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**EFFECT OF OCCUPATIONAL SAFETY AND HEALTH RISK MANAGEMENT
ON THE RATE OF WORK – RELATED ACCIDENTS IN THE
BULGARIAN FURNITURE INDUSTRY**

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ABSTRACT

The aim of this study was to analyze the effects of occupational safety and health (OSH) management practices (in terms of comprehensive risk assessment) on the rate of work-related accidents in the Bulgarian furniture industry, and to identify the main occupational hazards. *Materials and methods:* The research was performed on basis of the officially published statistical data of occupational accidents in Bulgaria and the developed risk assessment questionnaire, tailored to the specific furniture industry characteristics. K-means clustering analysis was used for data interpretation and analysis. *Results:* The adoption of strict OSH legislation and the implementation of risk assessment procedures resulted in drop in occupational accident rate in the Bulgarian furniture industry by 76.9% during the studied period, from 2001 to 2017. The questionnaire and k-means analysis revealed different OSH awareness levels among the studied furniture enterprises. *Conclusions:* The findings of the study can be applied for sustainable improvement of the existing OSH measures and initiatives in the Bulgarian furniture industry.

Key words: occupational safety and health (OSH) management; risk assessment, work-related accidents; accident rate; furniture industry

1. INTRODUCTION

Despite the significant improvements of working conditions in most of the European countries, the rate of occupational accidents has remained persistently high in the recent decades. According to some authors (Hämäläinen, P., Takala, J., & Kiat, T. B, 2017), an estimated 2.78 million workers lose their lives every year as a direct consequence of occupational accidents and/or work-related disease - higher values than the 2.33 million cases estimated by the International Labour Organization in 2014 (ILO, 2014). As a result, approximately 6300 people die every day due to occupational accidents and work-related diseases. In addition, it was estimated that another 313 million people have suffered from work-related injuries resulting in absence from work of four or more days. This represents an average of 850,000 injuries per day. At the European level, in 2014 there were approximately 3.2 million non-fatal accidents that resulted in at least four calendar days of absence from work and 3 739 fatal accidents in the EU countries (Eurostat, 2014). The costs of work-related injuries and illness can be substantial. The ILO has estimated that the direct and indirect costs of occupational accidents and diseases lead to about 1.8% - 6% loss of annual gross domestic product worldwide, the average being 4% according to the ILO (Takala et al, 2014). Work-related injuries and illnesses result in the loss of 3.9% of all work-years globally and 3.3% of those in the EU, equivalent to a cost of approximately 2.680 billion and 476 billion, respectively (EU-OSHA, 2017). In general, 123.3 million disability-adjusted life years (calculated as the sum of the years of life lost due to premature mortality in the

population and the years lived with disability) for people living with the health condition or its consequences.) are lost globally as a result of work-related injury and illness and 7,1 million in the EU. 67.8 million of these are years of life lost due to fatal injury or illness (3.4 million in the EU) and 55.5 million are lived with disability (3.7 million in the EU) (EU-OSHA, 2017).

The number of occupational accidents is directly related to the respective economic sectors and the total number of persons employed. In terms of industries, there are several sectors, characterized by high levels of occupational risks, such as the construction, manufacturing, *forestry, woodworking and furniture industries*, which account for more than two-thirds of all fatal accidents at work.

Small and medium-sized enterprises (SMEs) are particularly vulnerable to occupational risks as they have fewer resources to put complex systems for worker protection in place. On the other hand, the Bulgarian furniture industry is a dynamic and labour intensive economic sector with substantial technological advances, comprised mainly by SMEs and micro firms (European Commission, 2018). This puts the workers and employees in these companies in a highly dangerous work environment. The main health and safety risk factors include working with machinery and equipment (25% of all major accidents); fire and explosion; slips, trips and falls (HSE, OSHA); exposure to wood dust and other hazardous substances (Mohan, Aprajita, & Panwar, 2013; Driscoll, Takala, Steenland, Corvalan, & Fingerhut, 2005; Alonso-Sardón et al., 2015; Ratnasingam, Natthondan, Ioras, & McNulty, 2010); exposure to increased levels of noise and vibrations at work (HSE, 2014; Ratnasingam & Ioras, 2010; Skovgaard Nielsen, & Stewart, 2007); manual handling operations and musculoskeletal disorders (Punnett et al., 2005; Thetkathuek & Meepradit, 2016), etc. These work-related injuries not only cause human suffering for workers and their families but also result in significant economic costs to individuals, businesses and society as a whole. The improvement of work environment in furniture enterprises is desirable not only from the perspective of workers, but also contributes substantially to labour productivity and promotes economic growth. The adoption of adequate occupational safety and health practices increases the competitiveness and productivity of enterprises by reducing the costs resulting from occupational accidents and by enhancing workers' motivation. Moreover, a decrease in work-related accidents and illness relieves the pressure on public and private social protection and insurance systems.

In order to achieve continuous improvement of workers' safety and health, a systematic, integrated, proactive, participative, and multiple-strategy approach towards Occupational Safety and Health (OSH) management is needed. This is addressed by the Framework Directive 89/391/EEC (European Union, 1989). The application of OSH management is based on relevant OSH criteria and standards, and is aimed at preventing workplace incidents (Kjellén, 2000). Sound OSH management in terms of adequate risk assessment and follow-up preventive measures, incorporated into the overall management of an organization, and addressing regulatory, technical/engineering, organizational, and managerial aspects, is critical to ensure OSH excellence (EU-OSHA, 2010).

The five-step risk assessment method, developed by the Health and Safety Executive in the United Kingdom as a simple approach to manage risks, particularly in SMEs, has been endorsed globally (ILO, 2011). This risk assessment procedure can be easily adapted to the size and scope of the enterprise, as well as to the available human and financial resources.

The present study is aimed at analyzing and estimating the effects of applying OSH management practices (in terms of comprehensive risk assessment) on the rate of work-related accidents in the Bulgarian furniture industry on the basis of the officially published statistical data and the developed risk assessment questionnaire, tailored to the specific furniture industry characteristics.

2. METHODS

According to the official definition of the ILO, occupational accident is “any unexpected and unplanned occurrence arising out of or in the course of work which results in one or more workers incurring a personal injury, disease or death” (OECD, 2002). The so called commuting accidents, occurring on the direct way between the place of work and the worker's residence, the place where the worker usually takes his/her meals, or the place where the worker usually receives his/her remuneration, which result in death or personal injury involving loss of working time, are considered as occupational accidents. According to the applicable Bulgarian legislation, the term occupational accident includes any sudden health impairment occurring during and in relation with the course of

work, as well as any work activity performed in the interest of the company which has caused temporary incapacity for work, has permanently reduced working capacity or has led to death. Pathological conditions due to diseases of any nature, such as epilepsy, chronic ischemic heart disease (all clinical forms, including myocardial infarction), stroke, diabetes mellitus, atherosclerosis, high blood pressure and mental illness are not considered as sudden health impairments and cannot be reported as occupational accidents (SSC, 1999). The national methodology and guidance for studying and assessing the occupational traumatism is provided in the Statistical System Occupational Accidents (NSI, 2014), adopted in 2001, which includes all the aspects of determining and classifying the accidents at work. The national statistical system is developed on basis of the European Statistics on Accidents at Work (ESAW) and ensures full compliance between the existing national legislation and the requirements for reporting work-related accidents in the EU countries. Occupational accident is defined in the ESAW methodology as “a discrete occurrence during the course of work which leads to physical or mental harm” (ESAW, 2001).

The phrase ‘*in the course of work*’ means whilst engaged in an occupational activity or during the time spent at work. Fatal accidents at work are those that lead to death of the victim within one year of the accident. Non-fatal accidents at work are those that imply at least four full calendar days of absence from work (also called ‘serious accidents at work’).

According to the applicable legislation, the risk assessment in Bulgaria should be performed by the employer in compliance with the requirements of the Labour Code, Law on Safety and Health at Work and the Decree No. 5 of 11 May 1999 on means, procedure and periodicity of risk assessment (Labour Code, 1986; Law on Safety and Health at Work, 1997; Decree No. 5, 1999).

A detailed risk assessment questionnaire, adapted to the specific characteristics of the furniture industry, was developed and sent to 50 Bulgarian furniture companies, mainly micro and SMEs. The questionnaire consisted of 82 questions, divided into the following 12 sections, covering key occupational safety and health aspects in the furniture industry: Occupational Safety and Health Management; Work Premises; Electrical Safety; Fire and Emergency Safety; Physical and Chemical Factors of the Working Environment (occupational microclimate, lighting, noise, vibrations, etc.); Hazardous and Harmful Factors; Manual Handling Operations; Machinery and Equipment; Compressed Air Systems; Warehouse Facilities and Vehicles; Explosive Work Environment; Surface Treatment of Furniture.

The respondents were given statements to react to in a 5-point Likert scale (Likert, 1932) where 1-strongly disagree (SA), 2-disagree (D), 3-neutral (N), 4-Agree (A), 5-Strongly agree (SA).

K-means clustering approach was used for data interpretation. According to MacQueen (1967) this method represents a simple way to classify a given data set through a certain number of clusters (k clusters) fixed a priori. The partition clustering is a data analysis technique that intends to unveil the inherent structure of a set of points by partitioning it into a number of disjoint groups, called clusters (Capó, Pérez & Lozano, 2015; Stefanova, 2013; Levrard, 2018). For the purpose of the present study the SPSS Statistics version 19.0 software was used.

3. RESULTS

The furniture industry in Bulgaria is among the economic sectors characterised by sustainable development. At present the sector accounts for about 2.4% of the manufacturing industry added value. According to the current classification of economic activities (NSI, 2008) the Bulgarian furniture industry includes the following subsectors: "Manufacture of office and shop furniture", "Manufacture of kitchen furniture", "Manufacture of mattresses and beddings", "Manufacture of other furniture". The total number of companies in Bulgaria registered with an activity related to production of furniture and other wood products is about 2600. These are mainly micro and small enterprises - about 95% of the companies in the industry, a trend that is also characteristic for the rest of the European Union member states. Due to the nature of their activity, most furniture industry companies are located in certain areas close to the raw material base or the major consumer centers. The territorial distribution of furniture enterprises provides the framework for development of networks, partnerships and industry clusters as some of the modern approaches to stimulate the entrepreneurship, enhance the competitiveness and access to technological innovation.

During the period 2001-2015 the sector provided employment for about 23000 people, as shown on Fig. 1.

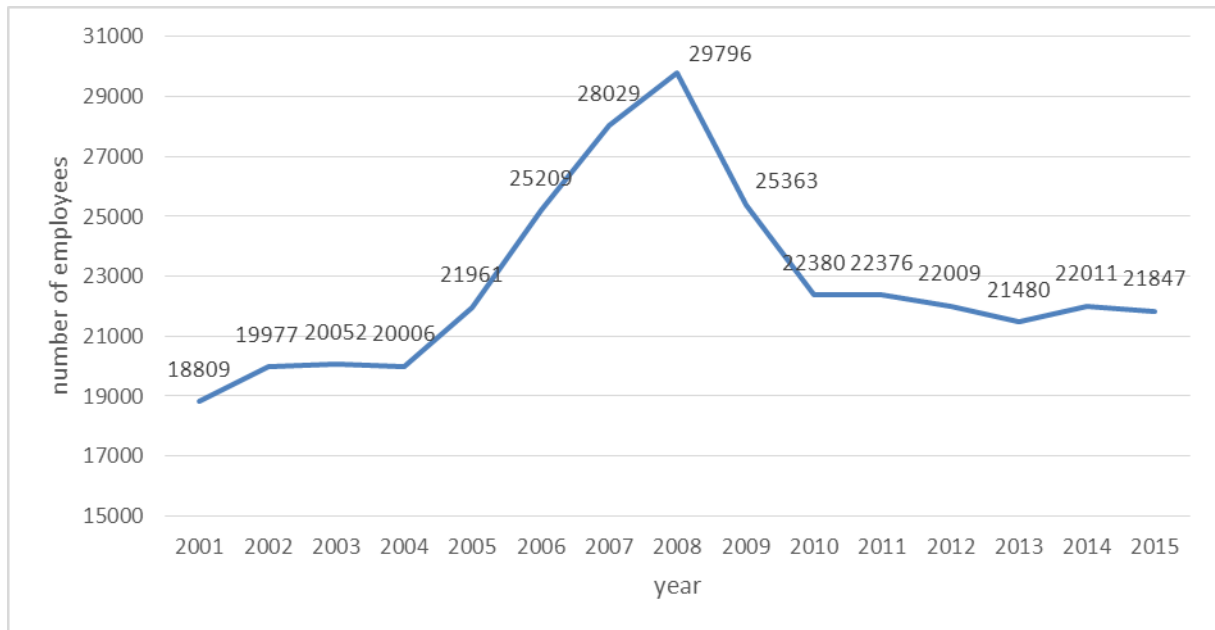


Figure. 1. Employment rate in Bulgarian furniture industry, 2001-2015 (source: NSSI, 2018)

In the period 2001-2008 there was a steady trend of increase in the number of employees in the respective sector, followed by a sharp decrease until 2010 as a direct consequence of the unfolding of the global financial and economic crisis in 2008. After that period the number of employees remained relatively stable.

Bulgarian furniture sector faces huge competition from countries having lower production costs, for example China. The reliance on foreign markets is a competitive advantage of the Bulgarian furniture industry – due to the long-term partnerships between Bulgarian furniture SMEs and leading UK retail chains, a 25% growth in furniture exports to the UK was determined in 2016.

The furniture sector is also faced by serious structural problems in terms of ageing workforce and difficulties to attract young workers and engineering specialists, which may lead to serious problems in maintaining a skilled and motivated workforce. Moreover, the operational costs of furniture enterprises are continuously increased by different environmental, sustainability and technical standards and legislative regulations. All these factors, combined with the severe consequences of the recent economic crisis, have led to an appreciable decrease in the number of companies, jobs and turnover, from which the sector is still trying to recover.

Data about the total number of occupational accidents in the Bulgarian furniture industry for the period 2001-2017 is presented on Fig. 2. The figures for the last two years are operational, since there is a great number of occupational accidents which are still under investigation.

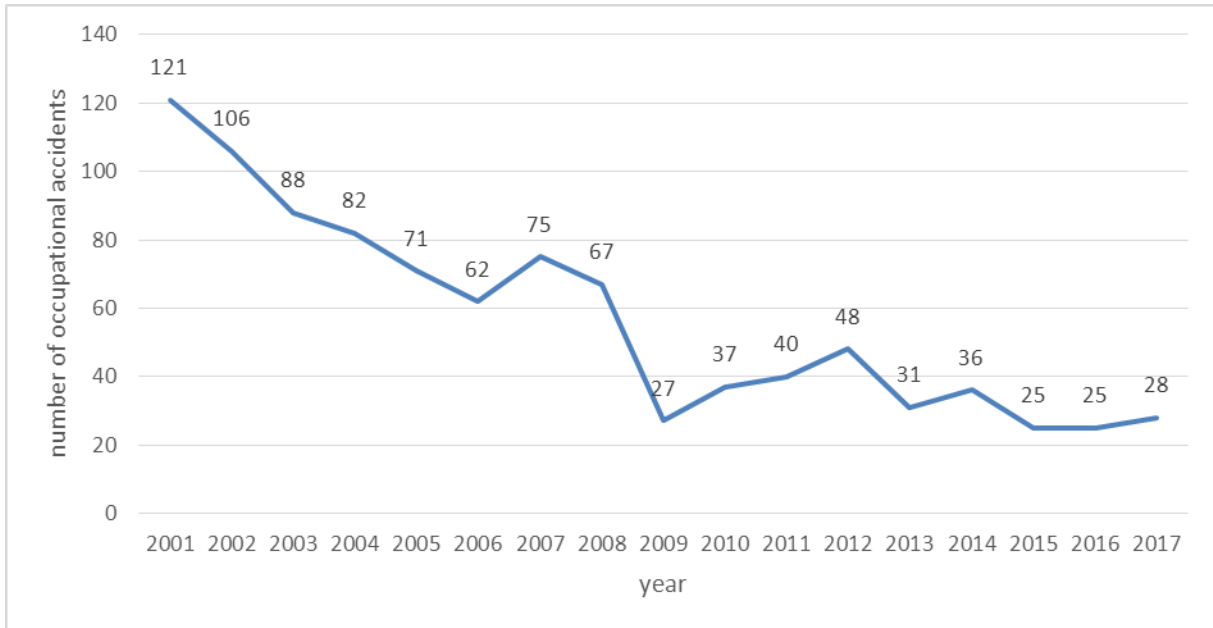


Figure 2. Occupational accidents in Bulgarian furniture industry, 2001-2017 (source: NSSI, 2018)

The woodworking and furniture industry in the country is characterized by one of the highest accident rates of all manufacturing industries. As seen from the figure, the number of occupational accidents for the studied period tends to decrease. This can be attributed to the adoption of the uniform methodology of accident reporting, as well as to the serious legislative efforts and implementation of national OSH policy measures in terms of comprehensive occupational risk assessment, which has directly affected the level of safety and health at work in the sector.

K-means clustering provides a new perspective of the conducted questionnaire survey. It forms new sections in the form of safety management implementation fields. The prerequisite for at least two sections per cluster has been met. After performing the K-means clustering analysis it was determined that the number of actual sections is four. We found that the number of actual sections is four. The results are presented in Fig. 3.

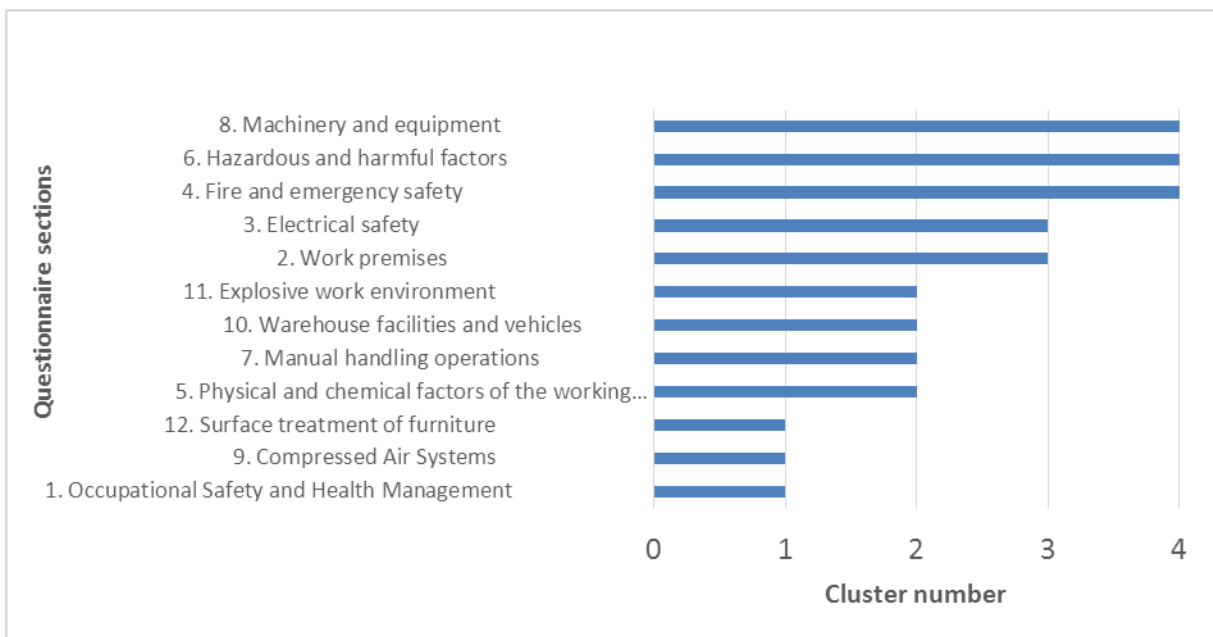


Figure 3. Sections of the survey questionnaire and their belonging to the clusters

The results, given on the figure above clearly present the manner and understanding of OSH management in Bulgarian furniture enterprises. The first cluster is a combination of the following three sections of the questionnaire – surface treatment of furniture, compressed air systems and OSH management. If not properly implemented, surface coating operations may have a serious impact on health and safety of workers, as well as some significant environmental impacts due to the hazardous substances used (paints, varnishes, solvents, etc.). In 39.2% of the enterprises surveyed surface coatings applied with a handgun was performed in spraying booths with the required local exhaust ventilation. Although 59.1 % of the respondents stated that the necessary personal protective equipment is used in operations involving manual dosing and preparation of paints and varnishes, only 11.6% answered that the preparation of the work mixtures is made in isolated premises equipped with the necessary ventilation systems.

Compressed air, vacuum and pneumatic air systems all play an important role in the furniture industry, and if not operated and managed properly, they represent a serious risk to employees' safety. That is why they should be regularly checked and properly guarded, which is recognized by 45.6% of the surveyed enterprises.

The second cluster includes four sections of the survey questionnaire. Physical and chemical factors of the working environment, such as microclimatic factors (workplace temperature, relative humidity and air velocity) go along with the occupational hazards due to logistic and supplementary activities. Manual handling operations are quite common in the Bulgarian furniture industry and cause a large number of occupational accidents each year due to handling timber and panel materials, machine operations and assembly, handling and storage of the final products, etc. Although 58.8% of the respondents stated that the enterprises have introduced specific rules for carrying out loading and unloading activities, only 7.5% agreed that these operations are mechanized or automated. Lifting and handling aids can significantly reduce the risk of injury and various manual handling solutions have been introduced in almost 80% of the surveyed enterprises.

Wood dust, apart from the numerous health hazards, is considered to be explosive, especially if the mean particle size is less than 200 μm . Approximately $\frac{1}{4}$ (25.6%) of the respondents clearly stated that the places with high risk of explosive atmosphere are properly identified and marked with the respective warning signs and labels (59%). A major concern is that automatically operating emergency ventilation system is available in only 31.7% of the surveyed furniture companies.

The third cluster includes only two sections of the survey questionnaire – electrical safety and work premises. Electrical injuries (shock, burns, loss of muscle control, etc.) are not among the most common occupational accidents in the Bulgarian furniture industry and the electrical safety issues are recognized by the vast majority of the surveyed enterprises. Electrical equipment is maintained by qualified personnel (62%), machines and installations are safe and secure (58.8%) and workers are familiar with the safety requirements and precautions (93.2%).

Although 24.6% of the enterprises answered that the work premises are maintained in good condition, only 9.9% strongly agreed that the enterprise territory is thoroughly and regularly cleaned, and 16.7% stated that the work floors are clean, level and secured against slips and trips, which are the most common cause of occupational accidents and may lead to other serious accidents, such as falls from height.

The fourth cluster comprises three sections of the questionnaire related to major occupational safety issues - machinery and equipment, hazardous and harmful factors and fire and emergency safety. Machinery accidents, caused by contact with the moving parts/tools, kickbacks, inadequate guarding, poor work practices, insufficient training of operators, etc. are the main cause of serious injuries in Bulgarian furniture industry. Although according to the questionnaire results woodworking machines are properly guarded (67.8%), equipped with the necessary command panels, emergency stop devices and locks (67.2%), and machining is performed with appropriate and sharp cutting tools/blades (82.2%), most of the machinery and equipment is rather old, which is a prerequisite for occupational injuries. More than two-thirds of the reported machinery accidents occurred on circular saws, surface planers and vertical spindle moulders.

Wood dust and some chemicals used in furniture industry (adhesives, solvents, varnishes, paints, wood preservatives, etc.), can have serious adverse effects on human health. According to the respondents' answers, the dangerous chemicals are stored properly and separately (82.8%), the necessary Material Safety Data Sheets are available (91.2%) and the workers are provided with the

necessary personal protective equipment, determined in accordance with the risk assessment (80.7%). However, only 12% of the respondents strongly agreed that the hazardous waste treatment and transportation is performed in accordance with the legal requirements.

Fire and emergency safety measures are developed and introduced in the surveyed enterprises. Work premises and dust extractions systems are regularly cleaned from wood dust (68.2%), fire extinguishing equipment is available and easily accessible (97%), and is regularly checked (91%).

4. CONCLUSIONS

The general OSH awareness of furniture enterprises in the country is related primarily to the fundamental occupational hazards, identified by the clustering analysis. However, underestimation of all other “secondary” occupational hazards could have serious negative effects on the overall safety and health in Bulgarian furniture companies, resulting in considerable human and economic costs. In this respect, the collective efforts of the state, companies and workers should continue in terms of creating, implementing and strengthening a preventative safety culture among current and future professionals in the furniture sector. Measures should include control and management of occupational risks, constant investments in OSH as well as provision of training, including necessary further training and qualification development of workers.

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