towards the systematic process of safety management. The companies need to have a supportive safety climate. Our investigation showed that psychosocial hazards are difficult to measure and to find suitable control measures and solutions. Danish study (Hohnen & Hasle, 2011) showed similar result: psychosocial work environment turned to be complex and the solutions to find were complicated.

OHSAS 18001 is regarded as the strategic tool for improvement safety performance. The knowledge of the company, which is the tendency of safety elements (real or formal safety), able the company to reallocate the resources in a way that all safety elements are covered. It is natural to deal with real safety elements as they are more visible, but also with formal and combined safety, as those elements add value to the systematic health and safety work in a company. A safety management system can be effectively implemented also without 18001 implementation, but then it requires affiliation to a larger corporation or concern. This indicates that OHSAS 18001 does not contribute significantly to most of the real safety activities.

The implementation of the results is supplied with the preparation of a “training through the questionnaire” learning package providing the management with tacit knowledge. This may enhance the working conditions with minimal or moderate efforts.

4. CONCLUSIONS

The study showed that the implementation of OHSAS 18001 contributes to the enhancement of safety management system at enterprises. However, the same target can be achieved by the other means (e.g. corporate guidelines) combining safety objectives directly with managerial goals. The results of the doctoral thesis propose an effective implementation of the safety auditing to determine the key elements in the safety management system enabling the whole company to benefit from it. Based on the research of the Estonian manufacturing companies (textile, metal, plastic etc. engineering), a conceptual model of OHSAS 18001 contribution was created in order to enhance safety activities.

According to the safety activities score, the companies were examined in three different categories: 1) OHSAS 18001-certified organisations, 2) organisations that belong to a larger corporation or concern but are not OHSAS 18001-certified and 3) non-certified, locally established and owned companies. The study showed considerable differences in the safety level in the OHSAS 18001-certified and non-certified, locally established and owned companies.

The relevance of various key elements on the safety management system were determined (like safety policy, management's commitment to the safety, recourses, workplace hazard analyses etc.). Analyses of the association between the key elements in the conceptual model proved that the weakness of one key element might affect others to function properly. The safety activities in a company depend strongly on the consistency of safety policy and the manager's commitment to the safety activities. OHSAS 18001 is a recommended tool to improve safety performance. Safety management system can be effectively implemented also without possessing the OHSAS 18001 certification, but in the Estonian economy market, it usually requires affiliation to a larger corporation or concern.

For the investigation of the safety management system, the MISHA method can be successfully used in the manufacturing industry. It offers a comprehensive possibility to evaluate a SMS in the present-day society: among other activity areas on top management commitment and safety knowledge, it emphasises psychosocial hazards and integration of personnel management. However, some modifications may be needed due to the national differences in the safety activities (e.g. occupational health service principles and structure vary from country to country). One possible extended and modified version of MISHA method has been created as a new learning package "Learning through interviews" in order to increase managers' safety knowledge and thus, safety level in SMEs. It should be kept in mind that the interviewer should be competent in OHS legislative and other requirements. The study proved that key elements provided by MISHA method can be successfully integrated to a new conceptual model for safety management systems.

The theoretical contribution of the study is providing a conceptual model of safety management system through clarification of the key elements and incorporating OHSAS 18001 core principles. The model creates a support to safety

management system and emphasis the significance of interactions of real, formal and combined safety.

The dissertation presents important empirical evidence of the existing occupational hazards (chemical, physical, physiological) in manufacturing industries and indicates some essential safety flaws. Several recommendations for the improvement of the occupational health and safety status (Articles I - V) have been proposed: the risk assessment as the first step towards systematic OHS prevention; workplace safety enhancement through management supportive approach towards safety activities; implementation of cooperation between the manager, the safety personnel, work environment representative and workers in order to promote OHS matters; the certification of OHSAS 18001 for integrating safety to management goals; the contribution of MISHA method for comprehensive safety auditing; the availability on written safety policy to elaborate SMS; the need of emphasising formal safety elements which affect real safety performance and vice versa. The study increases understanding of the current management knowledge about OHS activities and provides the conceptual clarification of **the role of systematic discussion** during the interviews for increasing the management's safety knowledge (Article IV, VI).

There are two valuable methodological contributions of the thesis. First, the study sheds new light on the usability and applicability of the two comprehensive safety auditing methods (Diekemper & Spartz and MISHA) for the investigations of the functioning of the safety management system at enterprises. The evaluation of safety audit methods identified few weaknesses and proposed modifications for explicit implementation. The second methodological contribution includes the proposed, advanced education elements containing approach to improve the managers' safety knowledge. For this purpose, the new learning through the interviews package is developed (Article VI).

Practical value of the thesis lies on the identification of the commonalities in order to improve the contribution of safety auditing to safety management processes and practices in a selected sample of Estonian enterprises. The thesis provides several practical proposals for the use of the safety audit in order to assess real safety elements; for minimising the discrepancies between the real and formal safety with an effective safety auditing; for the improvement the OHS situation at the enterprise level and to increase managers' safety knowledge with a new learning package „Training through the questionnaires".

The results from the current research are valuable for the safety and strategic management researchers, for lecturers, students, OHS professionals, and safety managers in manufacturing enterprises, for the decision-makers at the organizational and state level.

Some **limitations of the study** are inevitable to describe. The first limitation concerns the usage of qualitative and quantitative approach within the same study. Even though it gives a comprehensive overview the qualitative is limited to a certain number of person interviewed, and thus the results reflect their tacit knowledge and experiences. Furthermore, the sample of case studies may not be entirely representative to draw general conclusions for all manufacturing enterprises. However, the study is able to provide main tendencies and characters of safety

management in manufacturing industry in Estonia. The second limitation is mainly connected with the necessities to expand the MISHA method scope. The current method was developed in 2000, but due to the rapid change of technologies, new emerging risks arisen during 2000-2015 needs updating. These include risks connected with the electromagnetic fields from the industrial equipment (Baltrenas and Buskus, 2011; Bednarek, 2010; Röösli et al., 2004), (non-)ionizing radiation (Schemhammer et al., 2006), the use of computing and mobile equipment at work.

Several future research areas can be addressed. In the current study, the manufacturing companies were divided into three groups: OHSAS 18001-certified organisations; organisations within larger corporation or concern but are not OHSAS 18001-certified and non-certified, locally established and owned companies. However, the research showed that OHSAS 18001-certified organisations can be sub-divided as well: OHSAS 18001-certified and corporated companies and OHSAS 18001-certified and locally owned companies. These four groups can give different results and should be used for further investigations. In-depth analysis of safety values, attitudes and formal/real safety performance in different management levels (top management, line management, supervisor, workers' representative etc.) are needed. So, further investigations have to concentrate more on interviews (the employers and the employees representatives) in the same company. In the selected enterprises, the top management, middle-stage safety personnel, working environment specialists and working environment representatives were interviewed. The safety values and formal/real safety can be perceived differently in different management levels. Those differences should be studied in-depth, which remains for the future research. It is also recommended to link the cost-effectiveness analysis with the results of the study on safety key elements. In addition, "Training through the questionnaire" learning package validation is needed and its implementation in the Estonian safety training practices is highly recommended.

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APPENDIX 1

Article 1

P. Tint, M. Järvis, K. Reinhold, **Õ. Paas**. Risk assessment and measurement of hazards in Estonian enterprises. *Environmental Engineering and Management Journal,* 2008, **8** (5), 1165-1170.

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Environmental Integrated Management and Policy Making

RISK ASSESSMENT AND MEASUREMENT OF HAZARDS IN ESTONIAN ENTERPRISES

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Abstract

The paper focuses on occupational hazards and the determination of risk levels. Indoor climate, lighting, noise, chemicals and dust are examined. A simple/flexible risk assessment method is provided. The results of measurements of occupational hazards in six industries (mechanical, printing, wood, plastic, clothing and water purification plants) in Estonia are presented. The overall purpose of the paper is to draw the attention to the importance of measurements of occupational hazards in industry and to act as a reminder of number of issues of practical relevance to effective workplace risk assessment from which employees, employers, occupational hygienists and physicians as well as authorities can benefit.

Key words: measurement of hazards, occupational hazards, risk assessment

1. Introduction and theoretical basis

Risk assessment in the work environment has been a topic for the Estonian occupational health and safety (OHS) researchers since 1996 when the EU's "Guidance of risk assessment at work" became accessible. The Act on Occupational Health and Safety that requires risk assessment to be carried out at every workplace was adopted in Estonia in 1999 (DGV, 1996; OHSAF, 1999).

The existing risk assessment models (on the basis of BS 8800) contain the need to determine the probability of occurrence and the severity of the consequences of the impact of hazardous factors on worker. Some of the versions of risk assessment from BS 8800 (BSI, 1996; BSI, 2004), where the probabilities are given more clearly for the user, are provided by Pekkarinen (2007), Rantanen (2001); the determination of acceptable risk is given by Vasilescu et al. (2008). The model that could be used in the case of accidents is presented in the Table 1.

The chemical exposure limits in Estonia (Resolution, 2007) are determined by two different values: 8 hours' mean concentration in the air of the work environment and short term exposure limit (15 minutes). In addition, the norms also identify three levels of hazardousness of the chemical: harmful, toxic, very toxic.

Table 2 contains two factors: probability (likelihood) of the occurrence and consequences of the harm when a particular hazard is identified. The percentage of exposure limit (<10%, 10-50%, 50-100%) is presented as the probability. Exposure limits are usually expressed as time-weighted, whole-shift concentrations and where necessary, short-term peak concentrations. But in many cases exposure time to the chemical has to be considered at low concentrations, not exceeding the limits.

The determination of the probabilities is complicated for the employer (in Estonia risk assessment could be carried out by the employer himself or by the person or office recognized by the Health Care Board). From 2004, a new version of BS8800 is available that is yet more complicated than the first one (from 1999) (EVS, 2004).

Therefore the Estonian employers, particularly from small and medium-sized enterprises (the number over 50,000) where looking for a simple, flexible risk assessment method that would take into consideration the work environment hazards in a small firm. A method for risk assessment that the employers themselves could use, was needed.

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Table 1. Criteria for the likelihood and consequences of an occupational accident (Pekkarinen, 2007)

Consequences/ Likelihood of dangerous situations	**Slightly harmful** Absence less than 3 days, temporary, slight consequences, sprains, bruises	**Harmful** Absence 3-30 days, long, serious consequences, lasting harm, fractures, burns	**Extremely harmful** Absence more than 30 days, permanent disability, death
Highly unlikely Dangerous situations occasional, appears seldom	**1. Trivial risk** No actions needed	**2. Tolerable risk** Monitoring	**3. Moderate risk** Risk control needed
Unlikely Dangerous situations almost daily, near misses have occurred	**2. Tolerable risk** Monitoring	**3. Moderate risk** Risk control needed	**4. Substantial risk** Urgent actions
Likely Dangerous situations often and regularly, accidents have occurred	**3. Moderate risk** Risk control needed	**4. Substantial risk** Urgent actions	**5. Intolerable risk** Immediate actions

Table 2. Determination of risk level in the case of hazardous chemicals in the air of work environment (Rantanen, 2001; Reinhold et al., 2009b)

Consequences → **Probability** ↓	**Slightly harmful** uncomfortable, irritable feeling, overcoming illnesses R20, 21, 36, 37, 38	**Harmful** burning, skin diseases, long-lasting severe damages, stable slight disturbances R23, 24, 25, 33, 34, 40, 43, 48, 62, 63, 64	**Extremely harmful** poisonings, occupational cancer, asthma, stable severe damages, illnesses dangerous to health R26, 27, 35, 39, 41, 42, 45, 49, 60,61, 65
Highly unlikely severe damage from <10% of the limits (ELV[1]), other 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, other 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, other over limits	**moderate risk** risk reduction measures needed	**substantial risk** risk reduction measures inevitable	**intolerable risk** risk reduction measures to be implemented at once

[1]ELV – Exposure limit value

A simple/flexible risk assessment method was worked out in Tallinn University of Technology (Tint and Kiivet, 2003). It is based on a two-step model that can be enlarged.

In the case of the assessment of the magnitude of risk a simple (flexible) risk assessment scheme is presented (Fig. 1).

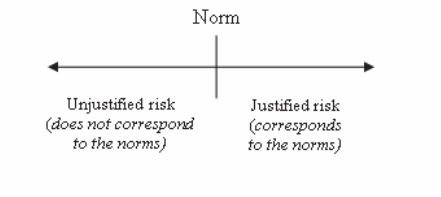

Fig. 1. Two-step model

The two-step model is an attempt to provide a clear, understandable schema which is simple for the user. The model has one boundary line, which is a stable, largely spread number such as an exposure limit (norm in the Fig. 1). The no/yes principle is used or corresponds to the norms/does not correspond to the norms or justified/unjustified risk. The model suits small enterprises and that do not have a complicated combination of hazards or may have inexperienced personnel in work safety assessment.

The model can be enlarged into a six-step model (Fig. 2), where the boundary line is a dotted double line that fixes zero-risk or negligible risk. In fact, we can speak of zero risk only when no hazards exist in the work environment.

The flexible model presented offers every enterprise an opportunity to choose a suitable and feasible scheme for implementation into practice.

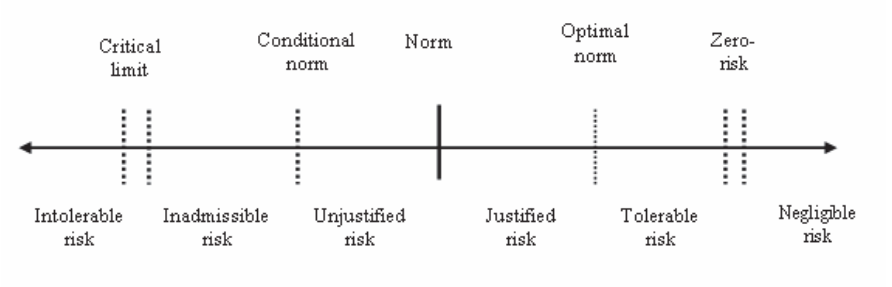

Fig. 2. Six-step model

Table 3. Summary of the investigated companies

Industry	*Number of investigated companies*	*Number of workers in the company*	*Main health hazards measured*	*Awareness of company safety management*
Textile and clothing	5	120…225	Indoor climate, lighting, noise, textile dust	+ (4 cases) ± (1 case)
Printing	3	24…140	Indoor climate, lighting, noise, paper dust, isopropanol	+ (2 cases) – (1 case)
Wood processing	5	25…200	Indoor climate, lighting, noise, wood dust, chemicals	+ (2 cases); ± (2 cases) – (1 case)
Mechanical	2	90…175	Indoor climate, lighting, noise, welding dust, O_3, CO, CO_2, NO-NO_2, HF	± (2 cases)
Plastic	3	25…180	Indoor climate, lighting, noise, general dust, HF	+ (1 case); ± (2 cases)
Water purification	1	160	Indoor climate, lighting, noise	+ (1 case)
Office rooms	18	15…100	Indoor climate, lighting, noise, formaldehyde	+ (9 cases) ± (7 cases) – (2 cases)

(Abbreviations: "+" - stimulating, supportive; "–" - impeding, negative; "±" - neutral)

2. The investigated companies

The examined enterprises were selected considering the most common and obvious occupational hazards present in the industrial sector in Estonia (Table 3). Microclimate, noise and lighting were measured in all industries. Chemicals were selected from those present in the examined industries (formaldehyde (R23/24/25, R34, R40, R43) in the textile and the wood processing industries, toluene (R11, R38, R48/20; R63; R65, R67), xylene (R10, R20/21; R38), butanol (R10-22-37/38-41-67), styrene (R10, R36), benzene (R11, R45, R48/23/24/25), isocyanides (R20/22) in the wood processing industry, hydrogen fluoride (R26, R27, R28, R35, R41) in the plastic industry, isopropanol (R11, 36, 67) in the printing industry, welding gases in the mechanical industry). All the chemicals are characterized with risk phrases (Identification, 1998). Dust was measured in all types of manufacturing industries.

In each company, the management attitude towards health and safety was assessed on the basis of the interest in the results of the research, the supportive actions to provide adequate information and details about the company and its investments into health and safety and the appreciation of workers' health through available protection, benefits, technical and administrative solutions present in the company and further efforts to enhance workplace safety. The awareness and supportive actions of the company management concerning occupational health and safety were assessed as stimulating/supportive, neutral or impeding/negative.

3. Results of the measurements in the work environment

To perform the measurements of occupational hazards, the following standard methods were used: ISO 7726:1998 "Thermal environments – Instruments and methods for measuring physical quantities" (for indoor climate); DIN 5035-6:2006 "Artificial lighting. Measurement and evaluation" (for lighting); ISO 9612:1997 "Acoustics – Guidance for the measurement and assessment of exposure to noise in a working environment" (for noise); WCB method 1150:1998 "Particulates (total) in air" (for dust); EN 482: 1994 "Workplace atmospheres – General requirements for the performance of procedures for

the measurement of chemical agents"; EN 689: 1996 "Workplace atmospheres – Guidance for the assessment of exposure by inhalation to chemical agents for comparison with limit values and measurement strategy"; EN 481:1993 "Workplace atmospheres- Size fraction definitions for measurement of airborne particles"; EN ISO 10882-1:2001 "Health and safety in welding and allied processes- Sampling of airborne particles and gases in the operator's breathing zone – Part 1: Sampling of airborne particles"; EVS-EN 1231:1999 "Workplace atmospheres – Short term detector tube measurement systems – Requirements and test methods"; WCB method 1150:1998 "Particulates (total) in air".

The results of the measurements in the work environment are given in Table 4 and 5.

The five-stage simple/flexible risk assessment model was used for the assessment of working conditions (Fig. 3). The results of risk assessment in other industries are given in Table 6 and in graphical way (Reinhold et al., 2006; 2009a).

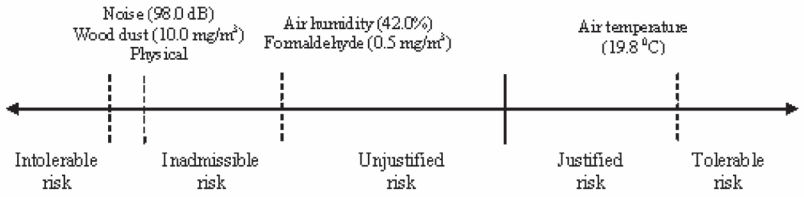

Fig. 3. Assessment of work conditions using a simple risk assessment method in the wood processing industry

Table 4. The results of measurements of indoor climate and noise in manufacturing

Industry	*Indoor air temperature, ^0C, U* = 0.6 ^0C*		*Indoor air humidity, %, U* = 2.0%*		*Air velocity, workplace, m/s, U* = 0.01 m/s*	*Noise level, dB(A), U* = 2.0 dB*
	Cold season	*Warm season*	*Cold season*	*Warm season*		
Clothing	20.3…23.5	22.7…25.6	44.4…53.0	48.2…53.0	0.01…0.04	62.1…89.5
Printing	21.7…22.4	22.5…24.3	38.2…52.2	44.2…62.4	0.01…0.26	66.4…90.3
Wood	21.2…24.0	24.3…26.5	34.2…42.6	35.1…47.6	0.02…0.30	84.2…94.4
Mechani-cal	10.8…21.4	17.6…23.2	31.3…39.9	41.4…48.7	0.01…0.21	73.0…97.5
Plastic	14.0…22.4	18.6…25.5	26.1…40.7	36.5…45.7	0.02…0.07	61.1…83.8
Offices	18.7…23.0	22.4…26.7	32.6…47.9	39.5…54.6	0.01…0.17	46.7…62.4

Table 5. The results of measurements of lighting, dust and chemicals

Industry	*Lighting, lx, U* = 10.4%*	*Dust, mg/m^3, U* = 0.3 mg/m^3*	*Chemicals, ppm or mg/m^3 U = 10…30%*	*Exposure limits for chemicals, ppm or mg/ m^3 (Resolution, 2007)*
Clothing	525…2040	0.4…1.0 (textile dust)	formaldehyde – n.d.	0.6 mg/ m^3
Printing	264…1625	1.2…4.4 (paper dust)	isopropanol - 100 ppm	150 ppm
Wood	320…1050	2.0…10.0 (wood dust)	formaldehyde - 0.5 mg/m^3 toluene - 1- 941 mg/ m^3 xylene- 2.5-347 mg/ m^3 butanol- 0.5- 285 mg/ m^3 styrene- 1-208 mg/ m^3 benzene- 0.8-1 mg/ m^3	0.6 mg/ m^3 192 mg/ m^3; 221 mg/ m^3 150 mg/ m^3 90 mg/ m^3 1.5 mg/ m^3
Mechanical	88…1256	0.7…2.5 (welding dust)	ozone – 0.2 ppm carbon monoxide – 0.1…0.2 ppm carbon dioxide – 120…200 ppm nitrogen oxides – n.d.	0.1 ppm 35 ppm 5000 ppm 25 ppm
Plastic	138…742	2.05…6.04 (general dust)	hydrogen fluoride – 0.5 ppm	1.8 ppm
Offices	644…2640	n/m	formaldehyde- n.d. carbon dioxide-800...3000 ppm	0.6 mg/ m^3 5000 ppm

(Abbreviations: n.d. - not detected, n.m. - not measured, *U - uncertainty, k=2)

Table 6. Determination of risk levels in industrial activities

Industry	*Noise, EL, dB(A)*	*Noise, risk level*	*Lighting, EL, lux*	*Lighting, risk level*	*Dust, EL, mg/m³*	*Dust, risk level*	*Air Humidity, EL, %*	*Air humidity, risk level*
Clothing	85	ID	500-1500	T	1-5-10	J	40-60	J
Printing	85	UJ	300-1200	J	2-5-10	J	40-60	J
Wood	85	ID	400	UJ	2-5-10	ID	40-60	UJ
Mechanical	85	ID	400	UJ	3-5-10	J	40-60	J
Plastic	85	J	300-1000	J	3-5-10	J	40-60	UJ
Water purification	85	J	300-400	J	5-10	J	40-60	J
Offices	55	UJ	400-500	J	5	n.m.	40-60	UJ

(Abbreviations: EL- exposure limit; IT- intolerable; ID- inadmissible; UJ-unjustified; J- justified; T- tolerable risk; n.m.-not measured)

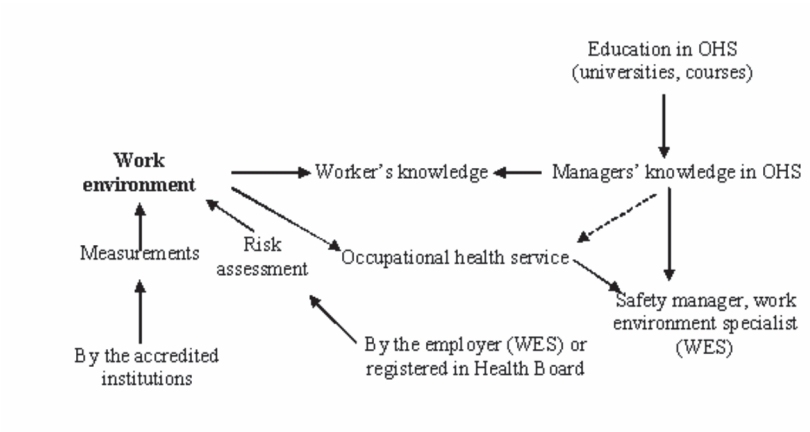

Fig. 4. Model for OHS management at enterprises

4. Model for safety management at enterprise

The investigation of OH personnel (Järvis and Tint, 2009; Kempinen and Sarap, 2002) showed that one of the main obstacles in the way for improvement of safety culture at enterprises is bad quality of risk assessment. Therefore the knowledge given to the managers and also to workers is very important. A model for OHS management at enterprise was developed, implemented into practise (in 6 enterprises) and the key-elements for improvement the situation at enterprises are (Fig. 4): risk assessment at workplaces, cooperation between the employer and occupational health personnel, knowledge management of managers and workers in OHS.

5. Conclusions

Based on the study, the following conclusions can be drawn and remarks should be made:

1. A systemic approach to occupational safety is the key optimizing workplace safety in enterprises. A consistent method for assessing the occupational hazards is recommended. The case studies showed that the simple/flexible risk assessment method created by the authors is viable and applicable in the selected industries assessing physical and chemical risks. The methodology can be used in any kind of company, but small and medium-sized companies are preferred.

2. Using the Estonian experiment, five or four risk levels to characterize risks in a work environment are sufficient and unsophisticated for the employer to understand and use. Triggers need to be in place, so people know how to conduct an effective risk assessment, who to involve and who to inform of the outcome. Preferably, risk assessment should be performed by a person with the necessary technical competence.

3. In the investigated Estonian enterprises, most of the hazards were under control. Noise is one of the main health hazards present in many industries. In the studied enterprises, the noise level exceeded the norms in several cases. The risk to experience noise-induced hearing loss among workers who misuse the protective equipment is significant. The employers should attempt to find additional technical measures to lower the noise levels and encourage the workers to use the personal protective equipment properly.

4. New possibilities for the involvement of workers in the safety management at enterprises have to be considered by the top management of the enterprises. In many of the investigated enterprises, the management's attitude towards occupational health and safety was stimulating and supportive and

the management showed eagerness to enhance workplace safety. However, in several cases it was suggested that the employers should improve the dissemination of information to workers on safety matters, particularly on the accidents and incidents in the enterprise in order to remind them of the importance of following the safety measures for achieving a safe workplace. It is also essential to understand the occupational health and safety needs of an enterprise to allow sufficient freedom to enable workers to use the experience, judgment and skills they have acquired if necessary.

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APPENDIX 2

Article 2

P. Tint, **Õ. Paas**, K. Reinhold.
Cost-effectiveness of safety measures in enterprises. *Engineering Economics*, 2010, **21**(5), 485-492.

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Cost-Effectiveness of Safety Measures in Enterprises

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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.*

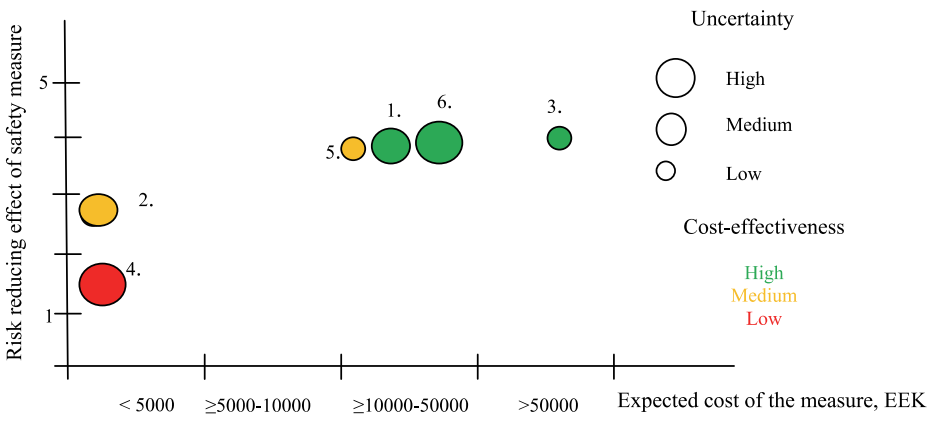

Figure 1. Cost-effectiveness of safety measures in metal processing industry

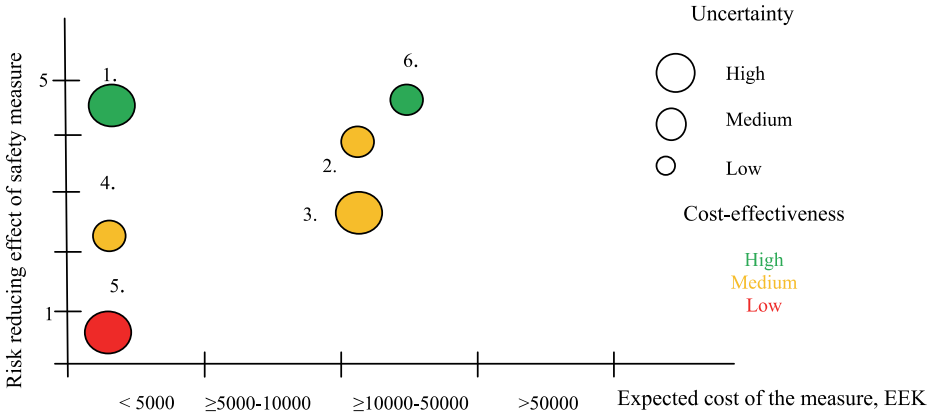

Figure 2. Cost-effectiveness of safety measures in printing industry

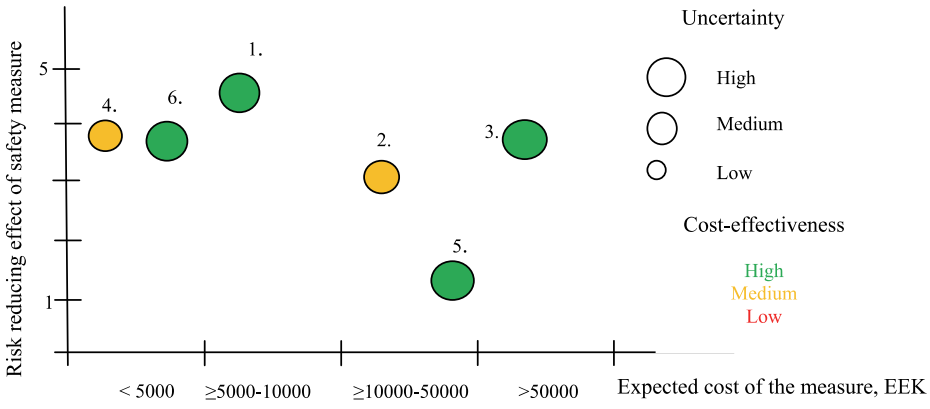

Figure 3. Cost-effectiveness of safety measures in plastics industry

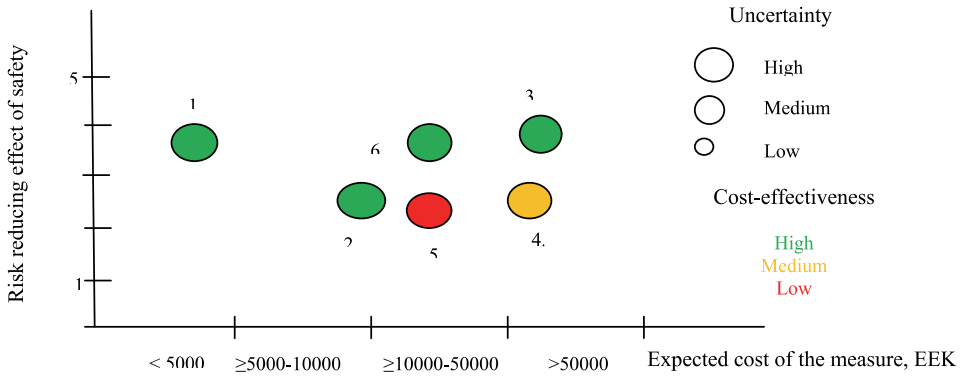

Figure 4. Cost-effectiveness of safety measures in wood processing industry

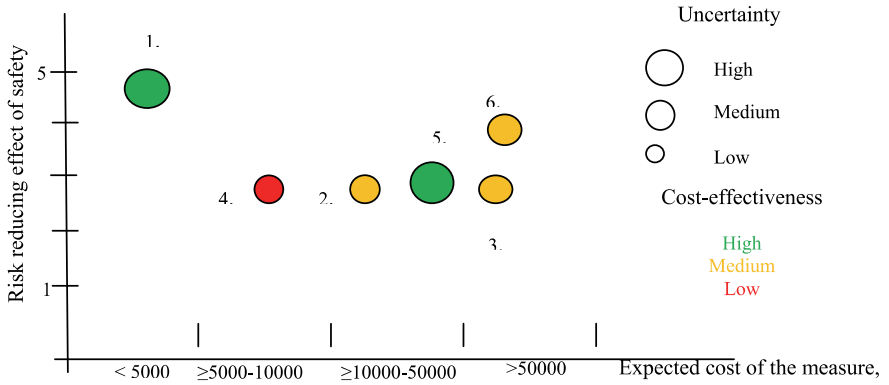

Figure 5. Cost-effectiveness of safety measures in garment industry

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.

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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.*

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APPENDIX 3

Article 3

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Estimation of safety performance by MISHA method and the benefits of OHSAS 18001 implementation in Estonian manufacturing industry

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Abstract. The paper concentrates on safety auditing as a tool for assessment of safety system and safety management in Estonian manufacturing enterprises. The aim of the research was to estimate the safety performance in Estonian manufacturing industry and explore the benefits of OHSAS 18001. Different available safety auditing methods are described. During 2014, 8 (OHSAS 18001-certified organisations) and 8 (non-certified organisations) Estonian enterprises from different branches of manufacturing were interviewed using MISHA method which is in accordance with the present requirements and is the most comprehensive. The results showed that non-certified organisations could be sub-divided into 2 categories: organisations which belong to a larger corporation or concern and locally established and owned companies. The latter showed the lowest scores as in these firms there are deficiencies in several OHS activity areas. Safety activities in a company depend strongly on consistency. Safety needs commitment and systematic approach. If one of the key elements of safety management system is missing, then it can be seen in the results of other framework elements. Our study demonstrates that OHSAS 18001 certificate automatically will not ensure high safety activities in the company. However, following the OHSAS 18001 standard gives a good incentive for a systematic safety activity in all levels in the company and promotes strong improvement process put in use. MISHA method can be successfully used for evaluating safety management systems in manufacturing industry, but it has to be kept in mind that some modifications may be needed due to national differences in safety activities.

Key words: safety audit, safety management system, OHSAS 18001, safety performance, MISHA method.

INTRODUCTION

Safety management system (SMS) is designed in order to deal with occupational health and safety (OHS) in a systematic way by the following activities: setting company's safety targets and objectives; designating roles and responsibilities for safety personnel; planning and performing the hazards mitigation; monitoring, measuring, and improving the on-going system and its effectiveness (Robson & Bigelow, 2010). Measurement is a key step in any management process and forms the basis of continual improvement (HSE, 2001). If measurement is not carried out correctly, the effectiveness of the SMS is undermined and there is no reliable information to inform managers how well the health and safety risks are controlled.

Various evaluation methods can be used for assessing the different aspects of the SMS. The most commonly used methods are: (1) measurement on safety performance through injury and accident statistics, (2) safety audits and (3) management reviews. Safety performance measurement through injury and statistics rates may be problematic due to under-reporting. An emphasis on injury, ill-health and accident rates as a measure, particularly when related to reward systems, can lead to such events not being reported in order to 'maintain' performance. Additionally, injury and accident statistics reflect rather the outcomes than the causes. Safety audit, on the other hand, is a means of directly and comprehensively measure the implementation and effectiveness of company's SMS and covers all the aspects (Karapetrovic & Willborn, 2000). The primary purpose of measuring safety performance is to provide information on the progress and current status of the strategies, processes and activities used by an organisation to control risks to health and safety. The performance measurement system - auditing - must cover each element of the SMS as demonstrated in Fig. 1. For example, the measuring process should establish that a written health and safety policy statement exists, meets legal requirements and best practice, is up to date; and is being implemented effectively.

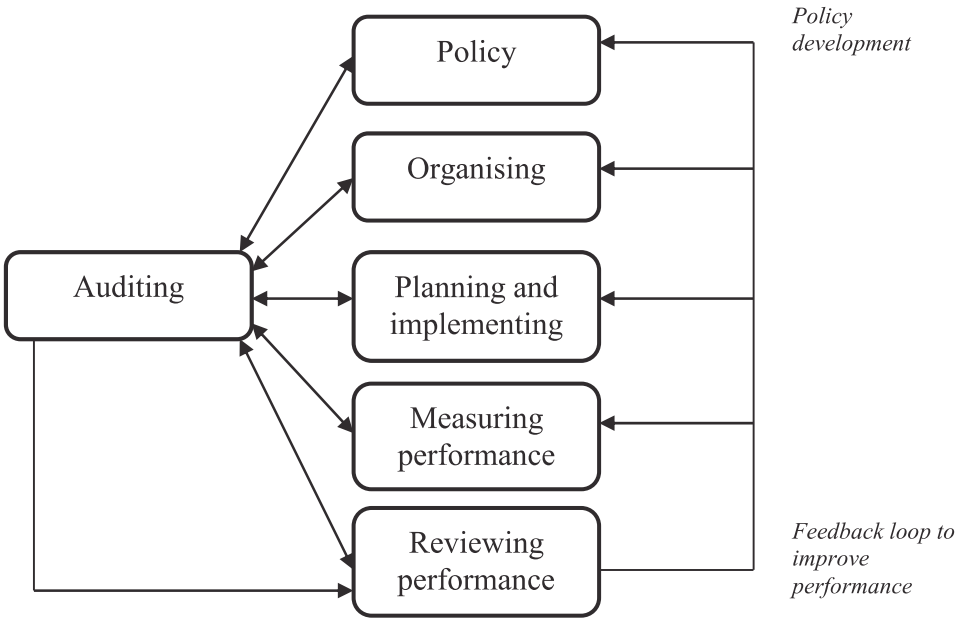

Figure 1. Auditing and performance measurement within the safety management system (adopted from HSE, 2001).

Fernández-Muniz et al. (2007) have significantly expanded the construct in recent years, suggesting an effective SMS should contain six important subfactors: safety policy, incentives for employee participation, training, communication, planning, and control. Fernández-Muniz et al. (2007) included a separate factor of employee involvement. Thus, the additional research in safety management area is needed in the following areas in SMS-s: safety policy, procedures and rules; training; communication;

incident reporting and analysis; safety audits and inspections; rewards and recognition; employee engagement; safety meetings/committees; suggestions/concerns; discipline (Bakker & Schaufeli, 2008; Frazier et al., 2013; Trauman et al., 2013a; Trauman et al., 2013b).

Several safety management related standards, directives, and regulations have been published after 1990's. This progress has been noticeable especially in Europe. The BS 8800 (BSI, 1996) has become the first widely spread general safety management standard. In 1999 the first version of OHSAS 18000 (OHS Assessment Series) was released. The Series consisted of two specifications: 18001 provided requirements for an OHS management system and 18002 gave implementation guidelines. It was intended to help organizations to control OHS risks. Since its publication, OHSAS 18001 has gained considerable acceptance worldwide and has a revised version OHSAS 18001:2007 (OHSAS Project Group, 2007). The fundamental objective of this standard is to support and promote good practice in the area of OHS via a systematic and structured management (Chang and Liang, 2009; Fernández-Muniz et al., 2012b). Another reason for implementation is the need of competitiveness as it enables the organisation to demonstrate to interested parties that the company has an adequate and functioning SMS.

The OHSAS specification is applicable to any organisation that wishes to: (a) establish an SMS to eliminate or minimise risk to employees and other interested parties who may be exposed to OHS risks associated with its activities; (b) implement, maintain and continually improve an SMS; (c) assure itself that the system complies with its stated OHS policy; and (d) demonstrate compliance with this standard to others (OHSAS Project Group, 2007).

Several researchers have demonstrated that OHSAS 18001-certified organisations have an adequate and functioning SMS in order to control occupational hazards (Chang and Liang, 2009; Fernández-Muniz et al., 2012a) and have a stronger management commitment, better organized safety training, higher workers' involvement in safety, more efficient safety communication and feedback, explicit safety rules and procedures, fairer safety behaviour and reasoned safety promotion policies (Vinodkumar & Bhasi, 2011; Fernández-Muniz et al., 2012b). Abad et al. (2013) demonstrates that OHSAS 18001 can be seen as a strategic cost-control tool in order to create and maintain a safe working environment and through it, lower the rate of workplace accidents and interruptions in the production process.

Several instruments have been developed (Diekemper & Spartz, 1970; Eisner & Leger, 1988; Collision & Booth, 1993; SafetyMap, 1995; Dyjac et al., 1998; Redinger & Levine, 1998; Kuusisto, 2000; Bunn et al., 2001; Pearse, 2002; LaMontagne et al., 2004). Authors of the current study started with D&S method (Diekemper & Spartz, 1970; Tint et al., 2010b). However after the analyses of different methods, the MISHA (Method for Industrial Safety and Health Activity Assessment (Kuusisto, 2000)) method was chosen based on its comprehensiveness and compliance with high expectations for health and safety. As the results for the MISHA instrument (Kuusisto, 2000) can be considered preliminary (compared to other methods which do not apply), since they were investigated in only workplace for the final version of the instrument, the authors have decided to test this method.

The aim of this research was to estimate the safety performance in Estonian manufacturing industry and determine the benefits of OHSAS 18001 certification.

The main objectives were: (1) to evaluate the available safety auditing methods and determine the most relevant for manufacturing industry, (2) to conduct safety interviews in 16 industrial companies in order to find the gaps in safety activities and performance and (3) to examine the positive outcomes of OHSAS 18001 for real safety performance.

MATERIALS AND METHODS

On the basis of critical overview of the existing auditing methods, MISHA method (Kuusisto, 2000) as the most innovative was chosen for the current study. The MISHA method considers the following area of industrial activities: A. organization and administration (safety policy and safety activities in practice, personnel management); B. participation, communication, and training; C. work environment (physical work environment, psychological working conditions, hazard analysis procedures); D. follow-up (occupational accidents and illnesses, work ability of the employees, psychological work ability).

To select industrial companies for the research, the database of Estonian Association for Quality (2014) was scanned. By January 2014, 178 Estonian companies owned OHSAS 18001 certification. The scan showed that 32% of certified firms come from manufacturing sector. The authors contacted each of these firms and explained briefly the purpose and the scope of the research. Finally eight companies (representing main manufacturing areas in Estonia such as printing, textile, metal, food industry etc.) agreed to participate which was enough to perform a qualitative study. In order to compare the results with non-certified organizations, eight companies with similar background were selected. The data collection was performed during 2014, when 8 (OHSAS 18001-certified organisations, group I) + 8 (non-certified organisations, group II) 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 were asked from each of the person interviewed (MISHA method). Once data collection had ceased, the first author and the interviewer (ÕP) re-heard the records, and checked the coding strategy used for consistency and ensured that all questions had been answered. The second author (KR) then listened to the records and made notes about understanding the answers. After that, the two first authors discussed the answers of each company to come to a good level of agreement about the results (Table 2, 3 and 4). Table 1 presents the characteristics of the examined enterprises – the activity area, lifetime, size, the overall assessment on safety by an expert-interviewer, if OHSAS 18001 is implemented, and the persons interviewed (position and age).

RESULTS AND DISCUSSION

The results described were derived from on-site observations as well as from employee interviews and calculations by MISHA method. According to MISHA method, the total activity scores (Table 2) varied 73.94…93.33 for OHSAS 18001-certified organisations (group I) and 29.10…88.08 for non-certified organisations (group II). This demonstrates that normally, companies who have implemented OHSAS 18001 benefit from it in safety performance as the activity scores are considerably higher than for non-certified companies.

Table 1. The characterisation of enterprises investigated (N = 16)*

Id. of the company	The activity area	Life-time, years	Size, employees	The overall assessment on safety** Likert scale***	OHSAS 18001 imple-mented	The persons interviewed: position, age
K (Int 1)	Textile industry	11–25	50–249	3	–	Production manager, 38
L (Int 2–4)	Plastic industry	11–25	50–249	4	+	Quality manager, 41 Safety manager, 62 WER, 25
M (Int 5)	Furniture industry	> 50	50–249	4	+	Personnel manager, 64
N (Int 6)	Heat industry	> 50	50–249	5	+	Quality and environment manager, 58
O (Int 7)	Printing industry	1–10	< 50	2	–	Production manager, 36
P (Int 8–9)	Metal industry	> 50	≥ 250	5	–	Safety manager, 35 Trade union representative, 60
Q (Int 10–12)	Elect-ronics industry	11–25	≥ 250	5	–	Quality manager, 36 Safety specialist, 42 WER, 53
R (Int 13–15)	Food industry	> 50	≥ 250	4	–	Safety specialist, 62 WER I, 34 WER II, 39
S (Int 16–18)	Elect-ronics industry	11–25	≥ 250	5	+	Quality manager, 59 Safety manager, 39 WER, 66
T (Int 19)	Metal industry	> 50	≥ 250	5	+	Safety manager, 64
U (Int 20)	Food industry	> 50	≥ 250	5	+	Safety manager, 37
V (Int 21)	Metal industry	1–10	< 50	4	–	Production manager, 36
W (Int 22)	Wood processing industry	1–10	≥ 250	4	+	Quality manager, 47
X (Int 23)	Food industry	> 50	≥ 250	5	+	Safety chief specialist, 68
Y (Int 24)	Glass industry	11–25	< 50	3	–	Production manager, 41
Z (Int 25)	Textile industry	11–25	≥ 250	2	–	Health and safety manager, 67

*Companies are listed and coded in chronological order; **assessed by expert-interviewer; ***Likert scale: 1 – poor, 2 – average, 3 – good, 4 – very good, 5 – excellent;
Abbreviations: Id. – identification; Int – interview, WER – working environment representative.

Table 2 also demonstrates that the activity scores for OHSAS 18001-certified organisations vary slightly while the activity scores of non-certified companies differ considerably more – which means that the safety level depends on ownership, size of the

company, dedication and attitudes of the top management, knowledge and resources availability and the consistency of safety activities in the company. However, the scores also show that some companies with no OHSAS 18001 certification can function as safely as the ones having the certification; mainly due to affiliation to a larger international consolidated company with developed safety systems.

The activity scores of the study showed that non-certified companies can be subdivided – 4 companies (P, Q, R and V) belonging to Nordic or global corporations (scores 79.80…88.08) and 4 companies (K, O, Y and Z) which are locally established and owned (scores 29.10…52.73). It shows that the safety management systems owned and run by local businessmen may lack in several OHS activity areas. The reasons may lay behind lack of resources, knowledge and skills, time while companies belonging to corporations are able to prioritize safety more. Examining results among group I (OHSAS 18001-certified organisations), there is no difference in scores between locally owned businesses (companies L, M) and international corporations (N, S, T, U, W, X).

Table 2. Activity rating according to framework elements calculated by MISHA method (grey rows – OHSAS 18001-certified companies; white rows – without certification; total score=100)

Identification	A: Organisation and administration	B: Training and motivation	C: Work environment	D: Follow up	Total activity score
K	31.88	57.58	60.00	44.44	46.67
L	85.02	68.69	74.07	42.59	73.94
M	85.51	78.79	75.56	61.11	78.79
N	92.75	87.88	80.00	66.67	85.45
O	24.64	33.33	35.56	22.22	29.09
P	86.96	96.97	90.00	69.44	87.88
Q	88.89	97.98	81.48	83.33	88.08
R	85.51	86.87	74.07	59.26	79.80
S	91.30	90.91	79.26	75.93	86.26
T	89.86	87.88	75.56	83.33	84.85
U	84.06	78.79	71.11	72.22	78.18
V	89.86	69.70	84.44	77.78	83.03
W	69.57	81.82	80.00	72.22	75.15
X	97.10	100.00	88.89	77.78	93.33
Y	31.88	54.55	57.78	16.67	41.82
Z	37.68	60.61	73.33	44.44	52.73

Looking at the results according to activity areas (Table 2), the following general conclusions can be drawn:

- The OHSAS 18001-certified organisations gain very high scores for element A (organization and administration) which is mainly establishment of written documents (formal safety). Non-certified companies have low scores for element A when they are locally owned and high scores when they belong to a larger consolidated company.
- The differences for element B (training and motivation) are not as high as for element A as training is strictly regulated by national legislation and therefore, each company, certified or non-certified, has to follow the requirements.

- Scores for element C (work environment) are high; vary slightly for certified companies and are lower and vary more for non-certified companies. The difference comes mainly from lack of dealing with psychological risk factors.
- Scores for element D (follow up) vary both for certified and non-certified companies. It represents the real safety performance, registration and investigation of accidents and absenteeism as well as the measurements of workability of employees. As parts of this is not regulated by legislation, the scores are diverse.

Table 3 and 4 represent the mean scores (0–3 scale) according to the activity area by MISHA method. Each four-category framework element consists of 3 activity areas which are examined by specific 55 items in the form of various interview questions/considerations.

Table 3. The mean scores (0–3 scale) according to the activity area (A and B) by MISHA method

Identification	A1*	A2*	A3*	B1*	B2*	B3*
	Organisation and administration			Training and motivation		
K	0.36 ± 0.67	1.63 ± 0.92	1.50 ± 0.58	1.67 ± 0.58	1.50 ± 1.29	2.00 ± 0.82
L	2.58 ± 0.50	2.67 ± 0.44	2.25 ± 0.88	1.56 ± 0.77	1.75 ± 1.37	2.75 ± 0.50
M	2.91 ± 0.30	2.25 ± 0.46	2.25 ± 0.96	2.33 ± 1.15	2.00 ± 0.82	2.75 ± 0.50
N	3.00 ± 0.00	3.00 ± 0.00	2.50 ± 0.58	2.67 ± 0.58	2.25 ± 0.50	3.00 ± 0.00
O	0.73 ± 0.65	0.75 ± 1.04	0.75 ± 0.50	1.00 ± 0.00	1.00 ± 0.82	1.00 ± 0.82
P	2.68 ± 0.56	2.63 ± 0.58	2.38 ± 0.48	2.83 ± 0.29	2.88 ± 0.25	3.00 ± 0.00
Q	2.76 ± 0.34	2.67 ± 0.36	2.42 ± 0.32	2.78 ± 0.38	3.00 ± 0.00	3.00 ± 0.00
R	2.76 ± 0.34	2.46 ± 0.43	2.25 ± 0.50	2.56 ± 0.51	2.50 ± 0.43	2.75 ± 0.17
S	2.97 ± 0.10	2.58 ± 0.43	2.42 ± 0.57	2.78 ± 0.38	2.67 ± 0.27	2.75 ± 0.50
T	2.82 ± 0.40	2.88 ± 0.35	2.00 ± 0.00	2.67 ± 0.58	2.25 ± 0.96	3.00 ± 0.00
U	2.64 ± 0.50	2.50 ± 0.53	2.25 ± 0.50	1.33 ± 1.15	2.75 ± 0.50	2.75 ± 0.50
V	2.55 ± 0.93	3.00 ± 0.00	2.50 ± 0.58	1.67 ± 1.15	1.75 ± 0.96	2.75 ± 0.50
W	2.36 ± 0.81	1.88 ± 0.83	1.75 ± 0.50	1.67 ± 1.53	2.75 ± 0.50	2.75 ± 0.50
X	3.00 ± 0.00	3.00 ± 0.00	2.50 ± 0.58	3.00 ± 0.00	3.00 ± 0.00	3.00 ± 0.00
Y	0.09 ± 0.30	2.13 ± 0.99	1.00 ± 0.00	2.00 ± 1.00	1.50 ± 1.29	1.50 ± 0.58
Z	0.36 ± 0.92	2.25 ± 1.04	1.25 ± 0.50	1.00 ± 0.00	1.75 ± 0.50	2.50 ± 0.58
Mean	2.16 ± 1.08	2.39 ± 0.59	2.00 ± 0.57	2.10 ± 0.69	2.21 ± 0.62	2.58 ± 0.58

***A1:** Safety policy; **A2:** Safety activities in practice; **A3**: Personnel management; **B1**: Participation; **B2**: Communication; **B3:** Personnel safety training.

According to Table 3, it can be seen that B3 (personnel safety training) obtained the highest mean score (2.58 ± 0.56) which is not surprising as Estonian legislation specifies the requirements for training and in-service training regarding OHS in detail (Resolution…, 2000). As seen from Table 4, B3 is followed by C1 (physical work environment), by score 2.52 ± 0.37, which demonstrates that companies generally know how to control occupational hazards such as physical and chemical risk factors; and proves that interviewed companies prioritize workplace risk assessment as one of the main requirement in OSH legislation in Estonia. The third highest score, 2.39 ± 0.59 points, is occupied by activity area A2 (safety activities and practice) where the items are strongly related to OHS legislation (e.g. obligations to elect working environment representatives, formulating duties for safety manager, etc.). The lowest score, 1.02 ± 0.44, was calculated for D2 (workability employees) which is very likely

connected with Estonian tax system where employer has to give strong evidence of expenses on connectedness of employees' health promotion or otherwise a high fringe benefit tax applies (Income Tax Act, 1999). Therefore, employers are not always eager to invest in health promotion.

Table 4. The mean scores (0–3 scale) according to the activity area (C and D) by MISHA method

Identification	C1*	C2*	C3*	D1*	D2*	D3*
	Work environment			Follow up		
K	2.22 ± 0.97	1.33 ± 0.58	1.00 ± 1.00	1.33 ± 0.15	1.50 ± 0.71	1.00 ± 0.00
L	2.59 ± 0.32	1.78 ± 0.69	1.56 ± 0.96	1.67 ± 0.53	0.33 ± 0.47	2.00 ± 0.00
M	2.44 ± 0.53	2.00 ± 0.00	2.00 ± 1.00	2.33 ± 0.58	1.50 ± 0.71	1.00 ± 0.00
N	2.67 ± 0.50	2.33 ± 0.58	1.67 ± 0.15	2.33 ± 0.58	1.00 ± 0.00	3.00 ± 0.00
O	1.44 ± 0.53	0.67 ± 0.58	0.33 ± 0.58	0.67 ± 0.58	1.00 ± 0.00	0.00 ± 0.00
P	2.94 ± 0.17	2.50 ± 0.50	2.17 ± 0.29	2.33 ± 0.58	1.25 ± 0.34	3.00 ± 0.00
Q	2.70 ± 0.35	2.11 ± 0.69	2.00 ± 1.00	3.00 ± 0.00	1.50 ± 0.24	3.00 ± 0.00
R	2.56 ± 0.60	1.78 ± 0.07	1.67 ± 1.15	2.78 ± 0.38	0.17 ± 0.24	3.00 ± 0.00
S	2.70 ± 0.51	1.67 ± 1.00	2.11 ± 0.77	2.89 ± 0.19	1.00 ± 0.47	3.00 ± 0.00
T	2.67 ± 0.50	1.33 ± 0.53	2.00 ± 1.00	3.00 ± 0.00	1.50 ± 0.71	3.00 ± 0.00
U	2.44 ± 0.73	1.00 ± 1.00	2.33 ± 1.15	3.00 ± 0.00	0.50 ± 0.71	3.00 ± 0.00
V	2.67 ± 0.50	2.33 ± 1.15	2.33 ± 0.58	3.00 ± 0.00	1.00 ± 0.00	3.00 ± 0.00
W	2.78 ± 0.67	1.67 ± 1.53	2.00 ± 1.00	3.00 ± 0.00	0.50 ± 0.71	3.00 ± 0.00
X	3.00 ± 0.00	2.33 ± 0.58	2.00 ± 1.00	3.00 ± 0.00	1.00 ± 0.00	3.00 ± 0.00
Y	2.11 ± 0.93	1.33 ± 0.58	1.00 ± 0.00	0.33 ± 0.58	1.00 ± 0.00	0.00 ± 0.00
Z	2.33 ± 0.87	2.00 ± 1.00	2.00 ± 0.00	1.67 ± 0.58	1.50 ± 0.71	0.00 ± 0.00
Mean	2.52 ± 0.37	1.76 ± 0.52	1.76 ± 0.55	2.27 ± 0.89	1.02 ± 0.44	2.13 ± 1.26

***C1**: Physical work environment; **C2**: Psychological working conditions; **C3**: Hazard analysis procedures; **D1**: Occupational accidents and illnesses; **D2**: Work ability of the employees; **D3**: Social work environment.

The next section presents the responses and differences between OHSAS 18001-certified organisations and organisations without it related to specific activity areas given in MISHA method (Kuusisto, 2000) through quantitative and qualitative data (interviews).

A1 Safety Policy

Interviews revealed that all examined organisations without OHSAS 18001 and local ownership do not hold any kind of written safety policy. Safety and health activities are performed following the current legislation. As the OHS Act of Estonia (1999) does not require a written policy in paper, then in normal conditions, it is not created. These companies which belong to a larger corporation have a written policy with the authority of the concern.

The examined OHSAS 18001-certified organisations, had all a written safety policy; however the implementation of it was different depending on the affiliation to a larger international group/concern. Those companies belonging to an affiliated group, are able to make very few modifications in the safety policy as it is usually a fixed document. Some changes can be made in order to comply the requirements in national legislation. The content and volume of a safety policy depends on policy makers' approach: some have just a few general paragraphs about company's safety commitment

followed by comprehensive implementation guidelines or a more detailed extension (a separate document) where main safety activities and procedures are described. Other OHSAS 18001-certified organisations have one single extensive safety policy document covering all areas (the role and importance of safety, safety goals, main safety activities and their administration, description of safety tasks and responsibilities etc.); while only a part of it is introduced to employees (often being up on the notice-board of manufacturing unit). It came out from the interviews that even when dissemination of safety policy among employees is usually quite well-organized, the companies do not prioritize informing external bodies such as clients, sub-contractors or authorities, although OHSAS 18001 requires it (OHSAS Project Group, 2007). Normally, the policy (or a shorter version of it) is presented on the company's webpage in order to make it available for all external bodies. There is often no clear practice how to inform about the changes in policy document after the revision.

One of the safety managers from the food processing industry summarized:
'When our partners sign or renew a contract and come to our territory, we introduce them the new policy or changes in the policy – usually during the training course'. – Company X, Int 23.

Normally, the safety policy lists the required documents such as work instructions and instructions for line-managers' and supervisors' safety duties, but how to perform and follow the duties is often unclear and unwritten. For example, the companies have no clear overview or guidelines which tools and knowledge should be used for effective safety training, no evaluation is given about the effectiveness of the training etc. In several cases, it was stated as follows:
'The supervisors' and line managers' performance how to train our employees, comes with experiences and additional training. There are no guidelines or good tips written in paper for them'. – Company L, Int 3; Company M, Int 5; Company S, Int 18; Company V, Int 21; Company Z, Int 25.

A2 Safety activities in practice

In both types of companies – group I and group II, safety personnel and their responsibilities are usually designated. In smaller companies, no full-time safety manager is hired; often a production manager or personnel manager fulfils the duties during the working hours. All companies had elected a working environment representative according to the OHS Act (1999). In the larger companies (over 50 employees), the Working Environment Council has to be appointed/selected; the frequency of meetings varies depending on the size of the company and the number of discussions needed – from one up to four times per year.

In both groups of companies, there were deficiencies in safety awareness and knowledge: in most companies no system and clear picture existed how safety and health aspects can be taken into account in the design of new workplaces and processes. The exceptions were 3 OHSAS 18001-certified organisations and 2 non-certified organizations who employ their own engineers in order to find out new solutions for health and safety in the company.

One good example was an enterprise in food industry:
'We have a list of health and safety aspects which need to be taken into account when creating new workplaces'. – Company X, Int 23.

A3 Personnel management

In most of the companies, short-term plans about human resources are made; but no long-term views are generated. The interviewees explained it with the fact that everyday life has shown that market needs change quickly.

The weakest part in several companies was the policy how to ensure elderly personnel's work ability.

A company (in paper industry) argued:
'We cannot allow ourselves discrimination, so we don't prefer one group of people to another – so therefore, there are no advantages for elderly people'. – Company W, Int 22.

Another company (in metal industry) answered:
'We only have young workers, so we don't need to think about the aging workforce yet'. – Company V, Int 21.

A few companies (Companies S and R) admitted that they would benefit from a document or a guideline where elderly personnel's' appreciation is justified. Even when there is no such written document available, the companies applied various activities in order to maintain the employees' health (including aging workforce) for instance providing a masseuse, massage chairs, thermotherapy, a neurologist, exercise equipment on-site etc.

The smaller the company is, the less the individual career planning is done. An example of attitude by production managers (in clothing industry):
'There are many sewers, but only 4 positions for line managers. There is practically no possibility to make a career if you have chosen to do sewing work in our company'. – Company K, Int 1; Company Z, Int 25.

A good example is from another small-scale company (Company V) in metal industry where a matrix has been created on a notice-board where workers' abilities and skills are ranked against equipment complexity: the more skills the person has, the more complex work can be performed by him and the more possibility he has for career promotion.

Normally, an evaluation about candidate's health and safety knowledge is not performed during the selection of new personnel. The reason lies mainly on low skilled workforce availability in Estonia.

B1 Participation

In many investigated companies, OHSAS 18001-certified or non-certified organisations, the weak point is the communication between supervisor and employee. The interviews revealed that immediate intervention is not efficiently practiced. Often, the communication is limited to certain times per week; for example:
'We don't interfere at once. We have a practice to go and gather all the problems and have an audit once a week. Then, we try to find the solutions'. – Company N, Int 6.

During interviews, only one company out of 16 admitted that they practice immediate intervention also among peers and not only by supervisors:
'The best practice in our company is, that my colleague will say to me at once if I do something wrong or unsafe'. – Company V, Int 21.

Concerning employee participation into the workplace design, there are almost no companies (no differences between group I and group II) who involve employees in order to alter workplace safer or healthier. The exceptions are the companies who employ design engineers.

B2 Communication

Companies' communication practices were generally in high level. Interviewees stated that the communication was organized effectively and sufficiently; for instance different communication tools were used: wall-boards, e-mails, internal leaflets, intranet etc. Some companies in the group II do not practice management information meetings for all personnel in regular basis, but in the group I it was predominant. Differences were dedicated in suggestions for improvement between group I and II. OHSAS 18001 states that there should be a procedure for collecting employees' suggestions (OHSAS Project Group, 2007). In the group II companies stated that suggestions for improvements are collected orally (Company O, V and Z) which means that no written procedure exists. Among group I, several company representatives mentioned that it is not common that the person who makes the suggestion can complete it afterwards. In Company X, the interviewee stated:
'The persons who have made the suggestions, will have the opportunity to complete the proposed improvements (all suggestions that have been evaluated to be suitable for implementation)'. – Company X, Int 23.

It means that there will be a team assigned to help him/her to complete it. However, several other companies were not convinced that everyone should have this chance as they may not have sufficient knowledge and skills for solving the problem.

In both groups employees were one or another way rewarded for the suggestions made (from verbal gratitude to monetary rewards).

The arrangement of health and safety campaigns in companies is strongly connected to company's practices (no difference between group I and II). For instance, companies U, V, X have strong culture for regular campaigns. The most common campaigns arranged were 'Occupational health days'; lectures on HIV, alcohol, smoking, healthy nutrition, reflectors; sport activities etc.

Another example comes from company in wood processing industry:
'We have no campaigns, but there are focus areas each year'. – Company W, Int 22.

B3 Personnel safety training

The need for safety training was evaluated on a regular basis on almost all companies. When preparing work instructions, several companies mentioned that managers and supervisors participate in preparation of the instructions. Employees participate more seldom. All companies stated that employees have seen work instructions, but whether they always act according to them, is questionable. A lot of

companies (M, N, P, Q, R, U, S, T, W, X) stated that they check on regular basis (audit) whether employees follow the instructions or do not.

Several companies (P, Q, R, S, U, V) stated that they involve employees in all levels of the work instruction preparation process. Other companies (K, O, Y, Z) use mainly supervisors when preparing the work instructions. It is widely known among companies that when instructions are updated, they need to be replaced and the old ones removed from the workplaces. As work permits are regulated by Estonian legislation (for example, Machinery Safety Act (2002)), then the companies who need these permits, keep them up-do-date.

Generally, all companies are able to assess working environment hazards, especially physical hazards such as noise, lighting, indoor climate and manual handling of loads. In some level ergonomics assessments are performed as well. It appeared that indoor climate and factors influencing it produce the most diverse opinions and challenges:

'While designing the new building, everything was taken into account in order to install the most suitable ventilation system. However, our employees complain about draught all the time and have an opinion that the ventilation system isn't built efficiently'. – Company S, Int 17.

All companies in group I show a very high level of assessment of chemical hazards and risk of major hazards. These factors are explored thoroughly because of the integrated system – all interviewed OHSAS 18001-certified organisations are certified also after ISO 14001 (ISO, 2004) which pays special attention to chemicals used in the enterprise. Some companies in group II, consider chemical exposure essential as well: for instance, in a company in metal industry (Company P), a chemical specialist has been employed.

A very few companies handle off-the-job safety – travelling between home and the workplace:

'We have drawn instructive lines from the territory to the bus station in order to have a safe lift home'. – Company R, Int 11.

The interviews indicated that the maintenance of machines and equipment and the cleanliness of the plant area depends rather on the size of the company than the affiliation or owning the OHSAS 18001 certificate. In smaller companies, employees are expected to keep the workplace in order and clean it after the end of the shift as well as do the small daily maintenance. Example from a printing industry:

'Our employees fix the small problems themselves. We call for outsourced service only when something breaks down and needs a specialist attendance'. – Company O, Int 7.

Some other companies (R, S, W) answered that they have minimized the off-the-job safety risks by offering a bus to transport the employees home after their shifts.

The difference arising among OHSAS 18001-certified companies compared to non-certified companies is the on-going and continuous improvement activity in order to establish better working conditions (see the section B2).

C2 Psychological working conditions

In examined companies, psychological aspects are not considered while designing new workplaces. During work process, the working load is usually monitored and evaluated – however, psychological factors are often neglected. Some companies ignore the problem:

'We do not have any stress factors in our company; so we really don't need to deal with it, thankfully'. – Company U, Int 20.

It turned out that working in isolation is often a privilege and not a psychological hazard because in recent years, people tend to feel that open-plan offices are psychologically more challenging than private offices. However, working alone is a problem in some of the investigated companies (U, W) – working in the nature, on sites.

Some of the physical hazards contribute into psychological hazards as well:

'My head is ringing as the production line is next to my office and it disturbs my work all the time'. – Company S, Int 16.

There were no differences between group I and group II companies while dealing with psychosocial hazards. In conclusion, it can be said that the knowledge about psychosocial hazards among managers in Estonia is still low.

C3 Hazards and analysis procedures

Risk assessment has been conducted in all interviewed companies (however, the quality of the assessment was not assessed during the visits to the enterprises). Many companies presented the results of measurements of working conditions, however, many of them were conducted several years ago and the situation may not be the same anymore. In all companies of group I, the risk assessment report lead to the preparation of an action plan. Three companies (K, O and Y) in group II confessed that no action plan has put together after the risk assessment procedure.

All companies except one (O) carry out personnel's health surveillance: they have an activity plan on an annual basis. However, the efficiency and quality of occupational health service varies greatly. It rather depends on a size of the company than whether it is certified by OHSAS 18001 or is not. General trend is the following: the larger the company, the more collaboration between the company and occupational health service provider. In small companies, an occupational health doctor contributes to the maintenance of employees' health through the health inspection and health control decision. Only few companies (P, S, U, X) confirmed that they get a detailed analysis of the results on a regular basis (once or twice per year) by occupational health physician, but many lack it. A company in furniture industry said:

'It would be essential to have the summary of the results sent to the top management – this way, they would see the employees' problems and understand their responsibility better'. – Company M, Int 5.

Generally, occupational health service specialists do not participate in employees' training, except in two companies (S, Z, R) who have invited specialists to give some lectures about specific health issue. However, this agreement is signed separately from general health surveillance service. This is the reason why most companies do not deal with it.

Safety organizations participate in safety analysis of the companies through occupational hygiene measurements and performing risk assessment. There is no good practice that the staff of safety organizations represents their results to management and employees. This, again, is usually not a part of the contract. Usually, the results of measurements and risk assessment is introduced by safety manager.

D1 Occupational accidents and illnesses

In group I, all companies keep statistics on accident rates and use it as a reference when new goals for safety improvement are done. In group II, those who belong to a larger affiliation or concern, report on a regular basis which consists the presenting of occupational accidents and illnesses statistics. In group II, companies K, O, Y and Z do not calculate statistics on accident rates. In Company W (less than 50 employees) they act very seriously on accidents and their causes: the root causes are sought, action plan is made, reasons are presented to all employees, information goes to wall-boards. When we look at the investigation of the near-accidents, then in group I it is done 100%. In group II, it is done, too, but not consistently. For example in companies S, W, R the near-accidents reporting is connected with yearly goals. The company decides how many near misses there have to be reported in a year per person as the statistics (Heinrich, 1941) shows that the more accidents the more near-misses exist. In these companies who do not integrate it to yearly goals, the near-accidents reporting rate is very low.

Absenteeism is often followed, but as Estonian legislation (Personal Data Protection Act, 2007) does not allow the separation of reasons of absenteeism, the results are often not analysed and used for goal setting.

D2 Work ability of the employees

As mentioned in section A3, there is generally no policy how to ensure elderly personnel's work ability. None of the companies had a systematic view for the rehabilitation for persons' whose work ability has decreased. However, some companies (P, Q, R, S, U, X, Z) offer various activities in order to maintain the employees' health: providing a masseuse, massage chairs, thermotherapy, a neurologist, exercise, equipment on-site etc.

Most companies answered negatively for the question about redesigning workplace for the persons who have difficulties in coping with the work. The answer was simple:
'Sorry, we can't do it and there is no similar work to offer'. – Company R, Int 11.

Or the next explanation:
'Our shifts are 12 hours long. If someone wants to work for 6 hours, we have difficulties to find another person with the same need'. – Company R, Int 11.

Companies K and S look at each case individually and try to provide the most suitable solutions:
'We have some workers who work 6 hours instead of 8 because of health reasons. As this is done every day, there is no particular work delays or unexpectancies'. – Company K, Int 1.

In the several companies, the work satisfaction survey is conducted regularly (usually outsourced), but psychological hazards questionnaires are hardly used. Some companies stated that dealing with this issue depends strongly on the managements' attitudes and knowledge.

A good example of emphasizing the psychological stress factors:
'We use occupational psychologists in order to help our supervisors to detect and solve the problems between the team members and how to intervene when stress level becomes too high'. – Company Z, Int 25.

D3 Social work environment

As mentioned in D2, companies in group I have a clear system how to measure social climate – they conduct regular work satisfaction surveys (except one company) either once or twice a year. Often, these surveys come from the concern they belong to or are outsourced. Interviews revealed that 4 companies (K, O, Y, Z) do not conduct these surveys. Most of them explained that they do not find it necessary in order to improve employees' health.

CONCLUSIONS

In conclusion, following statements can be presented:

1. According to the results, the companies can be divided into 3 different categories: (1) OHSAS 18001-certified organizations, (2) organisations which belong to a larger corporation or concern but are not OHSAS 18001-certified and (3) non-certified, locally established and owned companies. Clearly, OHSAS 18001-certified organizations show the highest scores.

2. The safety activities in a company depend strongly on consistency. The study showed that safety needs commitment and systematic approach. If one of the key elements of safety management systems is missing, then it can be seen in the results of other framework elements. For instance, lack of safety policy may influence the consistency in safety activities, the safety communication and safety knowledge and vice versa. These results are in line with the earlier studies (Tint et al., 2010b; Fernández-Muniz et al., 2012a; Reinhold et al., 2015).

3. Implementation of OHSAS 18001 automatically will not ensure high safety activities in the company. However, holding an OHSAS 18001 certificate, creates a basis for a systematic work in the area of safety management, hazards identification and prevention, and promotes strong improvement process put in use. Other authors (Ma et al., 2001; Fernández-Muniz et al., 2012b) have demonstrated, too, that OHSAS 18001 is only the first step towards the systematic and successful management of safety work. Besides that, companies need to have a favourable safety climate (a strong management commitment with the support of their workforce) (Fernández-Muniz et al., 2012b).

4. Concerning working conditions and occupational hygiene, all companies are able to assess work environment hazards. However, in OHSAS 18001-certified companies the control of chemical hazards and major accident hazards, is in very high level while non-certified organisations show the lower commitment to chemical safety. However, there are 2 good examples in non-certified organisations: a company in metal industry employs a chemical specialist and a company in food industry who outsources

company-specific chemical safety training. Physical hazards like noise and illumination are well managed in all interviewed companies, some challenges are faced with thermal conditions e.g. temperature, airflow and inefficiency of ventilation system. Ergonomics is valued by almost all enterprises; however dealing with it systematically and effectively depend on the size and consistency of the company. The maintenance of machines and equipment and the cleanliness of the plant area depends rather on the size of company than the affiliation or owning the OHSAS 18001 certificate. In smaller companies, employees are expected to keep the workplace in order and clean it after the end of the shift as well as do the small daily maintenance. The knowledge about psychosocial hazards among managers in Estonia is still low and there were no differences between group I and group II while dealing with psychosocial hazards. Our study results indicate that psychosocial work environment is not only difficult to measure, but problematic to detect its dimensions and find suitable solutions and control measures. A study conducted in Denmark (Hohnen & Hasle, 2011) showed a similar result – OHSAS 18001-certified manufacturing company had difficulties in dealing with psychosocial work environment as referred too complex, with multiple causes and too complicated for management to articulate clearly.

5. All interviews were conducted by using the MISHA method questionnaires. MISHA method offers a more comprehensive possibility to evaluate SMS in present-day society: it emphasizes among other activity areas on top management commitment and safety knowledge, psychosocial hazards and integration of personnel management. By reference to previous authors' experiences with other audit methods (Tint et al., 2010a; Tint et al., 2010b), for instance D&S method is a rough and outdated method. Some criteria in it are very easy to meet, too much emphasis is put on fire and industrial hygiene control, less attention is paid to follow-up and auditing. Compared to some other methods, developed in the USA (ISRS-Generic (Collision & Booth, 1993, Goodyear Tire and Rubber Company audits (Dyjack et al., 1998)), MISHA gives less attention to off-the-job safety. Although MISHA method can be successfully used for evaluating safety management systems in manufacturing industry, it has to be kept in mind that some modifications may be needed due to national differences in safety activities. For instance, occupational health service principles and structure vary from country to country.

As the result of the investigation and using the elements of the OHSAS 18001, the model for safety management in the small and medium-sized enterprises will be proposed.

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APPENDIX 4

Article 4

Õ. Paas, K. Reinhold, P. Tint
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Voluntary Safety Management System in the Manufacturing Industry – To What Extent does OHSAS 18001 Certification Help?

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***Abstract* – Occupational risk prevention can be managed in several ways. Voluntary safety management standard OHSAS 18001 is a tool, which is considered to give contribution in effective risk management in the manufacturing industry. The current paper examines the benefits of OHSAS 18001 based on the statistical analysis. MISHA method is used for safety audit in 16 Estonian enterprises. The results demonstrate the objectives why companies implement or are willing to implement OHSAS 18001, bring out differences in safety activities for 3 types of companies and determine correlations among different safety activity areas. The information is valuable for enterprises that are willing to improve their safety activities via a voluntary safety management system.**

***Keywords* – Health and safety audit, MISHA method, occupational health and safety management system, OHSAS 18001 certification.**

I. Introduction

The aim of the safety management systems is to manage the planning and implementation of a company's safety policy. A safety management system usually includes the setting and prioritising of safety goals and development of safety programmes. Different management tools can be used to fulfil legislation needs and company's demands in order to mitigate workplace risks effectively.

The literature on OHSMSs (Occupational Health and Safety Management Systems) often distinguishes mandatory OHSMSs from voluntary systems [1]–[6].

Mandatory OHSMS emerges from legislative requirements and sets core principles for the management of OHS (Occupational Health and Safety) to be implemented by employers. The most well-known European mandatory OHSMS is the Framework Directive 89/391/EEC [7], which defines employers' responsibilities in the management of OHS and requires insurance of safety and health of workers in every aspect related to their work. This directive sets general obligations: to conduct risk assessment at workplaces, to implement safety measures and to train and inform employees on the OHS hazards.

Voluntary OHSMSs are not state-regulated. These systems were first encouraged by commercial organisations, corporations and associations (e.g., industry associations). Voluntary OHSMSs tend to be more complex than regulatory systems, and more formalised in terms of specifications. According to Frick and Wren [4], the detailed specification of these systems helps to ensure the good integration of OHS policy into the management processes of enterprises. Voluntary OHSMSs are generally in the form of standards or guidelines, providing requirements for certification or giving simple guidance on good management practice for OHS. These standards or guidelines are international (e.g., ILO-OSH 2001) [8], national (e.g., BS 8800:2004 or OSHAS 18001:2007) [9]–[11], and sectorial (e.g., MASE, DT 78) [12], [13].

Organisations are increasingly concerned with achieving and demonstrating sound OHS performance by controlling their OHS risks, consistent with their OHS policy and objectives [14], [15]. In order to provide a recognisable OHSMS standard against which company's management system can be assessed and verified, the OHSAS 18001 standard has been developed. The OHSAS standards covering OHS management are intended to provide organisations with the elements of an effective OHS management system that can be integrated with other management requirements and help organisations achieve OHS and economic objectives [10], [11]. An effective OHSAS 18001 management system may contribute to the following: (1) Providing a structured approach for managing OHS; (2) Establishing and maintaining a strong commitment to OHS; (3) Promoting organisational structures with clear and unequivocal roles and responsibilities, (4) Ensuring strong levels of trust and communication, (5) Developing a continuously improving safety culture; (6) Providing reduction in incident and accident levels with increased measures of performance [16]–[19]. OHSAS 18001 intends to apply to all types and sizes of organisations and to accommodate diverse geographical, cultural and social conditions [10], [11].

The benefits of OHSAS 18001 have been studied by several authors in recent years [14]–[28]. Those studies demonstrate that the OHSAS 18001 improves the company's image and overall performance, integrates OHS into the company's management system, reduces the risk for accidents, improves the company's compliance with legal obligations, favours a learning process and helps to create a higher level of transparency. However, the OHSAS 18001 certification has also been criticised, especially having a tendency to increase the bureaucratisation of health and safety issues and, therefore, to

discourage genuine worker involvement. This may shift the focus from health and safety issues towards paperwork control, which may diminish the activities dealing with OHS problems [24]–[26].

The objective of the current paper is to study how the OHSAS 18001 certification influences safety activities and their improvement in Estonian manufacturing companies and to determine whether a noncertified company with a strong management support in safety is able to perform equally in OHS matters compared with the OHSAS 18001-certified organisations.

II. Material and Methods

On the basis of critical overview of the existing auditing methods, the MISHA method (Method for Industrial Safety and Health Activity Assessment) [29] as the most innovative one has been chosen for the current study. The Technical Research Centre of Finland (VTT) developed this audit tool in 2000 [29]. The MISHA method is primarily designed to be used in medium- and large-sized industrial companies in the manufacturing and process industry. The MISHA method considers the following area of industrial activities: A. organisation and administration (safety policy and safety activities in practice, personnel management); B. participation, communication, and training; C. work environment (physical work environment, psychological working conditions, hazard analysis procedures); D. follow-up (occupational accidents and illnesses, workability of the employees, psychological workability). Benefits of using the MISHA method include the relatively small amount of resources and time needed and inclusion of occupational health aspects relating to the ability to work [30]. The audit process using the MISHA method should have a leader who can be either internal or external to the organisation subject to the audit. Auditors should have prior experience in health and safety activities and carefully examine the application of the method prior to the audit [29].

To select industrial companies for the research, the database of Estonian Association for Quality (2014) [31] has been scanned. By January 2014, 178 Estonian companies have owned the OHSAS 18001 certification. The scan has shown that 32 % of certified firms come from the manufacturing sector. The authors have contacted each of these firms and explained briefly the purpose and the scope of the research. Finally, eight companies (representing main manufacturing areas in Estonia such as printing, textile, metal, food industry etc.) have agreed to participate. In order to compare the results with non-certified organisations, eight companies with similar background have been selected – 4 represented organisations that belong to a larger corporation or concern but are not OHSAS 18001-certified and 4 – non-certified, locally established and owned companies. Altogether, 25 interviews with employers, middle-level safety personnel and safety responsible persons have been conducted. During the interviews 55 questions (the validated MISHA method) have been asked to each of the person interviewed by the experienced health and safety auditor. After necessary coding and transcription, the results have been discussed with 4 experts on OHS to come to an agreement whether the results are interpreted correctly. Table IV presents shortly the characteristics of the examined enterprises – the activity area, type and size.

The analyses have been prepared using IBM SPSS Statistics 22.0 and R 2.15.2. The following statistical methods have been used: correlation, MANOVA, factor analysis, principal component method, independent T-test for hypotheses [32].

III. Proposed Conceptual Benefits of the OHSAS 18001: Hypotheses

The OHSAS 18001 offers a number of benefits to companies as the standard should promote and increase the quality of management in OHS discussed in previous sections. Before conducting the research, the OHSAS 18001 certified organisations have been asked about the reasons for adopting the standard and perceived benefits from the certification. The results are provided in Tables I and II, where a five-point Likert scale has been used [33] in order to measure objectives to adopt the OHSAS 18001 and perceived benefits from it.

TABLE I

Results of the Objectives to Apply for the OHSAS 18001 Certification among Estonian Manufacturing Companies

Objective to adopt OHSAS 18001	Mean	Not at all important, %	Very important, %	Extremely important, %
Improvement of the company's image in the society	4.50	0.0	25.0	62.5
Prevention of accidents and incidents	4.50	0.0	25.0	62.5
Maintenance of sector leadership in safety	4.13	12.5	12.5	62.5
Integration of safety into a corporate strategy	4.13	0.0	12.5	50.0
Maintenance of socially responsible behaviour	4.00	12.5	25.0	50.0
Satisfaction with customer demands	3.88	0.0	37.5	37.5
Improvement of employees' well-being	3.71	0.0	37.5	12.5
Pressure to follow competitors	3.50	25.0	12.5	50.0
Satisfaction with supplier/ subcontractor and/ or contractor demands	3.50	25.0	25.0	37.5
Reducing operational costs	3.00	25.0	25.0	12.5
Improvement of employee motivation	3.00	12.5	50.0	0.0
Enhancement of relations with public authorities	2.88	12.5	37.5	0.0
Improvement of company's competitive advantage	2.50	50.0	25.0	12.5
Compliance with legislation	2.50	50.0	0.0	25.0
Labour union pressure avoidance	1.25	87.5	0.0	0.0
Other reason(s)				50.0*

* Other reasons mentioned: very good offer from a certification body; to ease up relations with concern; decision making on a corporation level.

Companies are motivated to adopt OHSAS 18001 mainly to enhance the company's social image and reputation, and also to ensure a leading position in safety in the manufacturing industry. Companies also expect that adopting OHSAS 18001 the number of accidents and incidents occurring at the workplace will decrease. The Labour Union seems to have less influence in that matter, and the close relationship between the standard and legislative regulations are not seen.

Table II shows company's perceptions of the OHSAS 18001 standard benefits. All companies have functioned under the OHSAS 18001 compliance from 3 to 9 years. The most valuable aspect that companies see is a better organised safety documentation system. The second benefit is seen in the improved company's image, which is usually one of the main motivations for implementation OHSAS 18001. Even when not being one of the most important reasons to adopt the standard, OHSAS 18001 makes it easier to comply with safety legislation, which later gives a value for the companies.

TABLE II

RESULTS OF THE OBJECTIVES TO APPLY FOR THE OHSAS 18001 CERTIFICATION

Perceived benefits from OHSAS 18001	Mean	Not at all important, %	Very important, %	Extremely important, %
Improved organisation & documentation systems	4.88	0.0	12.5	87.5
Improved company's image	4.25	0.0	25.0	50.0
Improved company's compliance with legal obligations	4.13	0.0	25.0	50.0
Improved working conditions	3.88	0.0	25.0	37.5
Improved customer satisfaction	3.75	12.5	25.0	37.5
Improved employee satisfaction	3.63	0.0	37.5	25.0
Improved relations with suppliers & contractors	3.38	25.0	37.5	25.0
Improved relations with public authorities	3.38	25.0	25.0	37.5
Improved production times	3.25	25.0	25.0	25.0
Improved employee motivation	3.13	12.5	50.0	0.0
Improved product quality	2.88	37.5	12.5	25.0
Waste reduction	2.38	37.5	12.5	12.5
Improved company's profitability	2.75	37.5	0.0	25.0
Increased sales	2.13	37.5	0.0	0.0

The authors have put forward 11 hypotheses that can be derived as benefits. All of them are possible to be examined statistically by the MISHA method.

The hypotheses are the following:

Hypothesis H1. OHSAS 18001 helps to disseminate the information on all levels of organisation.

Hypothesis H2. Written safety policy plays an important role in the OHS management.

Hypothesis H3. OHSAS 18001 helps more effectively to organise OHS activities in the companies.

Hypothesis H4. OHSAS 18001 promotes interaction between supervisors and employees.

Hypothesis H5. The employees are better trained in OHS in OHSAS 18011-certified companies.

Hypothesis H6. OHSAS 18001 improves the development of the physical working conditions.

Hypothesis H7. There is a difference in psychosocial climate for OHSAS 18001-certified and non-certified organisations.

Hypothesis H8. Occupational health service activities are better organised in OHSAS 18001-certified organisations.

Hypothesis H9. OHSAS 18001 favours the registration and investigation of accidents, illnesses and near misses.

Hypothesis H10. Physical workability is more appreciated in OHSAS 18001-certified organisations.

Hypothesis H11. Social work environment is regularly monitored in OHSAS 18001-certified organisations.

IV. RESULTS

Hypotheses have been tested using Hotelling's T-square test statistic [32]. Sampling adequacy has been controlled by Kaiser–Meyer–Olkin (KMO) measure [32]. For these data, the KMO value is 0.83, which falls into the range of being great, so we should be confident that the sample size is adequate for the factor analysis.

Looking at the results (Table III), we can provide support for all hypotheses except H7 and H10, while comparing OHSAS 18001-certified (OHSAS) organisations with non-certified, locally established and owned (OHSASL) companies. The explanation behind H7 may be the fact that OHSAS 18001 does not emphasise psychosocial climate as one of its key elements. The study has shown that most of the companies examined irrespective of owning an OHSAS 18001 certificate have little knowledge and conception how to deal with psychosocial hazards. Hypothesis H10 is not supported while the study has revealed that physical workability irrespective of a company type is not assessed as there is generally no policy how to measure and deal with employees' workability. Comparing OHSAS 18001-certified organisations with organisations that belong to a larger corporation or concern but are not OHSAS 18001-certified (OHSASC), none of the hypotheses have been supported. This demonstrates that the level of OHS management in these companies is compatible with OHSAS 18001-certified companies as their safety activities are regular, properly established, monitored, revised etc.

Table IV represents the mean scores (0–3 scale) according to the activity area by the MISHA method. Each four-category framework element consists of 3 activity areas, which are examined by specific 55 items in the form of various interview questions/considerations. OHSAS 18001 requires preparation and implementation of safety policy (A1). The results of our study have shown that all OHSAS companies possess a safety

policy. Similarly, slightly lower results have been gained by NOHSASC companies, which shows the awareness of the importance of engaging OHS activities in general organisational procedures. However, all investigated NOHSASL companies strongly lack any activities in the area of safety policy.

The research has revealed that safety activities in practice (A2) do not strongly depend on the company type – NOHSASC companies have equal or even higher scores, some local companies have earned equally high points as well. In all types of companies, safety personnel and their responsibilities are usually designated. In smaller companies, no full-time safety manager is hired; often a production manager or personnel manager fulfils the duties during the working hours. All companies have elected a working environment representatives according to the OHS Act [34]. In most of the companies, short-term plans about human resources are made; but no long-term views are generated. The interviewees have explained it with the fact that everyday life has shown that market needs change quickly [35]. No changes have been detected between OHSAS and NOHSASC, but NOHSASL have gained considerably lower sores while they deal with personnel management ad hoc.

TABLE III

STATISTICAL ANALYSIS OF HYPOTHESES

Hypothesis*		Hotelling's T-square test statistic	P-value	Confidence intervals	
				lower	upper
H1: OHSAS 18001 helps to disseminate the information at all levels of organisation.	OHSAS VS NOHSASL	11.128	0.008	14.825	51.152
	OHSAS VS NOHSASC	0.280	0.608	−25.029	18.092
H2: Written safety policy plays an important role in OHS management.	OHSAS VS NOHSASL	259.461	0.000	68.870	90.982
	OHSAS VS NOHSASC	0.621	0.449	−5.997	12.565
H3: OHSAS 18001 helps more effectively to organise OHS activities in the companies.	OHSAS VS NOHSASL	8.944	0.014	7.701	52.714
	OHSAS VS NOHSASC	0.193	0.670	−18.963	12.713
H4: OHSAS 18001 promotes the interaction between supervisors and employees.	OHSAS VS NOHSASL	5.132	0.047	0.456	55.099
	OHSAS VS NOHSASC	0.310	0.590	−34.747	20.857
H5: The employees are better trained in OHS at OHSAS 18011-certified companies.	OHSAS VS NOHSASL	23.3383	0.001	19.644	53.278
	OHSAS VS NOHSASC	0.145	0.711	−7.136	5.053
H6: OHSAS 18001 improves the development of the physical working conditions.	OHSAS VS NOHSASL	15.167	0.003	9.046	33.237
	OHSAS VS NOHSASC	0.267	0.617	−9.854	6.146
H7: There is a difference in psychosocial climate for OHSAS 18001-certified and non-certified organisations.	OHSAS VS NOHSASL	2.076	0.180	−7.842	36.552
	OHSAS VS NOHSASC	2.593	0.138	−33.104	5.329
H8: Occupational health service activities are better organised in OHSAS 18001-certified organisations.	OHSAS VS NOHSASL	11.128	0.008	9.686	48.654
	OHSAS VS NOHSASC	0.280	0.608	−14.473	8.918
H9: OHSAS 18001 favours the registration and investigation of accidents, illnesses and near misses.	OHSAS VS NOHSASL	25.783	0.000	30.919	79.271
	OHSAS VS NOHSASC	0.207	0.659	−24.558	16.229
H10: Physical workability is more appreciated in OHSAS 18001-certified organisations.	OHSAS VS NOHSASL	1.808	0.208	−29.522	7.302
	OHSAS VS NOHSASC	0.044	0.839	−24.337	20.167
H11: Social work environment is regularly monitored in OHSAS 18001-certified organisations.	OHSAS VS NOHSASL	32.523	0.000	48.236	110.099
	OHSAS VS NOHSASC	0.968	0.348	−40.813	15.813

*F critical value = 4.964603; Abbreviations: OHSAS – OHSAS 18001-certified companies, NOHSASL – Non-certified, locally established and owned companies, NOHSASC – Organisations that belong to a larger corporation or concern but are not OHSAS 18001-certified.

OHSAS and NOHSASC companies actively engage supervisors to communicate with employees and encourage employee participation to improve working environment conditions (B1). Both company types have gained high scores, while NOHSASL companies stand out with considerably lower scores. The same conclusion can be drawn for communication procedures (B2). OHSAS and NOHSASC companies have demonstrated exceptionally high result in personnel safety training (B3), while NOHSASL companies have gained lower points mainly because employees participate more seldom in drafting work instructions. There are not considerably high differences between company types while dealing with physical work environment (C1); however, OHSAS organisations have shown a very high level of assessment of chemical hazards and risk of major hazards. These factors have been explored thoroughly because of the integrated system – all interviewed OHSAS 18001-certified organisations are certified also after ISO 14001 [36] that pays special attention to chemicals used in the enterprise. One of the hypotheses not finding statistical support is H7 that concerns psychosocial hazards. The results in Table IV show that the scores for psychological working conditions are low and none of company types stand out. As mentioned before, the knowledge about psychosocial hazards among managers in Estonia is still low. Hazard analysis

procedures (C3) have shown lower points for NOHSASL companies mainly due to lack of action plan after the risk assessment procedure and weak collaboration with OHS service providers. Almost all OHSAS companies actively collect and analyse accident statistics as well as investigate accidents and near-accidents (D1). The same trend can be followed among NOHSASC companies as it is important for the corporation to compare different subdivisions and their safety activities. The lowest scores among all company types have been gained for workability of the employees (D2). None of the companies have a systematic view for the rehabilitation for persons, whose workability has decreased. There is generally no policy how to ensure elderly personnel's workability. In several companies, the work satisfaction survey is conducted regularly (usually outsourced), but psychological hazard questionnaires are hardly used. Some companies have stated that dealing with this issue depends strongly on the management attitudes and knowledge [35]. All NOHSASC companies stand out with assessing the social working environment through climate surveys. Most of OHSAS companies have gained the same results. Almost none of the NOHSASL companies conduct social climate surveys and, therefore, have gained considerably lower scores.

TABLE IV

THE MEAN SCORES (0 –3 SCALE) ACCORDING TO THE ACTIVITY AREA BY THE MISHA METHOD

Type	Industry, id. of the company	Size, employees	A1*	A2*	A3*	B1*	B2*	B3*	C1*	C2*	C3*	D1*	D2*	D3*
			Organisation and administration			Training and motivation			Work environment			Follow up		
NOHSASL	Textile industry, K	50 – 249	0.36	1.63	1.50	1.67	1.50	2.00	2.22	1.33	1.00	1.33	1.50	1.00
	Printing industry, O	< 50	0.73	0.75	0.75	1.00	1.00	1.00	1.44	0.67	0.33	0.67	1.00	0.00
	Glass industry, Y	< 50	0.09	2.13	1.00	2.00	1.50	1.50	2.11	1.33	1.00	0.33	1.00	0.00
	Textile industry, Z	≥ 250	0.36	2.25	1.33	1.00	1.75	2.50	2.33	2.00	2.00	1.67	1.50	0.00
OHSAS	Plastic industry, L	50 – 249	2.58	2.67	2.25	1.56	1.75	2.75	2.59	1.78	1.56	1.67	0.33	2.00
	Furniture Industry, M	50 – 249	2.91	2.25	2.25	2.33	2.00	2.75	2.44	2.00	2.00	2.33	1.50	1.00
	Heat industry, N	50 – 249	3.00	3.00	2.50	2.67	2.25	3.00	2.67	2.33	1.67	2.33	1.00	3.00
	Elect-ronics industry, S	≥ 250	2.97	2.58	2.42	2.78	2.67	2.75	2.70	1.67	2.11	2.89	1.00	3.00
	Metal industry, T	≥ 250	2.82	2.88	2.00	2.67	2.25	3.00	2.67	1.33	2.00	3.00	1.50	3.00
	Food industry, U	≥ 250	2.64	2.50	2.25	1.33	2.75	2.75	2.44	1.00	2.33	3.00	0.50	3.00
	Wood processing industry, W	≥ 250	2.36	1.88	1.75	1.67	2.75	2.75	2.78	1.67	2.00	3.00	0.50	3.00
	Food industry, X	≥ 250	3.00	3.00	2.50	3.00	3.00	3.00	3.00	2.33	2.00	3.00	1.00	3.00
NOHSASC	Metal industry, P	≥ 250	2.68	2.63	2.38	2.83	2.88	3.00	2.94	2.50	2.17	2.33	1.25	3.00
	Elect-ronics industry, Q	≥ 250	2.71	2.67	2.42	2.78	3.00	3.00	2.70	2.11	2.00	3.00	1.50	3.00
	Food industry, R	≥ 250	2.76	2.46	2.25	2.56	2.50	2.75	2.56	1.78	1.67	2.78	0.17	3.00
	Metal industry, V	< 50	2.55	3.00	2.50	1.67	1.75	2.75	2.67	2.33	2.33	3.00	1.00	3.00

***A1:** Safety policy; **A2:** Safety activities in practice; **A3**: Personnel management; **B1**: Participation; **B2**: Communication; **B3:** Personnel safety training; **C1** Physical work environment; **C2**: Psychological working conditions; **C3**: Hazard analysis procedures; **D1**: Occupational accidents and illnesses; **D2**: Workability of the employees; **D3**: Social work environment.
Abbreviations: OHSAS – OHSAS 18001-certified companies, NOHSASL – Non-certified, locally established and owned companies, NOHSASC – Organisations that belong to a larger corporation or concern but are not OHSAS 18001-certified.

Tables V, VI and VII present statistical results of activity areas calculated by the MISHA method for OHSAS, NOHSASC and NOHSASL companies.

Table V shows that for OHSAS companies very strong correlations (above 0.85) are met between parameters A1-B1 and B2-D1; strong correlation coefficients (above 0.70) are met between parameters A1-A3, A2-A3, A2-B3, C3-D1 and B1-D2 ($p < 0.05$). The very strong correlation between Safety Policy (A1) and Participation (B1) may be explained by the fact that a carefully prepared, comprehensively structured and well-considered safety policy that embraces various necessary elements of OHSMS may contribute to higher employee participation into the work place design and better supervisor/ employee communication where the feedback of quality of work is regularly and explicitly given.

TABLE V

MEANS, DEVIATIONS AND CORRELATIONS BETWEEN ACTIVITY AREAS, OHSAS CERTIFIED ORGANISATIONS

	Mean	Deviation	A1	A2	A3	B1	B2	B3	C1	C2	C3	D1	D2	D3
A1	92.80	7.83												
A2	86.46	12.96	.690***											
A3	74.65	8.59	.804*	.700***										
B1	75.00	21.30	.856**	.582	.492									
B2	80.90	14.35	.040	–.048	.028	.186								
B3	94.79	4.31	.547	.777*	.301	.684***	.140							
C1	88.73	6.03	.177	.299	.103	.546	.567	.530						
C2	58.80	15.39	.518	.321	.510	.581	–.079	.423	.499					
C3	65.28	8.15	–.020	–.301	–.155	–.071	.671***	–.235	–.125	–.584				
D1	88.43	16.50	.037	–.102	–.240	.241	.857**	.209	.367	–.341	.811*			
D2	30.56	14.85	.686***	.269	.147	.734*	–.129	.465	–.016	.225	.134	.210		
D3	87.50	24.80	–.034	.304	–.023	.159	.683***	.417	.536	–.202	.251	.630***	–.251	

Abbreviations: ***A1:** Safety policy; **A2:** Safety activities in practice; **A3**: Personnel management; **B1**: Participation; **B2**: Communication; **B3:** Personnel safety training; **C1:** Physical work environment; **C2**: Psychological working conditions; **C3**: Hazard analysis procedures; **D1**: Occupational accidents and illnesses; **D2**: Workability of the employees; **D3**: Social work environment.
* Correlation is significant at the 0.05 level.
** Correlation is significant at the 0.01 level.
*** Correlation is significant at the 0.1 level.

The very strong correlation between Communication (B2) and Accidents and Illnesses (D1) are explained by the fact that SMEs do not prioritise to record, keep and present regular statistics on occupational accidents and illnesses, they tend to organise less regular health and safety campaigns, or if they do it lacks the focus on essential and emerging hazards in the company. Due to OHSAS 18001 requirements in OHS activities, OHSAS companies score generally higher points (often maximum) than other companies. Therefore, it is challenging to see all possible correlations between the elements due to the inconsiderable variability in scores between different OHSAS companies.

TABLE VI

MEANS, DEVIATIONS AND CORRELATIONS BETWEEN ACTIVITY AREAS, NOHSASC ORGANISATIONS

	Mean	Deviation	A1	A2	A3	B1	B2	B3	C1	C2	C3	D1	D2	D3
A1	89.52	3.33												
A2	89.58	7.56	–.904*											
A3	79.51	3.47	–.752	.942*										
B1	81.94	18.04	.859***	–.813***	–.578									
B2	84.38	18.75	.828***	–.700	–.422	.979*								
B3	95.83	4.81	.394	–.212	.115	.741	.834***							
C1	90.59	5.46	–.130	.066	.260	.395	.421	.751						
C2	72.69	10.41	–.604	.572	.682	–.123	–.056	.462	.853***					
C3	68.06	9.49	–.835***	.878***	.917*	–.506	–.401	.169	.535	.894***				
D1	92.59	10.48	–.143	.433	.377	–.532	–.419	–.408	–.746	–.419	.000			
D2	32.64	19.30	–.144	.418	.696	.183	.355	.790	.650	.702	.653	.000		
D3	100.00	0.00	.[b]	.[b]	.[b]	.[b]	.[b]	.[b]	.[b]	.[b]	.[b]	.[b]	.[b]	

Abbreviations: ***A1:** Safety policy; **A2:** Safety activities in practice; **A3**: Personnel management; **B1**: Participation; **B2**: Communication; **B3:** Personnel safety training; **C1:** Physical work environment; **C2**: Psychological working conditions; **C3**: Hazard analysis procedures; **D1**: Occupational accidents and illnesses; **D2**: Workability of the employees; **D3**: Social work environment.
* Correlation is significant at the 0.05 level.
** Correlation is significant at the 0.01 level.
*** Correlation is significant at the 0.1 level.
.[b] Cannot be computed because at least one of the variables is constant.

Table VI indicates a very strong positive correlation (above 0.85) for NOHSASC companies at a significance level of 0.05 between variables B1–B2. Interestingly, NOHSASC companies have gained slightly higher points in Participation

(B1) than OHSAS companies. Presumably, NOHSASC companies, due to the pressure from headquarters, emphasise strong priority on safety issues, well-regulated and effective communication procedures, information dissemination and up-to-date regular safety campaigns. Firm communication principles promote better employee and supervisor participation. Therefore, there is a very strong correlation between Communication (B2) and Participation (B1). At a significance level of 0.01, there is a very strong downhill (negative) relationship between variables A1–A2. In NOHSASC companies, a safety policy is often implemented in unmodified form with minimum possibilities (the most common change is to eliminate legislative disagreements) to adjust to company's particularities. Therefore, it often lacks the practical connection and reflection of the company's real needs. While being unable to participate in preparation process of the safety policy those companies address their resources more towards safety activities in practice. This explains the very strong negative correlation between Safety Policy (A1) and Safety Activities in Practice (A2).

TABLE VII

MEANS, DEVIATIONS AND CORRELATIONS BETWEEN ACTIVITY AREAS, NOHSASL ORGANISATIONS

	Mean	Deviation	A1	A2	A3	B1	B2	B3	C1	C2	C3	D1	D2	D3
A1	12.88	8.70												
A2	56.25	22.69	–.863											
A3	37.50	10.76	–.405	.521										
B1	47.22	16.67	–.793	.388	.258									
B2	47.92	10.49	–.715	.948***	.718	.221								
B3	58.33	21.52	–.405	.758	.800	–.086	.923***							
C1	67.59	13.31	–.751	.911***	.826	.356	.977*	.898***						
C2	44.44	18.14	–.569	.899***	.632	.000	.973*	.949***	.909***					
C3	36.11	22.91	–.464	.846	.564	–.135	.932***	.939***	.844	.990**				
D1	33.33	20.29	.127	.302	.707	–.487	.580	.849	.559	.671	.708			
D2	41.67	9.62	–.101	.424	.894***	–.192	.688	.894***	.723	.707	.700	.949***		
D3	8.33	16.67	–.058	–.061	.775	.333	.132	.258	.325	.000	–.081	.365	.577	

Abbreviations: ***A1:** Safety policy; **A2:** Safety activities in practice; **A3**: Personnel management; **B1**: Participation; **B2**: Communication; **B3:** Personnel safety training; **C1:** Physical work environment; **C2**: Psychological working conditions; **C3**: Hazard analysis procedures; **D1**: Occupational accidents and illnesses; **D2**: Workability of the employees; **D3**: Social work environment.
* Correlation is significant at the 0.05 level.
** Correlation is significant at the 0.01 level.
*** Correlation is significant at the 0.1 level.

NOHSASL companies represent a very strong positive linear relationship (above 0.85) at a significance level of 0.05 between variables C3–C2, B2–C1, B2–C2, B3–C2, D1–-D2 and A2–B2 (Table VII). Local companies with good Safety Activities in Practice (A2) tend to have good Communication (B2) skills and activities, too: the management has effective information channels to communicate with employees, personnel is aware of the hazard reporting system and they are encouraged to make suggestions. Local companies who do not emphasise the need of workplace risk assessment as the basic preventive tool in OHS are not eager to deal with psychosocial risk factors either. This gives correlation between Hazard Analysis Procedures (C3) and Psychological Working Conditions (C2). When local companies have established a good environment for communication, where employees are encouraged to make suggestions and those are considered, it contributes to a better and satisfying physical and psychosocial work environment. This explains the very strong correlations between Communication (B2) and Physical Work Environment (C1); Communication (B2) and Psychological Working Conditions (C2). Psychological Working Conditions (C2) are also very strongly correlated with Personnel Safety Training (B3). It is clear that the evaluation needs for training and insurance of adequate employees' safety knowledge reflect top management engagement. The management appreciation for employees favours better employees' psychological health. Local companies have very few resources to deal with accident statistics, accident investigation and absenteeism (D1). Those scores for all companies are considerably lower than that of OHSAS or NOHSASC companies. A significant number of investigated companies irrespective of their type do not handle the assessment of physical and psychological workability (D2). This leaves room for future improvements.

V. DISCUSSION AND CONCLUSION

The globalisation and constant competition in the world-wide market have encouraged companies to implement various standards to demonstrate engagement for quality, environment and OHS. OHSAS 18001 [10], [11] standard has gained the most acceptance managing OHS in the manufacturing industry. Several authors have studied the impact of OHSAS 18001 [16]–

[23], [26]. In the Estonian manufacturing industry, OHSAS 18001 certification has not gained too much attention yet. The investigated OHSAS companies have stated that their motivation to acquire OHSAS 18001 certification comes from some other managerial issues rather than the need to improve OHS. Those other aspects might be pressure to maintain competitiveness in the market, to improve company's image in the society and to integrate safety into the management strategy.

In our study, the investigated OHSAS companies perceive benefits from OHSAS 18001 certification as follows: (1) improved documentation management, (2) improved company's image and (3) better conformity of legal obligations. The same results have been obtained by Fernandez-Muniz et al. [18], [19] in Spanish owned SMEs: OHSAS 18001 helps companies comply with their legal obligations, improve their organisation and documentation system as well as enhance their corporate image. Another Spanish study [22] has indicated that the adoption of OHSAS 18001 standard decreases the rate of work accidents and that OHSAS 18001 can be used as a long-run strategic tool to achieve objectives that go beyond safety outcomes. They have concluded that businesses who adopted OHSAS 18001 show significant improvements in safety performance and labour productivity.

The current study supports different positive hypotheses about OHSAS 18001 benefits: it favours the registration of accidents, illnesses and near misses; it supports regular monitoring of social work environment; contributes to more effective safety training etc. However, two of the postulated hypotheses have not been confirmed: there is no difference in psychosocial climate between OHSAS and NOHSASL companies and also higher appreciation on physical workability has not been observed. Hohnen and Hasle [6] have noticed the same shortcomings in their study, especially lack of concern with psychosocial work environment in an OHSAS company.

In our study, looking at the results of audits, we can conclude that in OHSAS companies OHS management functions both in paper and in practice. However, in one or two cases there has been a doubt of window dressing and maintaining the system without practical value. Similar problem was encountered in a Danish study by Granerud and Rocha [26]. They demonstrated that five OHSAS 18001-certified manufacturing companies addressed health and safety issues in very different ways, including one manufacturer where the coupling took place and no legal requirements were complied. The study has raised the question of the impartiality of the certification agencies. In conclusion, Granerund and Rocha stated that OHSAS 18001 certification would not necessarily lead to higher levels of safety performance but it did not obstruct more advanced or innovative practices either. OHSAS 18001 can strengthen structured initiatives, feedback possibilities, help to create higher levels of transparency among companies and support the consultation of blue-collar representatives to perform reporting and evaluation.

Our study has also explored the differences between company types: OHSAS, NOHSASL and NOHSASC. The results have shown that companies, which belong to a larger corporation, are able to operate as efficiently as OHSAS companies since their OHS management system is strongly supported by the corporate policy, standards, guidelines etc.

The study conducted in Finland [20] to examine OHSMS in a global steel company revealed that local OHS practices and tools varied significantly between sites and there was not any common practice or tool in use. In addition, there was variation on how deeply the corporate OHS standards were adopted within subunits: some of them were exceeding the demands but some were below the standards. Corporate OHS management was based on OHS standards, vision and principle plan and targets. Management support of OHS effort was seen as the most important asset.

The results of our study have presented correlations between safety activity areas according to different company types. This promotes better conception to understand how various safety activities are connected with each other and gives an explanation how employers emphasising one specific safety element can smoothly influence positively other safety issues.

In conclusion, based on quantitative and qualitative data the study shows that OHSAS 18001 contributes, to a great extent, to establishment of company's written safety policy, development of physical work conditions, training needs of systematic training approach, better dissemination of information at all levels of organisation, occupational health service activities, more effective interaction of supervisors and employees, frequent registration and investigation of accidents and illnesses, regular monitoring of social work environment. The study results indicate that OHSAS 18001 does not provide support for assessing psychosocial climate and physical workability.

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APPENDIX 5

Article 5

Õ. Paas, K. Reinhold, P. Tint
OHSAS 18001 contribution to real and formal safety elements of safety management in manufacturing companies: results of statistical analysis
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Agronomy Research **XX**(x), xx–xx, 2015

OHSAS 18001 contribution to real and formal safety elements in safety management system in manufacturing

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Abstract. The current paper examines safety management systems in Estonian manufacturing industry. The aim of this research is to assess via safety audit, in what extent OHSAS18001 contributes to real and formal safety elements of SMS in manufacturing companies. During 2014, eight (OHSAS 18001-certified organisations) and eight (non-certified organisations) Estonian enterprises from different branches of manufacturing were interviewed and assessed using MISHA method. The results present via statistical analysis that OHSAS 18001 gives a significant impact on formal safety, real safety and combined safety elements. It can be also concluded that OHSAS 18001 certification facilitates company's commitment to health and safety activities and leads to dealing with additional topics promoting workplace health and safety. Therefore OHSAS 18001 might be seen as a strategic tool to improve safety performance. However, examining three types of companies we can conclude that safety management system can be effectively implemented also without possessing OHSAS 18001 certification, but in Estonian economy market, it usually requires affiliation to a larger corporation or concern. Based on the analysis, a conceptual model is created which assists the company to reallocate the resources in a way that all safety elements will be possibly covered.

Key words: MISHA method, OHSAS 18001, safety audit, safety management.

INTRODUCTION

Safety management system (SMS) can be considered as a systematic and comprehensive process for the proactive management of safety risks that integrates operations, technical services with financial and human resource management. In order to ensure successful outcome, the SMS must: (1) be comprehensive and integrated into all organization's decisions and actions with respect to adopted control measures; (2) be documented, implemented and readily accessible and used as the primary means of ensuring the safe operation; (3) comply with all of the requirements stated in occupational health and safety (OHS) regulation and (4) be continually reviewed and revised so that the SMS remains current and effective (Bottani et al., 2009; Fernandez-Muniz et al., 2009; Kamp and Blansch, 2000; Mežinska et al., 2015; Möldri et al., 2012; Rebelo et al., 2014; Yorio et al., 2015).

Frazier et al. (2013) suggests the following sub-factors in SMS: safety policy, procedures and rules; training; communication; incident reporting and analysis; safety audits and inspections; rewards and recognitions; employee engagement; safety meetings\ committees; suggestions\ concerns and discipline.

After the SMS procedures have been developed, they need to be implemented by people with the appropriate skills and knowledge. Training packages should be developed to explain the SMS and delivered effectively to all workers. One possibility to establish and ensure effective SMS is to apply for SMS certification (such as OHSAS 18001 (EVS, 2007)) which creates a basis for a systematic work in the area of safety management, hazards identification and prevention, and promotes strong improvement process put in use (Paas et al., 2015b). The benefits of OHSAS 18001 have been studied by several authors in recent years (Fernandez-Muniz et al., 2012a; Fernandez-Muniz et al., 2012b; Granerud and Rocha, 2011; Hale, 2009; Koivupalo et al., 2015; Nielsen, 2000; Rocha, 2010; Torp et al., 2000). Mentioned studies indicate that adopting OHSAS 18001 may improve organisation's image, reputation and performance; integrates OHS into company's management system, reduces risk for accidents, improves the company's compliance with legal obligations, favours a learning process and helps to create higher level of transparency. However, OHSAS 18001 certification has also been criticized, especially having a tendency to increase the bureaucratisation of health and safety issues and therefore discourage genuine worker involvement. This may shift the focus from health and safety issues towards paperwork control which may diminish the activities dealing with of OHS problems (Granerud and Rocha, 2011; Kamp and Blansch, 2000; Nielsen, 2000).

Aforethought SMS contributes to positive safety culture (Fernandez-Muniz et al., 2007a; Fernandez-Muniz et al., 2007b; Hale et al., 2010; Nordlöf et al., 2015; Yourio et al., 2015). A healthy and positive safety culture actively seeks improvements, is constantly aware of hazards and uses adequate tools for continuous monitoring, analysis and investigation. Other elements of a positive safety culture include personnel and management commitment to safety responsibilities and a documented set of rules and policies. Several studies prove that management's strong commitment to safety ensures the establishment and adherence to sound safety practices (Koivupalo et al., 2015; Nielsen, 2014; Nordlöf et al., 2015). It is important to note that safety culture cannot be effective without devolving to organizational culture (Järvis, 2013; Yourio et al., 2015). Therefore, the SMS should not be relied on a pure paperwork system; rather should it reflect the overall safety culture and be consistent with mitigation of occupational hazards gained from the risk assessment.

Poor safety culture will encourage an atmosphere of non-compliance to safe operating practices. Violation are likely to be most common in organizations where the unspoken attitudes and beliefs mean that production and commercial goals are seen to get priority rather than safety. Several studies illustrate the cultural expression when there is a constant competition between productivity and safety – e.g. taking shortcuts but not using the appropriate tools or ignoring safe procedures to increase productivity (Atak and Kingma, 2011; Brown et al., 2000; Nazaruk, 2011). Managers tend to perceive the resources for OHS as expenditures rather than investments. Therefore it remains difficult to convince management about the benefits of investing into the safety activities – implementation costs are often overestimated and potential failure costs underestimated (Amador-Rodenzo, 2005). Effective SMS should promote the achievement of an acceptable level of safety while balancing the distribution of resources between production and protection. In any manufacturing organization, production and safety risks are strongly linked (Fig. 1). According to James Reason (1997), when production increases, the safety risks may also increase if the necessary resources or process enhancements are not available. A company should determine its

key objectives of production and safety by balancing output with acceptable safety risks. If the resources are excessively allocated for protection or risk controls, it may result in the product becoming unprofitable, thus jeopardizing the viability of the organization. On the other hand, favouring the allocation of resources for production at the expense of protection can have an impact on the safety performance and can ultimately lead to an accident. Perhaps the most extensive effect of a poor safety culture will be evident in an unwillingness to deal proactively with no deficiencies – safety shortcomings will be worked around and allowed to persist.

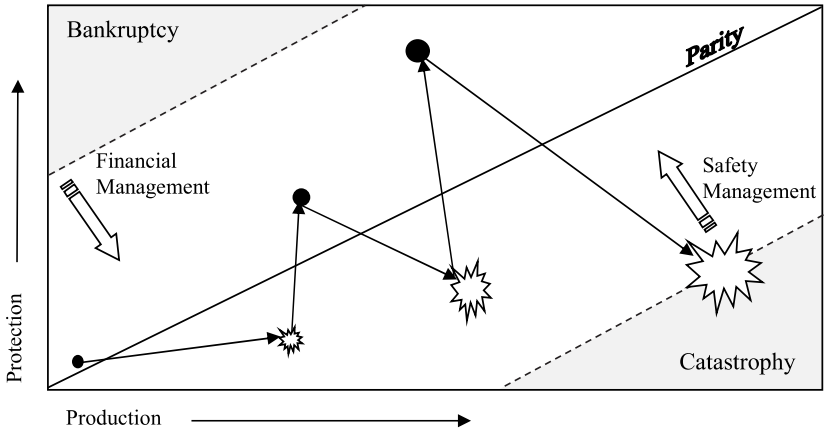


Figure 1. Relationship between safety and financial management to ensure positive safety practices (adopted by James Reason 1997)

Good safety culture should have favourable characteristics that contribute to a positive desirable and primarily stable state of safety. According to Silma and Lima (2005) an implemented prescriptive safety culture involves not only the congruence between *Safety values exposed* and *Safety values in use*, but a complete real and positive safety response encompassing values, behaviours, organisation and engineering. Naturally manufacturing companies with relatively high risk level of hazards should declare safety values and compose the safety policy as a part of formal safety. However this does not ensure prescriptive safety culture. According to some researchers (Granerud and Rocha, 2011; Meliá et al., 2012) a formal accent on safety sometimes can be used as an internal and external marketing procedure and hide some of the real safety weaknesses and lead to window coupling. Some of the flows which may negatively affect safety response are: 1) formal but not effective use of safety programmes, 2) existence of general safety instructions not adopted with company's real needs, 3) hazard analyses existing only on paper but no further action plans or activities are created, 4) lack of real safety communication including immediate intervention and 5) group specific descriptive safety cultures against safety procedures sometimes developing poor behaviours and attitudes towards safety practices.

The aim of this research was to assess via safety audit in what extent OHSAS 18001 contributes to real and formal safety elements of SMS in manufacturing companies.

The main objectives were: (1) to examine the impact of OHSAS 18001 to real and formal safety elements, (2) to conduct safety audit in 16 industrial companies (eight OHSAS 18001-certified companies (OHSAS), four non-certified locally established and owned companies (NOHSASL) and four organisations which belong to a larger corporation or concern but are not OHSAS 18001-certified (NOHSASC)) in order to find the relationships between company type and safety activities and (3) to perform a statistical analysis to find out the significant difference in formal, real and formal+real (combined) safety elements based on company type.

MATERIALS AND METHODS

In 2014, 16 safety audits were conducted in manufacturing companies in Estonia by MISHA method (Method for Industrial Safety and Health Activity Assessment) (Kuusisto, 2000) in the form of quantitative assessment (scale 0-3 for each item) and qualitative interviews. OHSAS companies were selected through the database of Estonian Association for Quality (2014). In order to compare the results with non-certified organizations, eight companies with similar background were selected – four represented organisations which belong to a larger corporation or concern but are not OHSAS 18001-certified and four were non-certified, locally established and owned companies representing main manufacturing areas in Estonia such as printing, textile, metal, food, furniture, plastic, glass, heat and electronics industry.

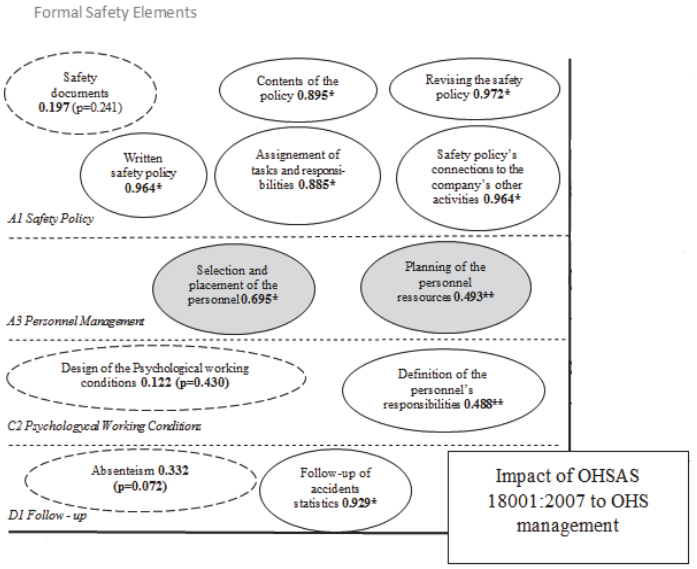
In order to see whether there is difference in OHSAS 18001 impact for formal and real safety performance, the authors interviewed top and line managers, also safety specialists and workers representatives in enterprises by the MISHA method. As a result, it was determined (using statistical methods) whether the safety element contributes to formal, real or combined safety. Some of the elements indicated possessed properties from both groups, which formed the third group – combined safety elements (Fig. 2b).

Altogether 55 questions were asked from each of the person interviewed (MISHA method). Once data collection had ceased, the first author and the interviewer (ÕP) re-heard the records, and checked the coding strategy used for consistency and ensured that all questions had been answered. The second author (KR) then listened to the records and made notes about understanding the answers. After that, the two first authors discussed the answers of each company to come to a good level of agreement about the results. The enterprises' number of workers varied from 50 to 250 (Paas et al., 2015).

The statistical analyses were prepared using programme *IBM SPSS Statistics 22.0 and R 2.15.2*. The following statistical methods were used: correlation, *MANOVA* and *Factor Analysis Principal Component method* (Field, 2013).

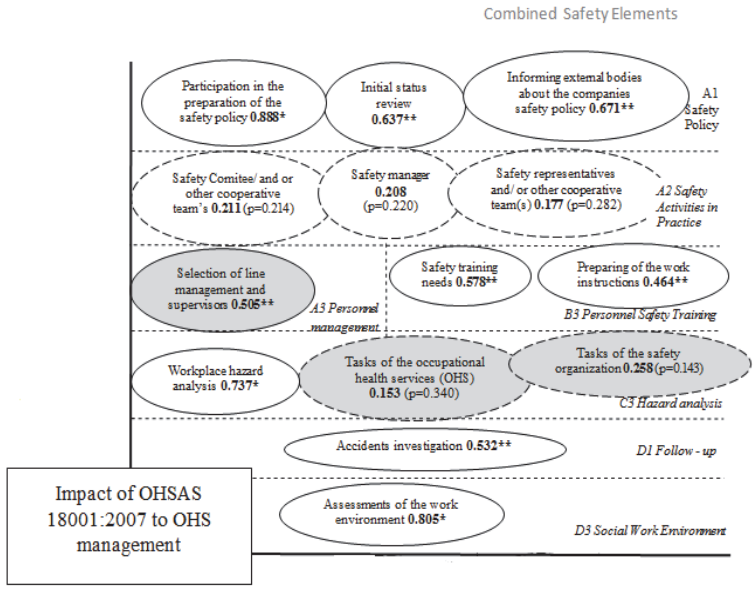
RESULTS AND DISCUSSION

This section presents the empirical findings of the study. For determination of OHSAS 18001 impact for formal and real safety performance, a statistical analysis was conducted. As a result, a conceptual model was created based on whether the safety element contributes to formal, real or combined safety (Fig. 2a, 2b, 2c).



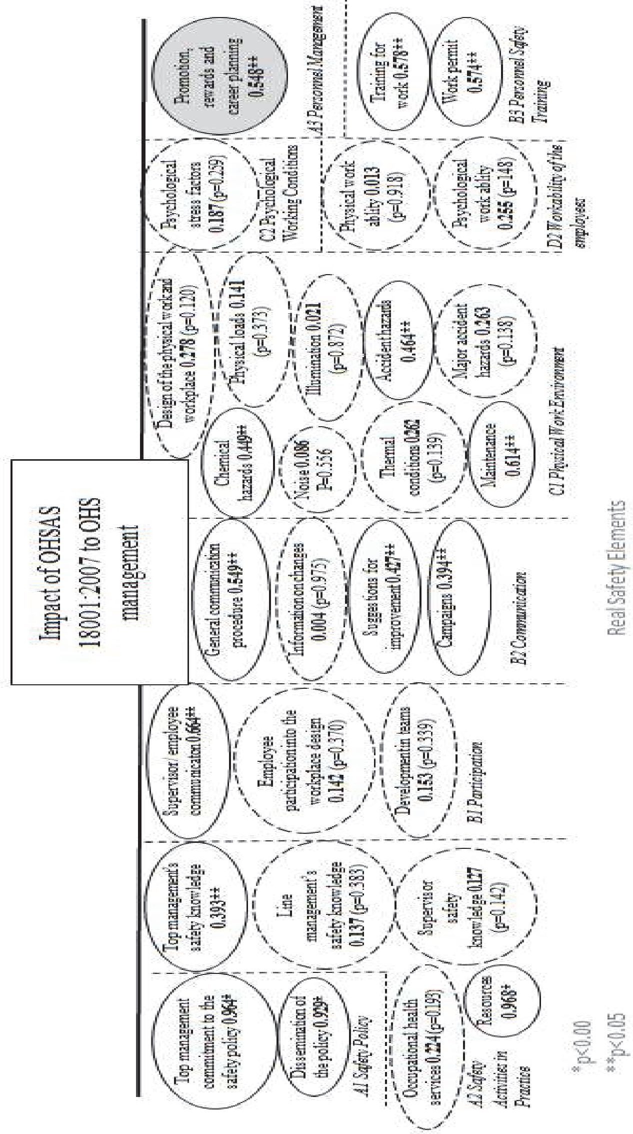
Safety elements covered in OHSAS 18001
Safety elements examined through audit but not covered with OHSAS 18001

Figure 2a. Formal safety elements



Safety elements covered in OHSAS 18001
Safety elements examined through audit but not covered with OHSAS 18001

Figure 2b. Combined safety elements



Safety elements covered in OHSAS 18001

Safety elements examined through audit but not covered with OHSAS 18001

Figure 2c. Real safety elements

Testing the significant impact of company type (OHSAS NOHSASL, NOHSASC) to above mentioned safety elements with Multivariate Analysis *MANOVA*, the results demonstrate that there was a significant multivariate main effect for company type on formal safety performance ($p<0.05$). The results also showed that there was a significant difference on real safety performance as well as on combined safety performance between different company types $(p<0.1)$.

A conceptual model (Fig. 2SUM): OHSAS 18001 and the impact of the safety elements in the scope of formal, real or combined safety can be combined from Fig. 2a, 2b, 2c.

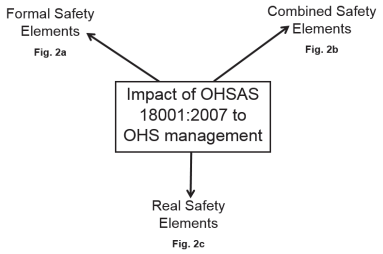


Figure 2SUM. A conceptual model: OHSAS 18001 and the impact of the safety elements in the scope of formal, rea or combined safety

a) Formal Safety Elements

MANOVA analysis showed that there was a statistically significant difference in formal safety performance based on a company type (OHSAS, NOHSASL, NOHSASC), $F(22, 6) = 10.047$, $p < 0.05$; *Wilk's $\Lambda = 0.001$, partial $\eta 2 = 0.974$*. Power to detect the effect was *0.988*. From Fig. 2a it can be seen that three formal safety elements: safety documents, absenteeism and design of the psychological working conditions were not dependent on company type since they did not show any correlation. Majority of safety documents are required by OHS legislation and therefore OHSAS 18001 does not play a significant role on implementing basic safety documents. Absenteeism investigation is required by OHSAS 18001, however this is complicated to conduct in practice due to restrictions in Estonian Personal Data Protection Act (2007), and therefore our study showed that all types of companies have difficulties with research about absenteeism. The active approach with dealing psychological working conditions is still low in all Estonian companies with no differences between three company types. This was also supported by the qualitative interviews conducted by the authors in addition to the current research (Paas et al, 2015a).

All other formal safety elements were dependent on company type. The highest impact was shown to written safety policy (0.964, $p< 0.00$), revising the safety policy (0.972, $p< 0.00$), safety policy's connections to the company's other activities (0.964 $p< 0.00$) and follow-up of accidents statistics (0.929, $p< 0.00$).

Company type showed also significant impact to contents of the policy (0.895, $p<0.00$), assignment of tasks and responsibilities (0.885, $p< 0.00$), selection and placement of the personnel (0.695, $p< 0.00$), planning of the personnel resources (0.493, $p<0.05$) and definition of the personnel responsibilities (0.488, $p<0.05$). This means that implementing OHSAS 18001 contributes to higher formal safety

performance – safety activities are systematically planned and it guarantees higher preconditions for formal safety performance.

Fig. 3 presents the results of each formal safety element calculated by MISHA method according to company type. From there we can conclude that for some elements OHSAS 18001 does not give the expected added value. For instance, organisations which belong to a larger corporation or concern but are not OHSAS 18001-certified (NOSHASC) show higher results in defining personnel's responsibilities and planning personnel resources. This shows that these elements are more strongly related to company's general personnel management and the content of job descriptions. Some of the corporated companies have applied a strong content for safety policy which indicates that if the top management reports full engagement to safety, the content of safety policy maybe more comprehensive and far-reaching than required by OHSAS 18001. Non-certified, locally established and owned companies (NOHSASL) show considerably lower results than OHSAS 18001 certified (OHSAS) and NOHSASC companies in formal safety elements which can be explained by more random attitudes and activities towards OHS management. Only a few of NOHSASL companies possess a written safety policy or deal with regular personnel resources and selection. Additionally the follow-up of accidents statistics is among NOHSASL companies very low. Meliá et al. (2012) conducted in-depth analysis of a NOHSASL company of a process industry in Southern Europe and identified several safety flows such as formal use of preventive observations, formal but not useful safety programmes, lack of safety communication etc.

Safety audits revealed that NOHSASC companies gained slightly higher results preparing safety documents such us work instruction, instructions for safety training, training of new employees, instruction for supervisors safety duties etc. than OHSAS companies. The reason behind this might rather depend on the size of the company than its type as smaller firms tend to put less effort on bureaucracy of safety documents.

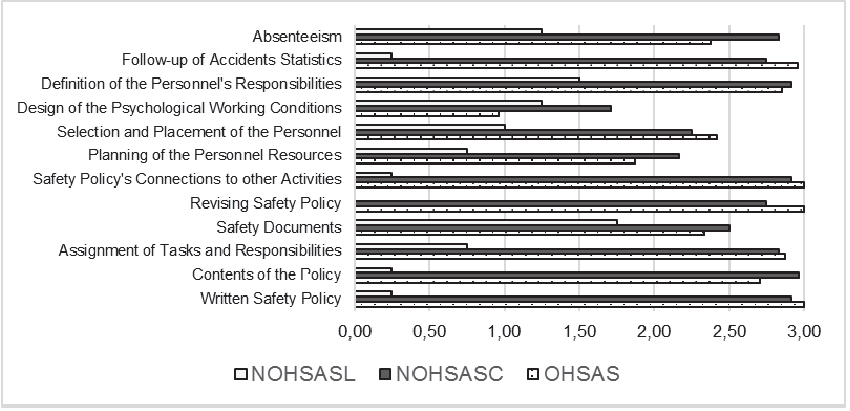


Figure 3. Descriptive statistics of formal safety elements providing mean (calculated by MISHA method) for the dependent variables according to company type. Scale 0-3.

b) Real Safety Elements

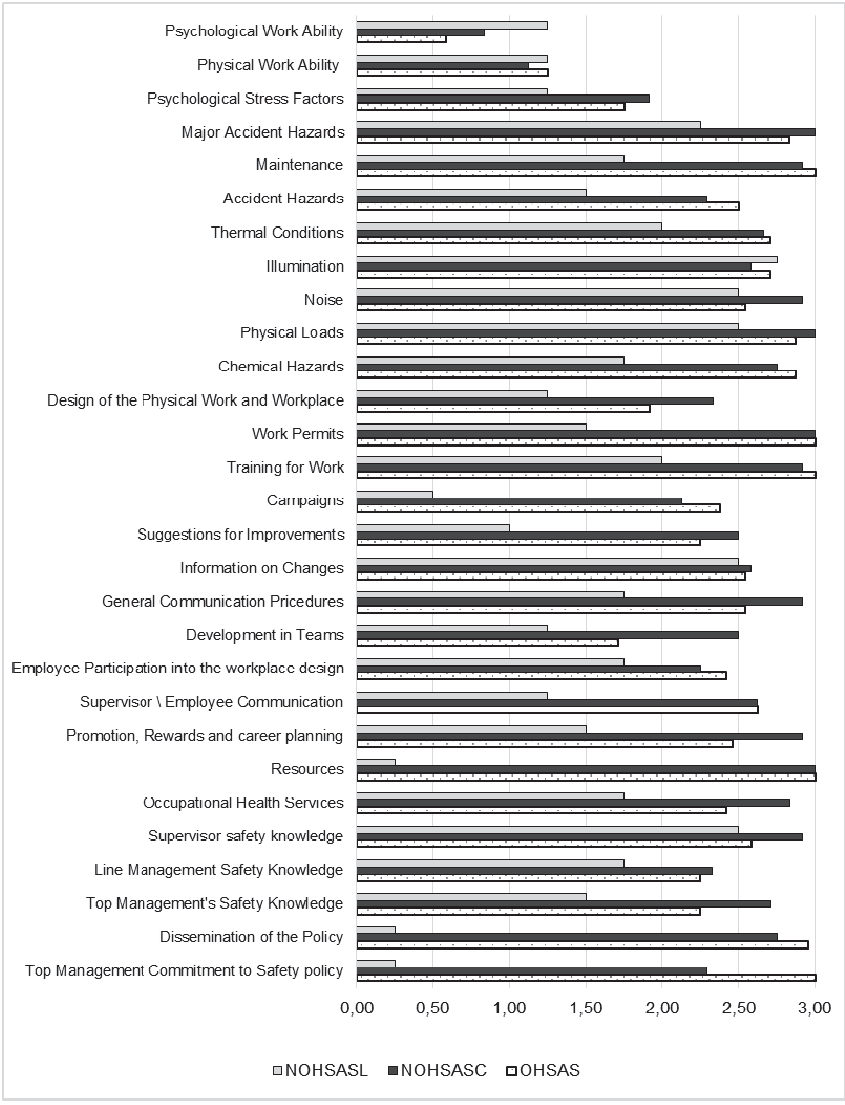


Figure 4. Descriptive statistics of real safety elements providing mean (calculated by MISHA method) for the dependent variables according to company type. Scale 0-3.

Examining real safety elements, there was a statistically significant difference in real safety performance based on a company type (OHSAS, NOHSASL, NOHSASC), F *(26, 2) = 17.311,* p *< 0.1; Wilk's Λ = 0.000, partial* η^2 *= 0.996*. Power to detect the effect was 0.854. Among real safety elements statistical analysis showed a lot more safety factors which do not depend on company type (Fig. 2): in activity area A2 occupational health services, supervisor safety knowledge, line management safety knowledge; in B1 employee participation into the workplace design, development in teams; in B2 information on changes; in C1 noise, thermal conditions, illumination, physical loads, major accident hazards and design of physical work and workplace; in C2 psychological stress factors; in D2 physical workability and psychological workability.

This indicates that OHSAS 18001 does not contribute in a great deal for many of real safety activities. For example dealing with physical work environment (C1) is a strict requirement derived from OHS act and is one of the main focuses of the annual visit of labour inspector. Employee participation in workplace design is rarely used in all three types of companies, due to the common belief in low OHS knowledge among employees. Therefore companies prefer to rely on engineers rather than involving employees in the stage of design with a few exceptions (Paas et al., 2015a). Development in teams is also seldom practiced among companies as it is not supported with Estonian OHS legislation.

Other real safety elements were dependant on company type: in activity area A1: top management commitment to the safety policy and dissemination of the policy; A2: resources, top management's safety knowledge, line management's safety knowledge and supervisor safety knowledge; A3: promotion, rewards and career planning; B1. supervisor\employee communication; B2: general communication procedure, suggestions for improvement and campaigns; B3: training for work and work permits; C1: chemical hazards, maintenance and accident hazards.

Very high influence emerged towards top management's commitment to the safety policy (0.964, *p< 0.00*), dissemination of the policy (0.929, *p< 0.00*) and OHS resources (0.964, *p< 0.00*). There are several other real safety elements that significantly depend on company type: top management's safety knowledge, supervisor employee communication, promotion, rewards and career planning, training for work, work permits and so on. From Fig. 4 all scores for real safety element according to company type can be seen. From these results we can conclude that implementing OHSAS 18001 standard contributes only partly to real safety elements such as top management commitment to the safety policy, dissemination of safety policy and resources. For many real safety elements (Fig. 4) strong demands from corporations influence safety activities more than requirements derived from OHSAS 18001 standard, for example suggestion for improvements; general communication procedures; promotion, rewards and career planning and safety knowledge among supervisors, line managers and top managers.

In 2011, Granerud and Rocha conducted in-depth analyses in five OHSAS manufacturing companies. One of the companies (plastic production) used several formal safety elements but in practice, it was difficult to find visible signs of safety activities – formal feedback channels and written procedures were not used in practice, employees were not involved in suggesting or making improvements and several physical and chemical risks were inadequately mitigated. This example shows that OHSAS 18001 certification is used to be merely window dressing for the company's

customers. In other four OHSAS companies both formal and real safety elements were handled with top management's commitment as safety is seen as a high priority and workers were actively participating in enhancement of health and safety.

c) Elements from Combined Safety

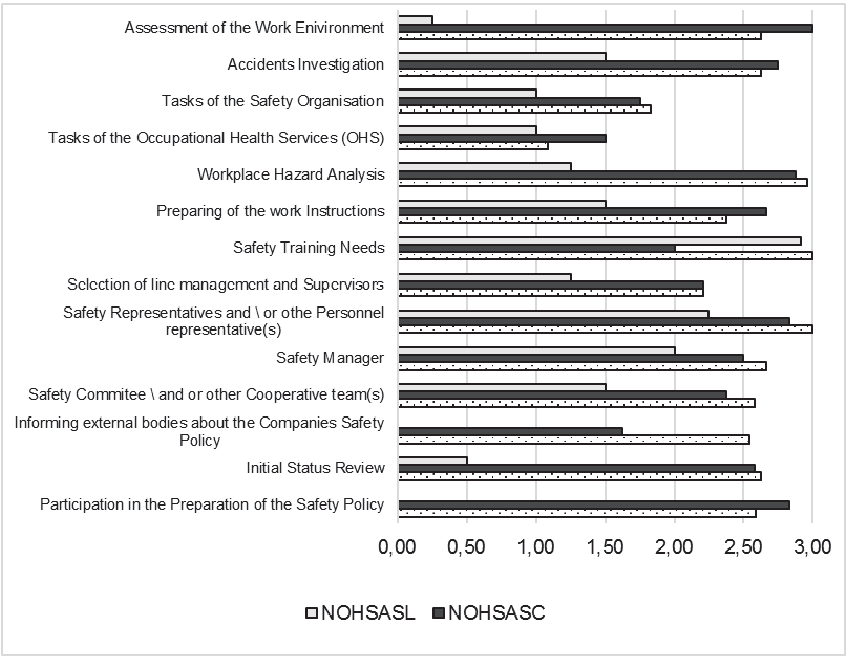


Figure 5. Descriptive statistics of real and formal safety elements providing mean (calculated by MISHA method) for the dependent variables according to company type. Scale 0-3.

There was a statistically significant difference in combined safety performance based on a company type (OHSAS, NOHSASL, NOHSASC), F *(26, 2) = 11.472,* $p <$ *0.1; Wilk's* $\Lambda = 0.000$*, partial* $\eta^2 = 0.993$. Power to detect the effect was 0.730. Fig. 5 presents the results of each real and formal safety element calculated by MISHA method according to company type.

The results indicate that all elements form safety policy (A1) depended on company type while all elements from safety activities in practice (A2) had no significance for company type. From hazard analysis procedures (C3) two elements – tasks of the occupational health services and tasks of the safety organization did not correlate with company type, while workplace hazard analysis was dependent on company type. Additionally elements from personnel safety training, accident investigation and assessment of the work environment showed significant difference. It is clear why OHSAS 18001 standard contributes to participation in the preparation of the safety policy as it is reasonable to engage employees in the preparation stage in

order to strengthen the relationship between employees' safety principles and employers' safety standards. Assessment of work environment was strongly dependant on company type although NOHSASC companies tend to carry out comprehensive risk assessment and occupational hazards measurements even more regularly than OHSAS companies, while NOHSASL companies hardly perform regular activities in this field. Interestingly, accident investigation is performed more actively by NOHSASC companies. Obviously the need to report and compare numeric results between subunits determines it. Clearly elements from A2 (presence of safety manager, safety committee and safety representatives) are required by general OHS law which every company irrespective of its type has to follow.

d) OHSAS 18001 contribution to overall safety

Our conceptual model presented in Fig. 2 highlights (in grey colour) those important safety elements which should be covered in safety audits but fall out of the scope of OHSAS 18001. The statistical analysis showed that four out of six mentioned elements were dependent on company type and OHSAS 18001 certification. This indicates that OHSAS companies tend to have higher commitment to OHS and therefore readily solve additional OHS related topics not required by the OHSAS 18001. This result may increase the attractiveness of OHSAS 18001 certification for managers and companies may see it as a strategic tool to improve safety performance. Those results are in line with other similar studies. Abad et al. (2013) proved via various statistical assessments that the work accident rate was lower in OHSAS 18001 certified companies and the certification had positive impact on operational performance as well as productivity. Fernandez-Muniz et al. (2009) stated in their study among Spanish OHSAS companies that occupational safety depends on managerial decisions related to preventive activities and confirms that effective safety management system is a factor of productivity and essential ingredient for improving the firms' position in the market. From this we can conclude that certified safety experience may have long-term benefits and OHSAS 18001 ads value not only for safety performance but overall business performance.

CONCLUSIONS

In conclusion, following statements can be presented:

1. Based on the research of 16 manufacturing companies in Estonia, a conceptual model of contribution of OHSAS 18001 of company's safety activities is created. We can say that OHSAS 18001 certification contributes significantly to formal safety elements such as existence of safety policy, follow-up procedures of accidents statistics, assigning safety tasks and responsibilities for employees. OHSAS 18001 contributes to some of real safety elements as well, but most of them do not depend on whether the company possess OHSAS 18001 certification or does not. Concerning combined elements, many of them – such as workplace hazards analysis, assessments of working environment, evaluation of safety training needs etc. are dependent on OHSAS 18001 certification.
2. Some of the elements examined by safety audit, but not falling in the scope of OHSAS 18001, are still dependant on company type: selection and placement

of the personnel, planning of the personnel resources, selection of line management and supervisors and promotion, rewards and career planning. This result shows that OHSAS 18001 certification facilitates company's commitment to health and safety activities and leads to dealing with additional topics promoting workplace health and safety. Therefore OHSAS 18001 might be seen as a strategic tool to improve safety performance.

3. Conducting safety audits and determining the company's tendency whether the focus leans for formal or real safety assists the company to reallocate the resources in a way that all safety elements are possibly covered. It is essential to deal with real safety, as this is often most visible and forms employee's safety attitudes and performance; but also with formal and combined safety as those elements often add value to the systematic health and safety work in a company.

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APPENDIX 6

Article 6

Õ. Paas, K. Reinhold, P. Tint
Learning Through Questioning in Occupational Health and Safety
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Poznan University of Technology, Poland

ZESZYTY NAUKOWE POLITECHNIKI POZNAŃSKIEJ
Nr 6 7 Organizacja i Zarządzanie 2 0 1 5

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LEARNING THROUGH QUESTIONING IN OCCUPATIONAL HEALTH AND SAFETY

The safety management system in 16 Estonian enterprises was analysed using the MISHA method. The statistical analysis was conducted for the interpretation of the results on health and safety level in OHSAS 18001 certified and non-certified enterprises. A new learning package "training through the questionnaires" has been worked out for the top and middle managers' to improve their safety knowledge, where the MISHA questionnaire has been taken as the basis. The tool assists SMEs with health and safety requirements according to the legislation, good practices and tacit knowledge.

Key words: safety management, Factor Analysis, Kaiser Normalization, learning through the questionnaires

1. INTRODUCTION

The knowledge about the occupational health and safety (OHS) is vital for the top and middle managers in order to understand the key issues in health and safety management in the companies. It contains the principles of legislation demands, good practices and the organizational and cultural issues such as leadership and communication skills [1]. From the mid-1980s, the active expansion of tools and methods of occupational health and safety management systems (OHSMSs) has been seen, including OHSAS18001 [2, 3]. The voluntary OHSAS 18001 standard is a supportive tool to design and implement OHSMS. The requirements in the standard are aimed to reduce the number of work accidents, promote recording of incidents and occupational illnesses, and diminish the possible financial losses. A review of the literature connected with the OHSMSs performance in companies [4, 5] shows that OHSAS 18001 itself will not improve the situation as the demands are considered too formal, the paperwork too extensive, the implementation too costly and numerous visits by audit teams too bothersome. Therefore, there is still a need for advanced research concerning the measurement properties of OHS management audits [6, 7]. It is also stated that OHSMSs auditors concentrate more on checking formal compliance with the relevant criteria, presented in OHSAS 18001, rather than paying sufficient attention to the technical measures, human factors

and ergonomics, and the relationship between employees and employers, which in fact provide a basis for successful step forward from the use of OHSAS 18001 [8]. In the connection with the OHSMSs audits, Blewett [9] highlights the re-conceptualization of their importance where the main centre should be put on the development of healthy and safe working environment, not on auditing the system. In accordance with the above, the presented opinion shows the need [10] to find the new advanced and novel solutions and measures that would improve the performance of OHSMSs. Podgorski [10] offers a tool to assess OHS performance through setting key and proactive performance indicators. The questionnaire covers all individual OHSMS components such as OHS policy and workers participation; organising OHS training programmes and risk assessment processes; evaluating performance, investigation of work accidents and diseases and their impact on OHSMS audit and assessing continuous improvement results. The goals can be set either in numbers or in percentages (for example: number of OHS improvements presented by workers or percentage of periodically verified OHS requirements presented in the specifications). The tool can be used in a large scale enterprise while a systems based on large number of indicators would be very complex, require maintaining extensive documentation and would also generate high number of the personnel involvement [10].

Therefore in the current study a more suitable method for SMEs, MISHA method (Kuusisto, 2000) [11], for safety audits is modified to work as a learning package. The goal of the tool is to improve management's safety knowledge in small and medium sized enterprises (SMEs). The motivation to propose a modified questionnaire in the interview style learning package is the OHS investigation in 16 Estonian manufacturing enterprises. Eight enterprises where the interviews were carried out owned OHSAS 18001 certification while eight enterprises did not own the certification. The statistical verification and the interpretation of the qualitative interviews of the results were presented earlier in scientific publications [12, 13]. The review on the effectiveness of the OHSMS interventions are given in [14] about voluntary (4) and mandatory (5) OHSMS. Four studied voluntary OHSMS interventions reported positive findings such as better safety climate, higher hazard reporting rate by employees, more organizational action taken on OHS. All five studies involving mandatory OHSMSs reported positive findings as well: e.g. employees' higher satisfaction with the physical and psychosocial working environment, employees' more active participation in OHS activities, reduced rates of lost time injury etc.

The aim of the current paper is to propose a concept of "training through the questionnaires" learning package to improve the safety knowledge of the managers' in order to manage professionally key and proactive safety performance indicators.

2. LEARNING FROM INTERVIEWS

The recent research in education science suggests that learning involves skills development through situated action and contact with other persons [15]. The questionnaires compiled for the assessment of safety activities at enterprises can be used as a tool for learning and obtaining more information on safety in companies. Learning is likely to be more effective when participants are actively involved in a dialogue in which they are co-constructors of the meaning [16]. Particularly it is essential for the top and middle managers' as management's commitment to safety is generally acknowledged as a fundamental aspect of successful safety performance [17]. The line managers and working environment representatives (WER) are usually more competent in safety activities due to practical safety training and extensive theoretical training required by OHS regulation [18]. There are several possibilities to learn through questioning: for students [19, 20] and adults in the safety area [15, 21, 22, 23]. It is a well-known fact that asking questions frequently during safety discussions is positively related to learning facts. Edwards and Bowman [19] proved with their study conducted in graduate-level occupational therapy class that improved classroom questioning strategies may contribute to development of higher cognitive skills. Jonnaert et.al [15] state that learners are no longer considered as passive receivers of knowledge, but are acting subjects who have taken their place at the centre of the dynamic process of developing and constructing their own enacted identities and knowledge.

The evaluation of the results of the interviews is essential: it has to be simple, the analysis has to be understandable and the content has to reflect all sides of the safety performance in the company. Therefore the interviewer has to be competent in OHS matters.

3. PRACTICAL PART

During 2014, eight OHSAS 18001-certified (group OHSAS) and eight non-certified (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 [11] method consists of the following safety areas:

A. Organization 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. Work ability of the employees
D3. Social work environment.

Each area gives 25% of the total, so maximum total score (safety level) is 100. Each safety sub-area (like A1, A2 etc.) includes different numbers of questions (from 3 to 20).

The correlation analysis of all the questions in the MISHA questionnaire showed that the correlation between the components of the questionnaire is very strong or strong ($R<0.8$). The only group that was 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 significance level 0.01.

Statistical analysis was performed using IBM SPSS v. 22.0. Firstly, the correlation matrix was generated for all the variables and the analysis shows a strong correlations between the components A1, A2, etc. to the total score, except D2 (workability of the employees). KMO and Barlett's test of sphericity produces in the Kaiser-Meyer-Olkin measure of sampling adequacy (0.83) and in the Barlett's test significance (Sig.=0.000). Therefore, we should be confident that the sample size is adequate for factor analysis. The best model fit possible was achieved after reducing the proposed safety management system scale from 12 to 9 explanatory variables structured in two subscales. The items B1, B2, C2 were finally eliminated. Then SPSS extracted 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: work ability of the employees. Factors are uncorrelated.

1.1. OHSAS 18001 certified enterprises (OHSAS)

The best model fit was achieved after reducing the proposed safety management system scale from 12 to 11 and explanatory variables structured in four subscales. The item finally eliminated was B3 (Table 1, a). In addition, the Varimax rotation with Kaiser Normalization to simplify the definition factors was used (Table 1, b). These analysis 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 Varix rotation method were: Factor 1 - 30.2%, Factor 2 - 23.5%, Factor 3 - 19.7% and Factor 4 -18.3%.

1.2. Non OHSAS 18001 certified enterprises (NOHSAS)

The best model fit was achieved after reducing the proposed safety management system scale from 12 to 11 and explanatory variables structured in four subscales. The item finally eliminated was B1. SPSS then extracted 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 2, a). The Kaiser Normalization was used to simplify the definition of the factors (Table 2, b).

The results of the correlation, Factor Analysis Principal Component method (including KMO Barlett's test (Keiser-Meyer-Olkin measure of sampling Adequacy)) showed 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 not statistically important. None of the companies had a systematic view for the rehabilitation for persons whose work ability has decreased. There was generally no policy how to ensure elderly personnel's work ability. In several companies, the work satisfaction survey was conducted regularly (usually outsourced), but psychological hazards questionnaires were hardly used. Some companies stated that dealing with this issue depends strongly on the management attitudes and knowledge [12, 13].

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]

Components	Factor 1	Factor 2	Factor 3	Factor 4
D1. Occupational accidents and disease	.937[b]	.967[a]		
D2. Work ability 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	.714a			.803[b]

[a]Extraction Method: Principal Component Analysis. [b]Rotation Method: Varimax with Kaiser Normalization.

TABLE 2

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 disease	.933[a] / .896[b]	
D2. Work ability of the employees		.908[a,b]
D3. Social work environment	.914[a] / .849[b]	
B2. Communication	.868[a] 7 .849[b]	
C2. Psychological working conditions	.928[a] / .854[b]	
B3. Personnel safety training	.972[a] / .982[b]	

[a]Extraction Method: Principal Component Analysis. [b]Rotation Method: Varimax with Kaiser Normalization.

4. THE PROPOSED "TRAINING THROUGH THE QUESTIONNAIRE" LEARNING 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" or "not applicable (NA)"; alternatively, the respondents have to answer descriptively. The total result of the questionnaire is qualitative. If needed, the questionnaire and answers can be developed to the quantitative result. In this case, the employees in the safety chain can compare their knowledge in OHS. The questionnaire was tested in two enterprises (one OHSAS and one NOHSAS) with 3 persons (the employer, safety manager and the working environment representative (WER)). The feedback helped to review questions and make minor corrections. The validation of the questionnaire remains for the future research.

The proposed version of the "training through the questionnaire" learning package based on statistical and qualitative interviews and MISHA method is presented in Table 3.

TABLE 3

LEARNING PACKAGE FOR TOP AND MIDDLE MANAGERS

No	Activity areas	Related questions
1	Initial status review	Has the company mapped occupational health and safety level and determined current status in at least 3 years' timescale? *Yes/No* If yes, please describe the current status review! Has the labour inspector visited the company within 3 years' time period? *Yes/No* If yes, please describe the conformities and non-conformities! Has the company considered to apply for safety management system certification (eg. OHSAS 18001)? *Yes/No* If yes, please describe your reasons and steps already taken! Has there been any initiatives or pressure to take actions in order to enhance occupational health and safety in the company? *Yes/No* If yes, please describe! Has there been pressure to review your status from any other stakeholders? *Yes/No/NA* If yes, please describe!
2	Safety Policy	Does the company have the written policy? *Yes/No* How the employees get acquainted with the policy? *Describe!* How has the company's top management committed itself to the goals of the policy? *Describe!* Does the policy have the following elements: the characterization of the company's safety aims? *Yes/No* the safety tasks and obligations? *Yes/No* How is the policy distributed between the top management, line management, supervisors, working environment specialist (WES), working environment representatives (WER), occupational and health (OH) personnel and other interested parties? *Describe!*

No	Activity areas	Related questions
		Are the following employees' groups taking part in the compile of the safety policy: The top management? *Yes/No* Middle management? *Yes/No/NA* WES? *Yes/No* Line managers? *Yes/No/NA* Employees (e.g. WER)? *Yes/No* How often is the policy renewed? *Tell the timescale!* Who are responsible for revising the policy? *Describe!* In case of existence of environmental and/or quality policy are they connected with company's safety policy? *Yes/ No/NA*
3	Safety Documents	Are the following safety related documents available in written form: o Job descriptions? *Yes/No* o Instructions for safety training? *Yes/No* o Descriptions for training for new workers? *Yes/No* o Safety obligation descriptions for all employment stages (incl. top management, WES, WER)? *Yes/No* o Safety instructions for all tools, machines and instruments and also for work operations? *Yes/No*
4	Top Management's Safety Knowledge	Is the top management familiar with the following safety aspects: o How well the company's work environment and equipment meet the health and safety standards? *Describe!* o How well are OHS activities integrated to overall management operations? *Describe!* o Are health and safety (H&S) considered when designing the new workplaces? *Describe!* o Are H&S aspects considered when the new machines or equipment are purchased? *Describe!* o How are the employees satisfied, motivated and feel themselves psychosocially comfortable in the company? *Describe!* o What is the safety awareness and performance of the middle management? *Describe!* o What are the cost of accidents and occupational diseases? *Describe!* o What trend have the insurance costs? *Describe!* o What is the cost-effectiveness of the safety measures? *Describe!* o How is the occupational health service provider selected (e.g. financial considerations, competence, references, quality of the service)? *Describe!* o Which emergency risks are considered and how are they managed? *Describe!*
5	Middle Management's Safety Knowledge	Is the middle management familiar with the following safety aspects: o What is the level of housekeeping in the company? *Describe!* o What is the safety level of equipment? *Describe!* o Which safety training practices are used in the company? *Describe!* o How is the system of personal protective equipment (PPE) managed? *Describe!* o What is the employees' risk behaviour (conscious of taking risks?) *Describe!* o How to choose the specialist for internal or external safety audit?

LEARNING THROUGH QUESTIONING IN OCCUPATIONAL HEALTH AND SAFETY

No	Activity areas	Related questions
		Describe! o Which emergency risks are considered and how are they managed? *Describe!*
6	Line Manager's Safety Knowledge	Is the line management familiar with the following safety aspects: o What is the level of housekeeping in the company? *Describe!* o What is the safety level of equipment? *Describe!* o What is the safety training plan in the company? *Describe!* o What are the standards for safety of equipment, instruments, and devices? *Describe!* o What is the status of PPE? What PPE is needed and how used and maintained by the workers? *Describe!* o Which emergency risks are considered and how are they managed? *Describe!* o What is the employees' risk behaviour? *Describe!*
7	Safety Managers' (OHS advisor) duties and knowledge	Is the safety manager employed? *Yes/No* What is the safety manager's training and competence? *Describe!* Does the safety manager have enough time to deal with OHS matters? *Yes/No* Does the safety manager have enough resources to deal with OHS matters? *Yes/No* Does the company ask input from safety manager while determining the health and safety resources? *Yes/No* How does the top and middle management support safety manager's everyday activities? *Describe!* Does the safety manager cooperate actively with all interested parties (e.g. WERs, employees, WEC, OHs service providers, Labour Inspectorate, top management etc.)? *Describe!* Does the safety manager have the general overview how OHS is functioning in the company? *Describe!* Is the safety manager competent in the following safety aspects: o How is the risk assessment carried out? *Describe!* o What are the results of risk assessment? *Describe!* o Has the health and safety action plan been conducted? *Describe!* o How to measure the risk level of occupational hazards? *Describe!* o How is established internal control system and how to keep it up to date? *Describe!* o How to find external experts for safety audit, expertise, counselling, occupational hygiene measurements, health check-ups, etc.? *Describe!* o What is the housekeeping procedures in the plant? *Describe!* o What is the employees' risk behaviour? *Describe!* o How are employees instructed and trained in OHS matters? *Describe!* o How is the medical examination to the employees organized? *Describe!* o How to organize the PPE procedure in the company? *Describe!* o How is first aid arrangements organized? *Describe!* o What are the principles to proceed with work related incidents (e.g. fatal, first aid, near miss, etc.)? *Describe!* o Does the company deal with OHS issues proactively? *Describe!*
8	Working Envi-	Does company have adequate number of WERs elected? *Describe!*

No	Activity areas	Related questions
	ronment Representative (WER)	How were the WERs elected? *Describe!* Do the WERs have adequate training? *Describe!* Do the WERs have enough time to deal with OHS matters? *Yes/No* Do the WERs engage actively in solving OHS issues? *Describe!* Do the WERs engage actively in proposing proactive OHS activities? *Describe!* How are employees aware of who are their representatives? *Describe!*
9	Working Environment Council (WEC)	Is there a working environment council elected and appointed in the company? *Yes/No/NA* Does company have adequate number of WEC members (equal number of employee's representatives and employer's representatives) elected/ appointed? *Describe!* How were the WEC members elected? *Describe!* Do the WEC members have adequate training? *Describe!* Do the WEC members have enough time to deal with OHS matters? *Yes/No* Do the WEC members engage actively in solving OHS issues? *Describe!* Do the WERs engage actively in proposing proactive OHS activities? *Describe!* How are employees informed of who are WEC members? Describe! Does the WEC compose an annual activity plan for themselves? *Yes/No* How often does the WEC meet to discuss the arising OHS issues? *Describe!* Does the WEC keep records/protocols of their meetings? *Yes/No* Does WEC report their activities on regular bases to Labour Inspectorate? *Yes/No*
10	Personnel Management	Is safety manager involved if necessary in the process of personnel selection? *Yes/No* Is the safety manager involved in the arrangement of new employees during probation period? *Yes/No*
11	Interaction	Are the adequate and safe working manners regularly monitored (e.g. by supervisors, foremen, line managers, etc.)? *Describe!* Is regular and immediate feedback given to employees based on their behaviour (positive and negative)? *Describe!* Is it a common practice to involve relevant employees in the new (or redesign) workplace design process? *Describe!* Is it a common practice to involve relevant employees in the preparation or renewal of safety documents? *Describe!* Is it a common practice to involve relevant employees when purchasing new equipment or machinery? *Describe!* Is it a common practice to favour safety observations among pears? *Describe!* Is it common practice to promote employees to make OHS suggestions? *Describe!* Are the best suggestions awarded? *Yes/No* Can the employee who made the suggestion have the possibility to implement it afterwards? *Yes/No* Are health and safety issues included in career development discussion? *Describe!*

LEARNING THROUGH QUESTIONING IN OCCUPATIONAL HEALTH AND SAFETY

No	Activity areas	Related questions
		Is there a system how good health and safety behaviour is promoted and awarded? *Describe!*
12	Communication	How are employees informed about the common communication practices? *Describe!* Are these practices followed? *Yes/No* Does the management organize regular information meetings? *Yes/No* How is the communication from the employee level to the top management level arranged? *Describe!* Are there regular briefings organized for the employees? *Yes/No* What communication means are commonly used (leaflet, wallboard, intranet, email, briefing etc.)? *Describe!* Are the employees informed of how the information flow on incidents should go? *Yes/No* Are the new workers informed about the safety policy? *Describe!* How are the employees notified in changes in the safety policy? *Describe!* How do the employees get informed about the changes in the safety policy? *Describe!* Are the workers informed about the hazards connected with the changes in the production, technology and equipment? *Describe!* Are there health and safety campaigns organized in the company? *Describe!* How are the campaigns focus areas chosen (based on hazards, changes in production, actual questions, etc.)? *Describe!* Are the campaigns material up-to-date? *Yes/No* Is it possible to hire external experts in the campaigns? *Yes/No*
13	Employees' Instruction and Training	Are the health and safety training needs defined? *Yes/No* Are the records on health and safety trainings kept up-to-date? *Yes/No* Has the company defined areas that require work permits? *Yes/No/NA* Is it possible for employees to participate in the evaluation process of training needs? *Describe!* Are the employees responsible for the training and instructions defined? *Yes/No* Is the know-how of experienced workers used? *Describe!* Has the company defined all job operations and equipment which need to be covered with safety instructions? *Describe!* Is there a procedure for compiling health and safety instructions? *Yes/No* When are the health and safety instructions renewed? *Describe!* Do employees participate in the preparation process of health and safety instruction manuals? *Yes/No* Are the health and safety instruction manuals available for all the employees? *Yes/No* Do the employees follow the health and safety procedures? *Describe!* How is the permission to the work with particularly hazardous work activities organized? *Describe!* Does the company organize additional health and safety instructions on regular basis? *Describe!*
14	Physical Work Environment -	Is the OHS legislation taken into consideration while (re) designing the workplaces? *Yes/No*

No	Activity areas	Related questions
	General Issues	Are the workplace designers trained for considering the health and safety aspects? *Yes/No* Do the designers consult with the employees? *Yes/No* Are accident and incident statistics considered while (re)designing workplaces and processes? *Yes/No* Are physical hazards considered while (re)designing workplaces and processes? *Yes/No* Is ergonomics considered while (re)designing workplaces and processes? *Yes/No*
15	Chemical risks	Does the company have a system how to handle chemical hazards? *Describe!* Are industrial hygiene measurements organized regularly? *Yes/No/NA* Does the company have instruction how safely handle and store chemicals? *Describe!* Are the employees trained how to safely handle and store chemicals? *Yes/No* Does the company have information about toxic properties of chemicals in use? *Describe!* Does the company possess the material safety datasheets for all chemicals in use? *Yes/No* Are all the packages or containers labelled appropriately? *Yes/No* How is the up-dated and/or new material safety datasheets distributed? *Describe!* Are less hazardous chemicals favoured in work processes when possible? *Describe!* Are chemicals hazards considered when preparing PPE procedure? *Describe!* Does company use appropriate PPE against chemical hazards? *Yes/No* Are the PPE regularly and correctly maintained and checked? *Yes/No*
16	Handling of Heavy Loads and Ergonomics	Are there lifting and handling aids or automation preferred when handling heavy loads? *Describe!* Does the company assess monotonous tasks? *Yes/No* Does the company assess repetitive tasks during work processes? *Yes/No* Does the company assess working position and posture (sitting, standing, leaning etc.) during work processes? *Yes/No* Which methods are in use for minimising physiological risks? *Describe!* Is there a plan or good practice example for rehabilitation from the work related physical overload diseases? *Describe!*
17	Noise	Has the company assessed the nose level? *Yes/No* Has the company considered engineer control methods to decrease noise level? *Describe!* Are the areas where the exposure limit might be exceeded, clearly marked? *Yes/No* Is noise disturbing communication, observation, concentration? *Yes/No* Is the personnel equipped with suitable PPE? *Yes/No* Is the maintenance of PPE organized? *Yes/No*
18	Vibration	Is there any equipment that can cause hand-arm vibration*? Yes/No* Has the vibration level measured? *Yes/No* Are there any complaints from the side of employers? *Yes/No*

LEARNING THROUGH QUESTIONING IN OCCUPATIONAL HEALTH AND SAFETY

No	Activity areas	Related questions
		Is the protective equipment used? *Yes/No* *Has there others means that can reduce the vibration level? Yes/No* How is organized the PPE maintenance? *Yes/No*
19	Illumination	Has the company assessed illumination quantitatively (measurements)? *Yes/No* Has the company assessed illumination qualitatively (glare, shadows, uniformity, contrast, flickering etc.)? *Describe!* Has the company found appropriate measures how to control illumination hazards (based on quantitative and qualitative assessment)? *Describe!* Has the company assessed illumination needs according to different employees groups (e.g. shortsighted people, aging people)? *Describe!*
20	Electromagnetic fields (EMV)	Have the electromagnetic fields been measured? Is there any machines in the industrial area that induce EMV? *Yes/No* Are there any health complaints from the side of employees? *Yes/ No* Are the mobile phones very intensively used by the employees*? Yes/No* Are the EMV measured by the computers? *Yes/No*
21	Ionizing radiation	Are there any equipment where the sources of ionizing radiation are present? *Yes/No*
22	Indoor and Outdoor Climate	Has the company assessed indoor climate quantitatively (measurements)? *Yes/No* Is the temperature in the work environment in accordance with the nature of the work? *Describe!* Has the company considered how to control the indoor air flow? *Yes/No; to* control the indoor humidity? *Yes/No;* to control the indoor temperature? *Yes/No* Has the company considered what are the appropriate means for controlling outdoor abnormal weather conditions (clothing, breaks, drinks, etc.)? *Describe!*
23	Accident Hazards	Is the work environment area (floors, tables, racks etc.) clean from dust, products and raw materials? *Yes/No* Are the work-passes in clean conditions, is their surface free, are the walkways marked? *Yes/No* Are the work-passes separated from the motorways? *Yes/No* Are the devices and equipment in good condition? *Yes/No* Are the devices provided with safeguards? *Yes/No* Is the safety of motor vehicle traffic controlled? *Yes/No* Is safe travelling between home and work promoted? *Describe!*
24	Maintenance of the Machines and Equipment	Does the company arrange preventive maintenance for machines and equipment on regular basis? *Describe!* Does the plant have a maintenance plan? *Yes/No* Is the regular cleaning organized? *Yes/No* Is the maintenance of the devices and the tools in the appropriate level? *Describe!* Does the company organize and keep records on machine and/or equipment testing and/or inspection? *Describe!*
25	Emergency Accident and Major Hazards Risks	Does the company have a procedure how to act in case of the emergency? *Describe!* Does the company have the plan for the evacuation of the employees? *Describe!*

No	Activity areas	Related questions
		Are the risks and requirements of hot work considered? Yes/No/NA Are the explosive materials and hazardous chemicals safely stored? *Yes/No* Is the extinguishing system managed by the plan? *Yes/No* Has the major hazards risk assessment carried out if needed? Yes/No/NA Is there co-operation between the Fire Safety Board and the neighbouring premises organized (incl. information exchange)? Yes/No/NA
26	Psychosocial Work Conditions	Does the company have a good practice example of managing psychosocial risks? *Describe!* Has the company assessed work related stress level in the company? *Yes/No* Has the company assessed the social work environment climate? *Yes/No* Has the company assessed potential risks for employees who are working alone (in isolation)? *Describe!* Are the psychological demands considered while (re)designing work places (incl. mental under- and overload)? *Describe!* Are the results of the psychosocial issues regularly discussed openly in all levels of the company? *Describe!* What is the mentality of the top management towards harassment and work place violence? *Describe!* Is there a system for redesigning the work environment for the employees who have difficulties in coping with the work responsibilities? *Describe!* Are there employees working under extreme stress and is there a programme to follow-up their health? *Describe!*
27	Workplace Risk Assessment	Has the risk assessment been conducted according to the legislative requirements? *Yes/No* Is the risk assessment renewed regularly? *Yes/No* How often and when is the risk assessment renewed? *Describe!* Is the risk assessment conducted by the internal personnel or outsourced? *Describe!* Are the suitable methods and/or tools used when conducting OHS risk assessment (interview, checklist, observation, questionnaires etc.)? *Describe!* Are the OHS risk assessment results presented to managers? *Yes/No* Is there an OHS action plan compiled based on risk assessment? *Yes/No* Is the action plan renewed regularly? *Yes/No* Are the planned activities carried out? *Yes/No* How is the fulfilment of planned activities being monitored? *Describe!*
28	The External OH Service	How the occupational health service provider is selected (e.g. financial considerations, competence, references, quality of the service)? *Describe!* Does the OH service provider prepare an activity plan on regular basis? *Describe!* Does the OH service provider visit the company regularly to gather the information on working conditions? *Yes/No* Does the OH service provider offer the employer the feedback on regular basis? *Yes/No* Is the OH service provider participating in employee instructions or trainings? *Yes/No* How is the co-operation between the company and OH service provider organized? *Describe!*

No	Activity areas	Related questions
29	Occupational Accidents and Illnesses	Does the company analyse OHS accidents and incidents causes? *Yes/No* Does the company keep statistics on OHS accidents and incidents? *Yes/No* Has the company established who has the permission to access the OHS accidents and incidents statistics? *Describe!* Is there a procedure for handling OHS accidents, incidents and work related diseases? *Describe!* How is the management informed on accidents and incidents? *Describe!* Has the company established the process for accident investigation? *Describe!* Does the company keep the statistics on absenteeism? *Yes/No* Is the statistics (incidents, absenteeism) used for setting key performance indicators? *Yes/No*

5. CONCLUSIONS

During the study in 2014 safety interviews were conducted in 16 Estonian manufacturing companies. Processing the results of the interviews it appeared that top and middle management's health and safety knowledge in NOHSAS companies is generally lower than in OHSAS companies. During the interviews the interviewees emphasised beneficial and appropriate information they gained while answering and discussing MISHA questionnaire. They confessed that due to limited time it is complicated to be informed and regularly deal with OHS matters in SMEs. This brought a need to prepare a "training through the questionnaire" learning package in order to assist SMEs with fundamental OHS requirements according to the legislation as well as good practices and tacit knowledge. This may lead to enhancement of working conditions with minimal or moderate efforts. Nevertheless it should be kept in mind that the interviewer should be competent in OHS legislative and other requirements.

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APPENDIX 7

MISHA questionnaire

A. ORGANIZATION AND ADMINISTRATION

A1. Safety policy

A1.1. Written safety policy

- Does the company have a written safety policy?
- Are the personnel aware of the policy?

A1.2. Top management commitment to the safety policy

- Has company's top management (Factory manager, managing director) committed itself to the goals of the policy?
- Is the commitment visible in management's everyday activities?

A1.3. Contents of the policy?

Does the policy have the following elements?

- The role and importance of safety to the company
- A description of the company's safety goals
- The main safety activities and procedures
- A description of the organization and administration of the safety activities
- A description of the safety tasks and responsibilities

A1.4. Assignment of tasks and responsibilities

Are the tasks and responsibilities assigned to:

- The top management?
- The line management and the supervisor?
- The employees?
- The safety and health personnel?

A1.5. Participation in the preparation of the policy

Have the following personnel groups participated in the preparation of the safety policy?

- The top management
- The line management and supervisors
- The employees
- The safety and health personnel

A1.6. Initial status review

Were the following aspects reviewed before the policy was prepared?

- What is the current health and safety level in the company?
- What are the typical and potential hazards in the company?
- Is the current safety management system operating effectively?

A1.7. Safety documents

Does the policy list the following documents?

- Work instructions
- Instructions for safety training
- Instructions for training of new employees
- Instructions for line-managers' and supervisors' safety duties
- Safety organization's activity program

A1.8. Revising the safety policy

Has the company defined:

- How often the policy is revised?
- Who are responsible for revising the policy?

A1.9. Dissemination of the policy

Has the company defined?

- How the policy is made available to the personnel?
- How new employees can Access the policy?
- How the revised versions of the policy are distributed?

A1.10. Informing external bodies about the company's safety policy

Has the company defined:

- How temporary workers, sub-contractors, clients, authorities, and other external bodies can have access to the company's safety policy?
- Who inform these bodies about the policy?

A1.11. Safety policy's connections to company's other activities

Has the company considered how the safety policy is linked to:
- The company's quality policy
- The company's environmental policy

A2. Safety activities in practice

A2.1. Top management's safety knowledge

Is top management aware of:
- How well the company's premises and equipment meet the health, safety and usability standards?
- How health and safety is considered in the design of new workplaces and processes?
- What the satisfaction, motivation, mental well-being and social relationships are among the personnel?
- What is the safety performance of the line-management and the supervisors?
- What are the costs of occupational accidents and illnesses?
- What is the trend in the company's insurance costs?
- What is the cost-effectiveness of the safety activities?

A2.2 Line management's safety knowledge

Is the line management aware of:
- What is the housekeeping standard of the plant?
- Whether the safety training procedures are adequate in the company?
- What is the safety standard of machines, equipment and tools?
- What is the quality of the personal protective equipment?
- How employees use and take care of their personal protective equipment?
- What is the employees' risk behaviour (conscious risk taking)?
- How to find safety expertise from inside or outside the company?
- How safety and health aspects are taken into account in the design of new workplaces and processes?
- How health and safety aspects are taken into account when new machines or equipment are purchased?

A2.3. Supervisor's safety knowledge

Are the supervisors aware of:
- What is the housekeeping standard of the plant?
- What are the safety training procedures in the company?
- What is the safety standard of the machines, equipment and tools?
- What is the quality of the personal protective equipment?
- How employees use and take care of their personal protective equipment?
- What is the employees' risk behaviour (conscious risk taking)?
- How to find safety expertise from inside or outside the company?
- How safety and health aspects are taken into account in the design of new workplaces and processes?
- How health and safety aspects are taken into account when new machines or equipment are purchased?
- What are actions to be taken in an emergency situation (serious injury, fire, etc.)?

A2.4. Safety committee and/or other safety team(s)
- Does the company have a safety committee or some other cooperative safety teams?
- Does the committee/ team have both employer and employee members?
- Does the committee/team prepare an annual working program for itself?

A2.5. Safety manager
- Does the company have a safety manager?
- Has the safety manager received adequate safety training?
- Does the safety manager have adequate time and other resources for the safety activities?

A2.6. Safety representative and/or other personnel representative(s)
- Have the employees elected a safety representative (when required by law)?
- Has the representative received adequate safety training?
- Does the representative have adequate time and other resources for the safety activities?

A2.7. Occupational health services

- Does the company provide occupational health (OHS) services for all its personnel?
- Are the OHS personnel well acquainted with the company's organization and functions?
- Are the OHS personnel aware of the health and safety hazards typical to the company?

A2.8. Resources

- Does the company assign special resources to health and safety activities on an annual basis?
- Does the company seek advice from health and safety personnel when determining the resources?

A3. Personnel management

A3.1. Planning of the personnel resources

Are there short-term and long-term plans for:

- The number of needed personnel resources?
- The future production systems and work processes?
- How the business activities change in the future?
- How the elderly personnel's work ability is ensured?
- Actions in the situation where the company has to down-size?

A3.2. Selection and placement of the personnel

Has the company defined:

- Who participates to the selection of new employees?
- Which are the selection methods and criteria used?
- The rules for rotating personnel in the different tasks?

A3.3. Selection of the line management and supervisors

Does the selection include evaluation of the candidates?

- Leadership qualities?
- Ability to evaluate how the personnel copes with the work?
- Ability to motivate personnel?
- Ability to identify health and safety hazards?
- Ability to handle problems related to the human relations?

A3.4. Promotion, rewards and career planning

Has the company defined:

- How the personnel's quality of work is measured?
- What is the relationship between the quality of work and rewards?
- How individual career planning is done?

B. PARTCIPATION; COMMUNICATION, AND TRAINING

B1. Participation

B1.1. Supervisor/employee communication

- Does the supervisor follow and give feedback on employees' quality of work?
- Does the supervisor instruct employees in safe work practices?
- Are there regular supervisor/employee discussions on the employee's career development?

B1.2. Employee participation into the workplace design

- Are employees' opinions and suggestions asked when the work processes and work environment are (re)designed?
- Do employees participate to projects were the work processes and work environment are (re)designed?

B1.3. Development in teams

- Has the company established small groups with employee participation for developing the work?
- Are these groups effectively managed, and are they working actively?
- Do these groups have necessary management support and resources?

B2. Communication

B2.1. General communication procedures

- Are the personnel aware of the company's communication practices?
- Does the management arrange information meetings for all the personnel on a regular basis?
- Is the communication from the employee level to the upper organizational levels effectively arranged?

- Are the wall-boards, internal leaflets, e-mail, etc. effectively used?
- Are the new employees instructed for the communication practices?
- Are the personnel aware of the hazard reporting systems?

B2.2. Information on changes

- Are the personnel informed adequately and in advance on the new work practices and procedures?
- Are the personnel adequately informed on the potential hazards associated to the changes in the work?

B2.3. Suggestions for improvements

- Is there a systematic procedure for collecting employees' suggestions?
- Are the personnel encouraged to make suggestions?
- Do the personnel know the procedure for how to make the suggestions?
- Are the suggestions evaluated promptly?
- Is feedback provided to the person who made the suggestion?
- Can the person who made the suggestion complete it afterwards?
- Are the best suggestions rewarded?

B2.4. Campaigns

- Does the company arrange health and safety campaigns?
- Do the campaigns focus on potential hazards?
- Is the campaign material up-to-date?
- Is it possible to use experts in the campaigns?

B3. Personnel safety training

B3.1. Safety training needs

- Is the need for safety training evaluated on a regular basis?
- Can the employees participate in the evaluation of the safety training needs?
- Are the supervisors able to estimate the need for safety training?
- Does the safety training cover all personnel groups?
- Has the need for first-aid training been evaluated?

B3.2. Training for work

- Are the persons responsible for giving the training defined?
- Are all employees, including temporary workers, trained for their work?
- Is the experience of the senior workers used in the training?
- Have the employee seen the instructions, and can they operate according to them?
- Have the employees and supervisors participated in the preparation of the instructions?
- Are the instructions revised, and are the old ones removed?

B3.4. Work permits

- Has the company defined which work permits are necessary?
- Is the training for the use of work permits planned and realized?
- Does the company keep a record of the persons with permanent work permits (e.g. permit to do fire hazardous work)?

C. WORK ENVIRONMENT

C1. Physical work environment

C1.1. Design of the physical work and workplace

- Are the workplace designers trained for considering health and safety aspects?
- Do the designers consult with the employees?
- Do the designers consult with the supervisors, and the health and safety organization?
- Are accident risks considered in the design of workplaces and work processes?
- Is ergonomics, e.g. working postures and other physical activities considered in the design of workplaces and work processes?

C1.2. Chemical hazards

- Does the company have a system for distributing and updating the material safety data sheets?
- Are industrial hygiene measurements done on a regular basis?
- Does the company have instructions for the handling and storage of hazardous chemicals?
- Does every package and container of chemicals have the content identification attached?

- Are the personnel trained for the handling and use of chemicals?
- Are the personnel protective equipment suitable, and are their availability and maintenance arranged?
- Is there a system for using the least hazardous chemical when possible?

C1.3. Physical loads
- Have the heavy physical material handling tasks been eliminated by automation or other means?
- Has the company minimized the number of monotonous physical tasks one-sided motions, and rapid repetitive motions?
- Are the working postures ergonomically acceptable?

C1.4. Noise
- Have the areas where the Threshold Limit Value (TLV) is exceeded been clearly marked?
- Does the noise disturb communication, observations or concentration?
- Are the personnel protective equipment suitable, and are their availability and maintenance arranged?

C1.5. Illumination
- Has the company ensured that the quality of illumination is suitable in the different work tasks?
- Have reflections, dazzle, and contrast been considered in the planning of illumination?
- Has the need for local spotlights been considered, e.g. in quality control?
- Can senior persons increase the level of illumination in their workplace when necessary?

C1.6. Thermal conditions
- Is the temperature of the workplace appropriate considering the nature of the work?
- Is the air flow effectively controlled?
- Is the humidity effectively controlled?
- Does the company provide suitable clothing for the personnel in abnormal thermal conditions?
- Have the seasonal differences been taken into account in the design of the cooling/heating system?
- Does the work include adequate number of breaks in uncomfortable thermal conditions?

C1.7. Accident hazards
- Are floors, racks, etc. in order and clean?
- Are walkways in good condition, are their surface clean and free, are they marked, and are safety rails in place?
- Are walkways separated from the driveways?
- Are the machines and equipment in good condition, and are the safeguards in place?
- Is the safety of motor vehicle traffic ensured+
- Is the safety of travelling between home and the workplace promoted?

C1.8. Maintenance
- Is the maintenance of machines and equipment at adequate level?
- Does the company have a preventive maintenance program for machines/equipment?
- Is the regular cleaning of the plant area adequately organized?

C1.9. Major accident hazards
- Are fire hazardous tasks well planned?
- Are explosives and fire hazardous chemicals properly stored?
- Is the handling of explosives and fire hazardous chemicals properly managed?
- Is the extinguishing system controlled on a regular basis?
- Are emission of hazardous/harmful chemicals in control?
- Does the company have plans for the evacuation of personnel?
- Are the licences from the authorities for manufacturing, handling, and storage of hazardous materials in order?
- Are hazards analysis and risk assessments made for identifying potential major accident hazards?
- Is cooperation and communication with safety & fire authorities, and the people living in the neighbourhood adequately organized?

C2: Psychological working conditions

C2.1. Design of the psychological working conditions
- Is the work environment and work process designed considering the psychological aspects?
- Do the designers know the concepts of mental underload and overload?

C2.2. Psychological stress factors

Are the following stress factors under control in the workplace:
- stress, due to inadequate planning or organization of the work?
- monotonous work and repetitive work?
- work with automated production lines, e.g. with conveyor belts?
- work with constant need for attention, e.g. in a control room or in quality control?
- working alone, in isolation from the other workers?
- difficulties in decision-making, e.g. due to inadequate instructions?
- other stress building factors, e.g. noise, illumination, and thermal conditions?

C2.3. Definition of the personnel's responsibilities
- are the personnel's responsibilities and authorities clearly defined?
- Are the persons responsible for health and safety of other people, production losses, or the quality of work trained for their responsibilities?

C3. Hazard analysis procedures

C3.1. Workplace hazard analysis
- Are systematic analysis carried out on a regular basis?
- Are the targets of the analysis systematically planned?
- Are suitable and effective methods used in the analysis (e.g. checklists, observation methods, interviews, or questionnaire)?
- Are industrial hygiene measurement included in the analysis?
- Are the persons responsible for the analysis trained for the work?
- Are the analysis results reported to the management?
- Does the report lead to the preparation of an action plan?
- Is the follow-up arranged in order to see whether the proposed corrections/improvements have been done?

C3.2. Tasks of the occupational health services (OHS)
- Are the goals of the OHS activities discussed with the top management?
- Do the OHS personnel prepare an activity plan on an annual basis?
- Do the OHS personnel have skills and methods for analysing hazards at workplace?
- Do the OHS personnel follow the effects of their activities?
- Do the OHS personnel report their activities to the company management?
- Do the OHS personnel report their activities to the company management?

C3.3. Tasks of the safety organization
- Are the goals of the safety organization's activities discussed with the top management?
- Do the members of the safety organization have adequate training?
- Does the safety organization participate in safety analysis?
- Does the safety organization handle the analysis reports in safety meetings?
- Does the safety organization follow the effects of its activities?
- Does the safety organization participate in employee training?

D.FOLLOW-UP

D1. Occupational accidents and illnesses

D1.1. Follow-up accidents and illnesses
- Does the company make statistics on accident rates, and summaries on accident causes?
- Are the statistics and summaries available for the top management, the line management, and the supervisors?
- Are accident rates and trends presented to the employees, e.g. on wall-boards?
- Are the accident statistics used as references when new goals for safety improvement are done?

D1.2. Accident investigation
- Has the company defined who investigates accidents?

- Has the company defined how soon the accident investigation has to be done?
- Are all accidents that have injured a person investigated?
- Are the near-accidents investigated?
- Does the company have a systematic investigation method in use?
- Are the corrective actions done promptly in order to prevent similar accidents to occur?

D1.3. Absenteeism

- Does the company make statistics on absenteeism rates, and summaries on absenteeism causes?
- Are the statistics and summaries available for the top management, the line management, and the supervisors?
- Are the statistics and summaries used as reference when new goals for absenteeism reduction are set?

D2. Work ability of the employees

D2.1. Physical work ability

- Does the company measure employees' physical work ability on a regular basis?
- Is the individual person's work ability compared to the person's physical work laod?
- Are those persons working under heavy physical stress under special follow-up?
- Has the company a system for rehabilitation and/ or finding a new task for a person whose work ability has decreased?
- Has the company a system for redesigning the work or workplace of a person who has difficulties in coping with the work?

D2.2. Psychological work ability

- Does the company measure employees' mental work ability on a regular basis?
- Is the individual person's mental work ability compared to the person's work task or physical workplace?
- Are those persons working under extreme mental stress under special follow-up?

D3. Social work environment

D3.1. Assessment of the social work environment

- Does the company have a system for measuring social climate (e.g. climate surveys)?
- Are corrective actions done immediately when problems related to social relations have been observed?

APPENDIX 8

Summary of the original papers

Table 2. Summary of the original papers (composed by the author)

Original papers	Objective	Methodology and data	Results and contribution
I Risk assessment and measurement of hazards in Estonian enterprises	To investigate the hazards level at Estonian enterprises. Risk levels are determined in six type of companies.	EVS-EN 15251:2007; EVS-EN 1231:1999; EVS-EN 689:1999; EVS-EN 12464-1:2011 All equipment used for the measurements met the requirements set in the standards cited above and calibrated as required by the Metrology Act (2004). **Quantitative** study.	The case studies showed that the flexible risk assessment method created by the author is viable and for assessing work environment risks. In many of the investigated enterprises, the management's attitude towards OHS was stimulating and supportive and the management showed eagerness to enhance workplace safety. However, in several cases there were shortages in the dissemination of information to the workers on safety matters, particularly on the accidents and incidents in the enterprise in order to remind them of the importance of safety measures for achieving a safe workplace.
II Cost-effectiveness of safety measures in enterprises	To identify the safety level at 12 enterprises by the Diekemper & Spartz method.	Safety management system in 12 medium- and small-scale enterprises (printing, mechanical, plastic, wood and garment industries) in Estonia was investigated using D&S method. **Qualitative** and **quantitative** study.	Four levels of safety performance were stated: 1) the management is not interested in safety matters; 2) the safety issues acquire importance; top management believes accidents to be caused by stupidity and inattention of their employees; 3) the recognition by the management that safety does need to be taken seriously; 4) involves proactive approach to safety. It could be characterised with good practice in safety management.
III Estimation of safety performance by MISHA method and the benefits of OHSAS 18001 implementation in Estonian	To investigate the safety performance at the enterprises according to the MISHA safety audit method.	Large qualitative and quantitative study. 25 interviews with the chain of command in enterprises were carried out. The MISHA method for safety auditing was used.	The contribution: the enterprises according to the results got from the interviews' analysis, show, that the enterprises could be divided into 3 groups: non-OHSAS implemented, locally-owned, Estonian companies (NOHSASL); non-OHSAS implemented, corporated (NOHSASC) and OHSAS 18001 implemented (OHSAS). The safety scores were totally different. The results on safety scores are presented in the paper.

manufacturing industry			
IV Voluntary safety systems in manufacturing industry – to what extent does OHSAS 18001 certification help?	To clarify the most important safety areas on which OHSAS 18001 has the greatest influence.	**Quantitative** study. 16 enterprises were involved. The analyses are prepared using programme *IBM SPSS Statistics 22.0* and *R 2.15.2*. The following statistical methods were used: correlation, *BoxPlot, MANOVA, Factor Analysis principal Component method, Independent t-test* for hypothesis.	The scheme of the correlation between the different safety areas was worked out. The real and formal safety connections were determined. The results of the analytical approach are presented in the *Article V* and Summary. The contribution: 11 hypotheses in the safety activities area were settled, from which nine proved to be true.
V OHSAS 18001 contribution to real and formal safety elements of safety management system in manufacturing companies: results of statistical analysis	To investigate the level of impact of OHSAS 18001 on the formal, real and combined safety elements via statistical analysis.	**Quantitative** study. 16 enterprises were involved. The analyses are prepared using programme *IBM SPSS Statistics 22.0 and R 2.15.2*. the following statistical methods were used: correlation, *MANOVA and factor Analysis Principal Component method.*	It can be concluded that OHSAS 18001 certification supports company's commitment to the health and safety activities and leads to the dealing with additional topics promoting workplace health and safety. Therefore OHSAS 18001 might be seen as a strategic tool to improve safety performance. The contribution: in this paper the statistically justified **conceptual model** for taking into consideration the importance of 55 safety key-elements in the real, formal and combined safety area is presented.
VI Improvement of managers' safety knowledge through scientifically reasonable interviews	Modified MISHA questionnaire as a mean for training of the chain of command.	The method "learning from the interviews" was compiled.	The top managers need more attention and understanding towards the safety matters and the co-operation in the whole management chain in the safety area is very important. The necessity of additional questions (supplementary to the MISHA method) in the interviews was postulated based on the hazards profile of the current enterprise.

ELULOOKIRJELDUS

1. Isikuandmed

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Kodakondsus	Eesti
E-posti aadress	Onnela.Paas@gmail.com

2. Hariduskäik

Õppeasutus (nimetus lõpetamise ajal)	Lõpetamise aeg	Haridus (eriala/kraad)
Tallinna Tehnikaülikool	2008 -	Ärikorraldus, filosoofiadoktor
Tallinna Tehnikaülikool	2007	Tehnikateaduste magistri kraad
Tallinna Tehnikaülikool	2005	Mehaanika, bakalaureuse kraad
Tallinna Üldgümnaasium	1999	Keskharidus

3. Keelteoskus

Keel	Tase
Eesti keel	Kõrgtase
Inglise keel	Kõrgtase
Vene keel	Kesktase
Saksa keel	Algtase

4. Täiendusõpe

Õppimise aeg	Täiendusõppe korraldaja nimetus
31.08.- 25.09.2009	Rahvusvaheline juhtimissüsteemide treeningprogramm; Delhi, India Standardite Büroo
01.01.- 31.12.2009	Projektijuhtimise koolitusgprogramm, AS Tallinna Vesi
Oct.-Nov.2008	Talentide koolitus - ja vahetusprogramm, Manila, Manila Vesi
27.03.2008	Töötervishoiu ja tööohutuse juhtimissüsteemid (OHSAS) EVS 18001:2007 põhjal, Eesti Standardikeskus

5. Teenistuskäik

Töötamise aeg	Tööandja nimetus	Ametikoht
2012 –…..	AS ABB	Keskkonna- ja tööohutusspetsialist
05.2015 –.....	Töökeskkonnakeskus OÜ	Konsultant
04.2014 – 12.2014	Töökeskkonna Haldus OÜ	Riskianalüütik
2006 –2012	AS Tallinna Vesi	Töökeskkonna peaspetsialist
2005 –2006	Medicover Eesti AS	Töökeskkonna insener

6. Valitud artiklid

Paas, O., Reinhold, K., Tint, P. 2015. Estimation of safety performance by MISHA method and the benefits of OHSAS 18001 implementation in Estonian manufacturing industry. *Agronomy Research*, 13(3), 792-809.

Paas, O. Siirak, V., Hartsenko, J., Reinhold, K., Tint, P. 2015. Improvement of white collars' safety knowledge through scientifically reasonable interviews. *Scientific Journal of Riga Technical University. Safety of Technogenic Environment* (in press).

Möldri, M., Tammepuu, A., Tint, P., **Paas, Õ.,** Laaniste, P. 2012. Integration of the SMS to IMS in Estonian Seveso II establishments: selected case studies. *Risk Analysis VIII* (227 - 236). Ashurst Lodge, Ashurst, Southampton: WIT Press.

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Tint, P., **Paas, Õ.**, Reinhold, K. 2010. Cost-effectiveness of safety measurers in enterprises. *Inzinerine Ekonomika-Engineering Economics,* 21(5), 485 - 492.

Tint, P., **Paas, Õ.**, Järvis, M., Tuulik, V. 2010. Safety Management at Medium- and Small-Scale Enterprises in Estonia. Journal of International Scientific Publications: Ecology and Safety, 4(1), 300 - 310.

Paas, O., Tint, P. 2010. Health and safety management at Estonian enterprises. *In: The international hygiene association. Book of abstracts: 8th International Scientific conference, 28 september-2october 2010. (Eds.)ICOH.* Milan: International Hygiene association, 198 - 198.

Tint, P., Järvis, M., Reinhold, K., **Paas, Õ**. 2009. Risk assessment and measurement of hazards in Estonian enterprises. *Environmental Engineering and Management Journal*, 8(5), 1165 - 1170.

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Changing World (CD-ROM) Symposium Series 155 (729 - 738). Manchester, UK: The Institution of Chemical Engineers.

Reinhold, K., Tint, P., **Paas, Õ**. 2009. Risk assessment of chemicals in manufacturing. *In: GPE-EPIC Proceedings: 2nd International Congress on Green Process Engineering, Lido, Venice, June 2009*. Institut National Polytechnique de Toulouse, 6 pages.

Paas, Õ., Reinhold, K., Tint, P., Siirak, V. 2015. Safety auditing role in the improvement of safety performance at enterprises. *Entrepreneurial Business and Economics Review (EBER)* 2015, Vol.3, 15 pp (forthcoming).

Paas, Õ., Reinhold, K., Hartsenko, J., Tint, P. 2015. Safety management improvement possibilities in SMSs. *Scientific Annals of the Alexandru Ioan Cuza "University of IASI": Economic Sciences Section*. Submitted 19.03.2015. Accepted 19.06.2015.

Paas, Õ., Reinhold, K., Tint, P. 2015. OHSAS 18001 contribution to real and formal safety elements of safety management in manufacturing companies: results of statistical analysis. *Agronomy Research*, 15 pp. (forthcoming).

CURRICULUM VITAE

1. Personal data

Name	Õnnela Paas
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2. Education

Educational institution	Graduation year	Education (field of study/degree)
Tallinn University of Technology	2008 -	Business Administration, PhD
Tallinn University of Technology	2007	Master of Science in Mechanical Engineering
Tallinn University of Technology	2005	Mechanical Engineering, bachelor
Tallinn General Highscool	1999	High school education

3. Language Competence

Language	Level
Estonian	Fluent
English	Fluent
Russian	Average
German	Basic

4. Special Courses

Period	Educational or other organisation
31.08.- 25.09.2009	International Training Programme on Management Systems; Delhi, Bureau of Indian Standards
01.01.- 31.12.2009	Project Management Training Programme; AS Tallinna Vesi
Oct.-Nov.2008	Programme on Talent Exchange and Training, Manila, Manila Water Company
27.03.2008	Occupational Health and Safety Management Systems based on EVS 18001:2007, Estonian Centre of Standardization

5. Professional Employment

Period	Organisation	Position
2012 –…..	AS ABB	Health, Safety and Environment Advisor
05.2015 –.....	Töökeskkonnakeskus OÜ	Consultant
04.2014 – 12.2014	Töökeskkonna Haldus OÜ	Risk Analyst
2006 –2012	AS Tallinna Vesi	Health & Safety Chief Specialist
2005 –2006	Medicover Estonia AS	Work Environment Engineer

6. Selected Papers

1. **Paas, O**., Reinhold, K., Tint, P. 2015. Estimation of safety performance by MISHA method and the benefits of OHSAS 18001 implementation in Estonian manufacturing industry. *Agronomy Research*, 13(3), 792-809.
2. **Paas, O**. Siirak, V., Hartsenko, J., Reinhold, K., Tint, P. 2015. Improvement of white collars' safety knowledge through scientifically reasonable interviews. *Scientific Journal of Riga Technical University. Safety of Technogenic Environment* (in press).
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4. **Paas, Õ.**, Traumann, A., Tint, P. 2011. Chemical risk assessment in the air of the work environment. *In: Hazardsap 2011 presentations, on-line: Hazards AP IchemE, Asia Pacific Symposium, 27-29 Sept. 2011, Malaysia, Kuala Lumpur. (Eds.)IchmE, Institution of Chemical Engineers, UK*. IchemE, UK, on-line: Institution of Chemical Engineers, 4 pp.
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6. Tint, P., **Paas, Õ.**, Järvis, M., Tuulik, V. 2010. Safety Management at Medium- and Small-Scale Enterprises in Estonia. Journal of International Scientific Publications: Ecology and Safety, 4(1), 300 - 310.
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8. Tint, P., Järvis, M., Reinhold, K., **Paas, Õ**. 2009. Risk assessment and measurement of hazards in Estonian enterprises. *Environmental Engineering and Management Journal*, 8(5), 1165 - 1170.
9. **Paas, Õ**., Tint, P., Järvis, M. 2009. The assessment of major accident risks in Tallinn (Estonia). *Hazards XXI: Process Safety and Environmental Protection in a Changing World* (CD-ROM) Symposium Series 155 (729 - 738). Manchester, UK: The Institution of Chemical Engineers.

10. Reinhold, K., Tint, P., **Paas, Õ**. 2009. Risk assessment of chemicals in manufacturing. *In: GPE-EPIC Proceedings: 2nd International Congress on Green Process Engineering, Lido, Venice, June 2009.* Institut National Polytechnique de Toulouse, 6 pages.
11. **Paas, Õ**., Reinhold, K., Tint, P., Siirak, V. 2015. Safety auditing role in the improvement of safety performance at enterprises. *Entrepreneurial Business and Economics Review (EBER)* 2015, Vol.3, 15 pp (forthcoming).
12. **Paas, Õ**., Reinhold, K., Hartsenko, J., Tint, P. 2015. Safety management improvement possibilities in SMSs. *Scientific Annals of the Alexandru Ioan Cuza "University of IASI": Economic Sciences Section*. Submitted 19.03.2015. Accepted 19.06.2015.
13. **Paas, Õ.,** Reinhold, K., Tint, P. 2015. OHSAS 18001 contribution to real and formal safety elements of safety management in manufacturing companies: results of statistical analysis. *Agronomy Research*, 15 pp. (forthcoming).

ABSTRACT

Safety management system (SMS) can be considered as a key concept in the success of high level of occupational health and safety in industrial enterprises. A well-functioning SMS is described as a systematic and comprehensive system promoting participation from all stakeholders. However establishing an SMS may only formally lead to excessive bureaucracy, window coupling and additional costs, especially for SMEs. The thesis concentrates on the analysis of relationships between the key elements in safety management and finding solutions to enhance safety level in different types of the industrial companies. The thesis is composed on the basis of six scientific articles (published 2008-2015 or accepted in the journals ETIS 1.1 and 1.2).

The main parts of the study include the introduction, identification of the research problem, the aim, thesis contribution, overview of the approval of research results, theoretical framework, research methodology, results and conclusions.

Safety auditing was used as the main method to study the current safety level in the manufacturing companies. During the research period, two safety audit methods where used – the Diekemper and Spartz (Articles I-II), and the MISHA method (Articles III–VI). The statistical analyses were prepared by using *IBM SPSS Statistics 22.0 and R 2.15.2* (correlation, *MANOVA, Factor Analysis principal component method, Independent t-test,* etc). Additionally, qualitative data from safety interviews were studied and interpreted.

The novelty of the thesis lies in the **conceptual model of the safety management system**, that provides the key elements in formal, real and combined safety using qualitative and quantitative processing of audit results. This helps to determine the key safety elements and their impact on the overall safety performance. In 2008 and 2010, several risk assessments and cost-effective analysis were performed in order to clarify the current status of safety level in Estonian industrial companies. During the study in 2014, 24 safety interviews were conducted in 16 Estonian manufacturing companies. The investigated enterprises were first divided into two groups: OHSAS 18001-certified and OHSAS 18001 non-certified. But the latter proved to have a significant difference in safety level based on its affiliation: corporated enterprises showed better results in the safety activities than locally owned companies. The study showed that the implementation of OHSAS 18001 will not automatically ensure high safety activities in the company. However, holding an OHSAS 18001 certification creates a basis for the systematic work in the area of safety management, hazards identification and prevention, and promotes strong improvement process put in use.

The research revealed that OHSAS 18001 certification contributes strongly to formal safety elements. However – its contribution to the real safety elements was partial, e.g., to such elements as top management commitment to the safety policy, dissemination of safety policy and resources. For many real safety elements strong demands from corporations influence safety activities more than requirements derived from OHSAS 18001 standard, for example suggestions for improvements; general communication procedures; promotion, rewards and career planning and safety knowledge among supervisors, line managers and top managers. Concerning

combined elements, many of them – such as workplace hazards analysis, assessments of working environment, evaluation of safety training needs are dependent on OHSAS 18001 certification. Based on this novel knowledge a model between formal, real and combined safety elements and OHSAS 18001 was developed and presented.

The **conceptual model** also contributes to the safety key elements that are included into the MISHA method, but not in the OHSAS 18001. Such elements are: selection and placement of the personnel, planning of the personnel resources, selection of line management and supervisors, tasks of the occupational health services, tasks of the safety organisation. The significance of the last is not statistically under the line.

The model assists companies to determine whether the focus leans for formal or real safety and if needed, reallocate the resources in a way that all safety elements are possibly covered. It is essential to deal with real safety as this is often most visible and forms employee's safety attitudes and performance; but also with formal and combined safety as those elements often add value to the systematic health and safety work in a company.

The analysis of the results of the safety interviews revealed that top and middle management's health and safety knowledge in locally owned companies is generally lower than in OHSAS 18001-certified or corporated companies. Therefore, extra value of the thesis contribution is given through the preparation of a "training through the questionnaire" learning package in order to assist SMEs with fundamental OHS requirements according to the legislation as well as good practices and tacit knowledge. This may lead to enhancement of working conditions with minimal or moderate efforts.

The study adds to the understanding of the current management knowledge about OHS activities and providing conceptual clarification of the role of systematic discussion during the interviews for increasing their knowledge. The study contributes to providing conceptual clarification on the key elements of safety supported by OHSAS 18001 and possible benefits associated with SMS certification. In the methodology the study justifies the suitability of safety auditing as the main method for investigating the safety management system state in the enterprises; the suitability of the MISHA method for safety auditing, moreover, it indicate the areas in the safety management system that are not clearly visible with the MISHA method (the importance of psycho-social climate monitoring in the work environment). The practical value of the thesis is connected with the employees' knowledge improvement package "learning through the questionnaires".

KOKKUVÕTE

Ohutuse juhtimissüsteemi (OJS) olemasolu tööstusettevõttes võib pidada ohutuse ja äritegevuse edukuse tagamise võtmeküsimuseks. Hästitoimivat OJS-i kirjeldatakse kui süstemaatilist ja kõikehaaravat, millesse on kaasatud kõik huvirühmad. Kui aga OJS-i juurutatakse formaalselt, tekitab see liigset bürokraatiat, eraldumist muudest juhtimissüsteemiüksustest ja lisakulutusi, eriti väikestes ja keskmise suurusega ettevõtetes. Käesolev töö keskendub ohutuse juhtimise võtmeelementide omavaheliste seoste leidmisele erinevat tüüpi töötleva tööstuse ettevõtetes, et parandada ettevõtte ohutustaset.

Doktoritöö on kirjutatud kuue teadusartikli põhjal, mis on ilmunud või mille on heaks kiitnud ETIS 1.1 ja ETIS 1.2 ajakirjad (ilmunud või ilmumas 2008–2016).

Töö koosneb järgmistest osadest: sissejuhatus, tulemuste esitamine, teoreetiline lähenemine, uurimisobjektid ja uurimismeetodid, töö tulemused ja järeldused.

Peamise uurimismeetodina kasutati töös ohutusauditit, mille sobivust kinnitas eelnev põhjalik kirjanduse analüüs. Tööstusettevõtete ohutustaseme uurimise läbiviimisel on kasutatud põhiliselt kahte auditi meetodit: esimestes artiklites (I–II) Diekemperi ja Spartzi väljatöötatud küsimustikku, alates III artiklist aga MISHA-meetodi küsimustikku, mis on esitatud lisas 7. Statistiliseks andmete analüüsiks on kasutatud järgmisi meetodeid: *IBM SPSS statistika 22.0 ja R 2.15.2, BoxPlot, MANOVA,* faktoranalüüsi printsipiaalsete komponentide meetod, *t-test* jne. Selle kõrval on ohutusalaste intervjuude alusel läbi viidud kvalitatiivne analüüs.

Töö uudsus seisneb kvalitatiivse ja kvantitatiivse auditiprotsessi ühendamises ning formaalse, praktilise ja kombineeritud ohutuse vaheliste võtmeelementide ning nende omavahelise mõju määramises. 2008.–2010. a hinnati töökeskkonna riske mitmetes Eesti töötleva tööstuse ettevõtetes, et kindlaks määrata Eesti ettevõtete ohutustaset. 2014. a jooksul tehti 24 intervjuud 16-s Eesti ettevõttes. Uuritud ettevõtted olid esialgu jaotatud kahte rühma: ettevõtted, mis omasid OHSAS 18001 sertifitseerikaati ja ettevõtted, mis ei omanud OHSAS 18001 sertifikaati. Viimase rühma intervjuude tulemused näitasid, et esineb oluline ohutustaseme erinevus sõltuvalt ettevõtete alluvusest: välismaistesse korporatsioonidesse kuuluvad ettevõtted näitasid paremaid ohutusalaseid tulemusi kui kohaliku alluvusega ettevõtted. Töö tulemused näitavad, et OHSAS 18001 automaatne rakendamine ei too veel kaasa kõrget ohutustaset ega ohutustegevuste intensiivistumist. Ometi, kui ettevõttel on OHSAS 18001 sertifikaat, siis loob see aluse süstemaatilisele ohutustööle, nagu ohtude identifitseerimisele ja ennetamisele, stimuleerides parendusprotsessi käivitamist.

Käesolev uuring näitas, et OHSAS 18001 sertifikaat panustab tugevalt formaalse ohutuse elementidesse, kuid praktilise ohutuse elementidest ainult vähestesse, nagu tippjuhtide pühendumus ohutuspoliitikasse, ohutuspoliitika levitamisse ettevõttes ja ressurssidesse, mida ohutusele eraldatakse. Kombineeritud ohutuse elementidest panustab OHSAS 18001 sellistesse ohutuse võtmeelementidesse, nagu töötajate osavõtt ettevõtte ohutuspoliitika väljatöötamisse, töökoha ohutuse analüüsi ja töökeskkonna hindamisse.

Välismaiste korporatsioonide nõudmised paljudele praktilise ohutuse elementidele on rangemad kui OHSAS 18001 standardist tulenevad nõudmised. Näiteks võib tuua järgmised ohutuselemendid: parendusettepanekute tegemine, üldised teabevahetusprotseduurid, tunnustamine ja karjääri planeerimine ning ohutuspersonali ja (tipp) juhtide ohutusteadlikkus. Mitmed kombineeritud elemendid, näiteks töökoha riskianalüüs, töökeskkonna hindamine, ohutusalase koolituse kvaliteedi hindamine jne on sõltuvad OHSAS 18001 sertifitseerimisest.

MISHA-meetod abil oli võimalik uurida ka selliste ohutuselementide osatähtsust, mida OHSAS 18001 ei kata. Näiteks töötajate värbamine ja asendamine, töötajaskonna ressursside parendamine, keskastme juhtide ja töökeskkonnaspetsialistide valimine, koostöö töötervishoiuteenuse pakkujate ja ohutusega tegelevate ettevõtetega, kuigi viimased kaks osutusid statistiliselt kõige vähem tähtsaks.

Selle uudse, käesoleva töö tulemusel saadud teabe põhjal on koostatud **kontseptuaalne mudel,** mis põhineb OHSAS 18001 standardi formaalsete, praktiliste ja kombineeritud ohutuselementide vahelistel seostel ja on töös esitatud peale arutluse ka skeemi kujul. Mudel võimaldab ettevõtetel määrata, kas fookuses on formaalse või praktilise ohutuse elemente ja kui vaja, ümber suunata ressursid nii, et kõik ohutuselemendid saaksid kaetud. Tegelemine praktilise ohutuse elementidega on kindlasti olulisem, lisaks on see tegevus ka sageli nähtavam. Praktilise ohutuse elemendid mõjutavad rohkem ka töötaja ohutusse suhtumist ning panevad aluse töötaja ohutuskäitumisele. Samas tuleb tegelda ka formaalse ja kombineeritud ohutuse elementidega, kuna need annavad sageli ettevõtte süstemaatilisele ohutus- ja töötervishoiutööle lisaväärtuse.

Ohutusintervjuude analüüsimise käigus ja nende tulemuste alusel ilmnes, et tipp- ja keskastme juhtide ohutusteadmised on üldiselt madalamad kohalikes ettevõtetes, mis ei oma OHSAS 18001 sertifikaati, võrreldes nende ettevõtetega, kus OHSAS 18001 on sertifitseeritud või ettevõtetega, mis kuuluvad välismaistesse korporatsioonidesse. Seetõttu on käesoleva doktoritöö lisapanusena ettevalmistatud koolituspakett „Ohutuskoolitus küsimustike abil", et aidata väikestel ja keskmise suurusega ettevõtetel juurutada peamisi Eesti seadustest lähtuvaid ohutus- ja töötervishoiunõudeid, kasutades ka häid tavasid ja iseenesest mõistetavaid teadmisi. See võib aidata parendada töötingimusi minimaalsete või keskmiste kulutustega.

Töö tähtsus seisneb ettevõtte juhtkonna ja kogu töötajaskonna teadmiste taseme tõstmises, mis põhineb teaduslikel alustel, täpsemalt erinevate ohutuselementide tähtsuse väljaselgitamisel. Töö kaudu saab ettevõte suuniseid, millest alustada ettevõtte ohutustaseme tõstmist ja kuidas tuleks edasi minna. Tööohutuse ja töötervishoiu mõistete selgitamine ning arutelu tööandjate ja töökeskkonna volinikega, ning töökeskkonna inseneridega peetud intervjuude käigus suurendas nende ohutusalaseid teadmisi. Uuring pakub ohutuse võtmeelementide kontseptuaalseid selgitusi, mida toetab OHSAS 18001 ja näitab, milline kasu on ettevõttel ohutusstandardi sertifitseerimisest. Kasutatud meetod (audit: MISHA-meetod) sobib töötusettevõtetes ohutustaseme uurimiseks, kuid sama meetodit on võimalik kasutada ka teist tüüpi organisatsioonides (teeninduses, kontoriruumides). Sellisel juhul tuleks üle minna teemadest, mis ei kuulu vastavatesse valdkondadesse ja lisada need töökeskkonnariskid, mis on näiteks seotud kontoritööga. Töö tulemused

näitasid ka seda, et Eesti ettevõtetel puudub teadmine, kuidas tegelda psühhosotsiaalsete ohutegurite või töövõime hindamisega ning vajadust MISHA-meetodi nüüdisajastamiseks uute riskide esilekerkimise kohaselt.

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