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WORK SAFETY SYSTEM IMPROVEMENT AND DECREASING WORK ENVIRONMENT RISKS IN CONSTRUCTION INDUSTRY

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Abstract. Since the beginning of the Industrial Revolution, safety regulations and safe working conditions has been an essential task to retain an amiable and comfortable working atmosphere, especially for the employees at the construction sites in England, U.S.A. and many other countries. Preventing accidents and risk of accidents became the most vital priority method in maintaining an international safe working atmosphere. First of all, the aim of the paper is to portray the vital improvement process and conditions within the work safety system and to decrease the environmental risk factors involved within the working atmosphere within the construction industry worldwide and to increase the efficiency and production levels. Second of all, our plans are to evaluate the risks involved within the working environment at the construction sites and to develop the necessary preventive measures for obtaining positive results within Latvia and worldwide. Our intent is to implement the comparison and grouping methods for analysing the statistical data as well as the working environmental risk evaluating methods and schemes will be applied. Furthermore, our research investigation will offer the proposals of practical use for reducing psycho-emotional and ergonomic factors caused and the chemical working environment risks at the construction sites; considering the main risk factors that are frequently encountered by the employees at the worldwide construction sites.

Keywords: labor protection, risks, environmental risk.

JEL Classification: R19, L89, F60

1. Introduction

During today's rapid changing times, the global working environment is also changing – working conditions are becoming more intensive, requiring maximum concentration, matching workload with human mental and physical abilities, and solving various organizational issues (Hill, 1994). In fact, this has been a vital global concern addressed by the unions in England, the U.S. and many countries since the beginning of the Industrial Revolution. Currently, the traditional work environment risks such as noise, vibrations, dust, and hazardous chemicals are a serious menace problem in factory sites world–wide (Fong et al., 1999). These are globally considered as menacing factors or as unsafe workplace conditions with a wide range of psychological and social problems such as occupational

diseases, accidents at work, stressful reactions, dissatisfaction with work, and lack of welfare. Most of these problems can be reduced or even eliminated that will improve both the health and well–being of employees and the productivity and overall local and global economic performances (Harrison & Petty, 2002). Occupational risk factors are present in all sectors of local and global economies and can affect a large number of employees (Wacher & Yorio, 2014). The following vital occupational risk factors should be mentioned as the most important (Latvian Ministry of Welfare, 2007): chemicals (varnishes, paints, synthetic detergents); physical factors (noise, vibration, micro – climate, lighting); dust (welding spray, abrasive dust, wood dust); biological factors (tick – borne encephalitis agents, viral hepatitis B and C agents, HIV/AIDS); mechanical factors (working with work equipment, hazardous equipment, work at high elevations, working in explosive environments); ergonomic factors (work in forced body position, uniform movements, moving heavy objects); psycho – social factors (lack of time, overtime, work at night, poor relations with management, colleagues, conflicts) (Fu et al., 2009). The working environment cannot be maintained absolutely without the impact of risk factors. Their reduction and control is the responsibility of each employer while the selection and implementation of preventive measures must be assessed by assessing the magnitude of the occupational risk, the financial capacity of the company and the suitability of the relevant measures of specific activities in the respective enterprise/institution locally and globally. Full control and reduction of risk factors to acceptable levels is only possible if the employers, their responsible persons as well as the employees are aware of the nature of the work environment risk factors and are able to predict their possible consequences (Seyoum, 2004). This is essential for maintaining the safe working conditions and increase the production levels for local and global economic profits (Dong et al., 2007). According to the Labor Protection Law of Latvia, the preventive measures are understood as actions or measures taken or planned in the enterprise at all stages of work to prevent or reduce the working environment risks. The aim of these measures is to create a safe and healthy working environment and to prevent accidents at work and occupational diseases and increase the local and global productivity (Latvian Ministry of Welfare, 2007). In fact, construction is especially considered one of the most important and yet one of the most dangerous sectors from the standpoint of the International Labor Protection as the employees there more often than in Latvia on average suffer from work accidents and occupational diseases. It also involves many aspects, but as the most important ones should mention those numerous, diverse and international work environment risk factors that are met at every construction site, employees of different professions and different levels of vocational training, uncoordinated or inadequately coordinated activities of more subcontractors, as well as lack of time (Akhvlediani & Sledziewska 2015). However, the underlying reason is insufficient understanding of labor protection issues; by employers, employees and customers (Riga Stradins University, 2011).

2. Analysis of Accidents in Construction

According to the European Union, the construction sector has the highest risk of accidents; more than 1.300 people die every year in construction accidents. Construction workers world – wide face a threefold higher risk of death and a double risk of injury than workers of other occupations (European Agency for Safety and Health at Work, 2017). Every year more than a thousand accidents are registered in Latvia where employees are either traumatized or killed (Riga Stradins University, 2010). It is demonstrated descriptively in Tab.1, which compares

the total number of accidents in Latvia with the number of accidents in the construction industry in chronological order.

Table 1: Statistics of number of accidents in the Latvian construction industry 2009 – 2016

	2009	2010	2011	2012	2013	2014	2015	2016	Total
Accidents at work									
Total in country	1.203	1.232	1.397	1.545	1.748	1.763	1.712	1.846	12.446
Construction	120	102	138	174	157	149	122	124	1.086
%	10	8	10	11	9	8	7	6,7	8,7
including: grave accidents at work									
Total in country	175	175	196	219	230	213	166	184	1.558
Construction	37	27	30	41	45	42	22	39	283
%	21	15	15	19	20	20	13	21	20,7
lethal accidents at work									
Total in country	32	25	34	35	31	41	41	38	277
Construction	7	5	10	11	3	5	2	5	48
%	22	20	29	31	10	12	5	13	17,3

Source: (State Labour Inspectorate, 2016)

Accidents frequently result in persistent incapacity for work and severe health problems. As a result many of these workers are no longer able to perform the same tasks they did before the accident (Wacher & Yorio, 2014). The consequences of accidents affect the employees, but employers as well. Accidents cause substantial damages and become challenges for the company to operate successfully locally and globally (Riga Stradins University, 2010). Additional menacing consequences are lowering their reputation and their production efficiency that affect them locally and globally (Fong et al., 1999). According to the State Labor Inspection data, the following are the primary sources of construction accidents. Occupational safety regulations were not observed – 33% of all accidents in the construction sector. Insufficient management in the performance of duties – 24%. Unsatisfactory staff training – 6%. Deficiencies in work management, insufficient control – 6%; use of unacceptable or inappropriate working methods – 6%; no security equipment or personal protective equipment has been used – 4% (State Labor Inspectorate, 2016). After analyzing the sources of particular accidents, it is evident that accident prevention will not require big investments. A large quantity of accidents occur not only due to dangerous and inappropriate working conditions, but also due to non-compliance with or negligence of elementary requirements (Dong, Haile, Men, Miller, Waehrer, 2007). The registration and investigation of accidents is very important for both employers, employees and especially the state. In fact, it enables employees to recover after an accident. It is pertinent for the employers to evaluate the sources, identify the individuals responsible and to take proper actions to prevent future accidents. At the national level analyzing the frequent sources of accidents and to identify the most dangerous sectors by improving the labor protection requirements or providing the additional support, thereby reducing the costs of accidents (Dong, Haile, Men, Miller, Waehrer, 2007). At the national and international levels, it is also important for the employees to restore their health as much as possible and continue working instead of receiving disability benefits (Riga Stradins University, 2010).

3. Reduction of Work Environment Risks Caused by Ergonomic Factors

The physical (bio–mechanical) factor appears to be one of the most vital factors while assessing the work environment risks at construction sites. Considering the results of the survey and analyzing the movements of the employees during their activity at the construction

sites, the primary problems that course frequent injuries are lifting and moving very heavy loads. First of all, bending forward with a curved back causes the compression of the front part of the inter–vertebral disc and stretching of the rear (the thinnest) part of the disc. It can cause substantial damage to its structure (Fong, Naoum, Sawacha, 1999). The same risk relates to an excessive rate of bending forward due to the extension of the back ligaments. Substantial risk to disks and ligaments occurs while turning and bending the body. It results in damage to the disk caused by both front and side compression of the disk and extension of the opposite side. Second of all, keeping the weight on the shoulder joint while bending the body back becomes a risk to the disks and is caused by compression of their rear parts, as well as the load on the inter–vertebral joints behind the disks. The further the weight is from the body (at constant weight value), the greater the pressure is on the inter–vertebral disks. Furthermore, standing on knees or squatting (with rounded back), especially for long period of time without adequate protective equipment and without resting periods in different poses, a significant load is applied not only on the joints, but also on the muscles and the heart. Currently, there is no European norm to determine precisely the normal and safe weight, but it is possible to identify a recommended safe weight limit. To prevent these specific injuries, the weight should be measured, the frequency of lifting and the distance of the carried weight and size. These are vital factors to implement in order to reduce disabilities' benefits costs and replacement of workers. The high frequency of these injuries will cause the decline in the local and global productions. After the identification and assessment of risks, it is important to determine and implement the most efficient improvements to minimize and prevent these risks. Implementing efficient measures can reduce the consequences of possible traumatic effects of work environment risks. The most efficient way to reduce disorders of the musculoskeletal system is to avoid manual lifting and relocation of weights. In fact, it is possible to provide lifting equipment such as cranes for such jobs. The approximate cost of such installation is approximately EUR 400 that would compensate the reduction in time required for the work to be carried out since the worker would not need the rest breaks after the transfer of weight. Using such a device would only slightly increase the cost of the workplace organization but reduce the spending on disabilities' benefits and replacement of workers and increase the working and production efficiency locally and globally (Robertson et al., 2016). If load lifting and moving mechanisms are not available, then it is necessary to follow the correct lifting and moving principles when lifting manually. Moving the weights manually also involves other body parts such as muscles, joints and ligaments. When moving the weights, it is strongly advised to do it by keeping the weight close to own body, at the height between elbows and fingers, thus reducing the tension in the area of the sacral bone. Additional safety features must also be implemented. For instance, before lifting heavy objects, it should be certain that the lifted load has no sharp corners, slippery surface, as well as other possible risks that may affect the lifting. Understand the acceptable weight lifting rate (which should not be exceeded) must also be considered and seek help when necessary. If possible, split the load and reduce the lifted weight to make lifting easier. It is essential to be certain that the weight movement path is clear with no obstacles. The following steps should be taken when lifting a weight: stand close to the load feet shoulder width apart, move one foot a little forward and lean on the other one; squat, bending the knees and not the waist, shrink the chin while keeping back as vertical as possible; grasp the load with a firm grip before start lifting; start slow and smooth lifting using your legs. Never turn your back during this step. When lifting is complete, keep the load close to the body as much as possible. If the center of gravity is far from the body, it significantly increases the load on the back and

increase the risk of injuries. In order to promote safe lifting and carrying procedures, provide employees with personal protective equipment; working gloves with anti–slip coating are required to reduce the possibility of the movable weight to slip out, working boots with anti–slip sole and toe protection. The upper part of the shoes is treated against moisture access. Oil and gasoline resistant, anti–static, non–slip sole of PU2D.

4. Reduction of Psycho – emotional Risks in Work Environment

While assessing the local and global working environment risks at construction sites, one of the most important factors within the working environment are the psycho – emotional risk factors. While conducting this research, the main problems are observed when performing monotonous work where the performed actions are repeated numerous times (Fonget al., 1999). Within studied framework, we implemented the determination of the occupational stress index (OSI) at a specific construction site, (value of 13.5), which means that the employees have a very high stress index (>10), a high physical and psycho–emotional load. It is essential to focus on the preventive measures associated with stress management to prevent the development of damage to the musculoskeletal system. Stressful working conditions can cause serious health problems for the workers such as headache, dizziness, concentration problems, eating disorders, stomach problems, insomnia, irritability, memory impairment, fatigue and several other health disorders. The consequences of stress and the psycho–emotional climate at the workplace are a financial burden for every employer as consequences of stress can lead to a reduced or completely lost ability of the workers that result in reduced productivity. If a new employee must be sought for to replace the existing one, as well as financial expenses for the payment of incapacity compensation to the victim. Therefore, the preventive measures to reduce or fully eliminate the psycho–emotional risks are pertinent for a sustainable development of the company (Seyoum, 2004). The prevention of psycho–emotional risk factors is largely dependent on the organization of the work environment: organization of work schedules and work breaks, interrelations at the workplace and the involvement of the employer in improving the psychological micro–climate. According to the European Survey of Enterprises on New and Emerging Risks (ESENER), 70% of employers recognize that they are concerned about stress in the working environment while 40% of them believe that it is more difficult to deal with the psycho–emotional risk factors than with the traditional work environment risks (such as noise, vibration and lighting.) (Wacher & Yorio, 2014). There are several examples of good world practices how companies are aware of the psycho–social risk involved in the company; measures taken to reduce the high stress level. The most popular measures to reduce stress include: informing and educating the employees about stress management and advice on coping with stress (informative materials, internal newspaper, seminars, training, informative films), consultations with employees, assessment of work and provision of feedback on the accomplishments (mailboxes of ideas, internal competitions), regular provision of information about events in the company and the work tasks (management of the company explains the company development strategy, work tasks, timely informs and provides explanations about the planned changes in the company activity or structure and their necessity, since one of the reasons for the stress is lack of information), organization of working time (more convenient working hours, more suitable work schedule), respect for work and rest regimes and harmonization of family and work life (work breaks), providing employees with lounge rooms where employees can stay and relax during breaks, play games,

communicate informally, coffee breaks and lunch breaks, joint sports activities (gymnastics during breaks, arrangement of gymnasium, exercise machine (cycling machine) in the lounge room, participation in sports games); provision of free visits to swimming pool or sports activities (for rest after working hours) and organization of joint events for purposes of team – building. (Heizer & Render, 2011). Employees often encounter stress caused by the psycho–emotional risk factors. The following changes will reduce the impact of these factors; conducting monthly surveys of the employees on the psycho–emotional condition and working atmosphere, educating employees on the stress impact and coping with stress (to create message boards with informative materials in the accommodation trailers), conducting regular employee training by the labor protection specialists, and inviting the occupational health physician and relevant specialists.

5. Reduction of Hazardous Chemical Risks in the Working Environment

When assessing the working environment risks at the studied construction site, we discovered frequent problems with the hazardous chemical factors in the working environment. During the site inspection, the employees used hazardous chemicals such as acetone and paint that are not in the compliance within the work safety requirements (Bozarth & Handfield, 2006). According to the risk rating, hazardous substances through inhalation with the risk level 2 need to be provided with exhaust hoods or specially equipped ventilated working surfaces (airflow rate not less than 0.5 m/s). Personal protective equipment is necessary, including the respiratory protective equipment (breathing mask inhalers). Exposure to hazardous substances with the risk level 2 require work clothes, all–face protectors and suitable gloves, incl. disposable. Chemicals can get in the worker's body through the respiratory tract (respiratory way), through the skin (dermal way), through the intestinal tract (digestive way), through the wounds (parenteral way). If chemicals penetrate through the skin, then the symptoms of skin damage may be dry skin, redness and itching. Skin should be covered with squama; otherwise cracked skin as well as ulcers may develop. The human respiratory tract should be mentioned as one of the main pathways for the introduction of chemicals into the human body. Inhalation of chemical dust containing chrome-based salts may result in perforation of the inter-nasal septum. Quartz or asbestos-containing dust can accumulate in the lungs. When chemical substances dissolve in the blood, they can get also enter other organs. The upper respiratory tract mucous membranes and lungs can be damaged by water-soluble gases and vapors and can also cause a dry cough. Chemicals can often interfere with oxygen blood supply which can lead to asphyxia. Furthermore, chemicals can enter through the intestinal tract by accidental swallowing that caused burns. Replacement of chemicals with a safer substances, such as solvent-based paint with safer water-based paint is one of first essential tasks to reduce the risks. Replacing the paints leads to the risk reduction of developing malignant tumors and the risk posed by several other chemicals on the workers' health. It would also benefit not only to the health of the worker, but also to the economic aspects of the company, because water-based paints are cheaper. Thus the worker's exposure to hazard would be reduced when working with chemicals. In order reduce the more of exposure of workers to the impact of chemicals, the right technological processes choice is crucial. If the technical project provides the installation of forced ventilation and the installation of air supply valves, then windows and doors should be painted right after the installation of the ventilation system; providing air supply and exhaust to the premises and creating air exchange that will reduce the chemical substances release during painting

procedures. Minimizing the number of workers involved in the painting process and preventing unauthorized persons from entering during the painting process. It is pertinent for the employees to have the necessary knowledge and skills to work with chemical substances; being familiar with the correct working methods, the composition of chemicals, how the substance can affect the health conditions, the effect of the ventilation system on the concentration of the chemicals in the air, as well the right measure to reduce the risk. (Liu et al. 2017) Before using chemicals, employees must be familiar with the safety data sheets of chemicals used. To prevent exposure to hazardous chemicals and chemical products, it is essential to have proper storage and packaging with a thereon label with a hazard symbol, characterization of chemical's effect, the designation of safety requirements, proper storage of substances and essential chemicals. Storage of obsolete and unclearly identified chemicals are prohibited. The employer must control the collection, sorting, packaging and removal of chemical waste in proper conditions that guarantee employees' safety. To confine hazardous areas and post warning signs in accordance with the requirements of the Cabinet of Ministers Regulation No. 400 of 03 September 2002 "Labor Protection Requirements for Use of Safety Signs", Latvia. Individual protection measures are manifested as the use of personal protective equipment. While painting, the following information on the use of personal protective equipment recommended by the safety data sheet should be used: for respiratory protection, when working with a spray gun it is recommended to wear a face mask with a P3 type filter; for protection of hands, when working with paint for a long time, it is recommended to wear latex protective gloves. Gloves should be changed regularly and as soon as the glove material is damaged; for eye protection against splashes, use protective goggles; for skin protection, if necessary, wear protective clothing (preferably anti – static fabric) and anti – slip protective footwear. Protective clothing of anti – static fabric and protective footwear with anti–slip sole.

6. Conclusions

There are various techniques to reduce and eliminate the impact of the work environment risks by providing proper equipment, effective organization, applying the labor protection measures, ensuring the training of employees, reducing the exposure in hazardous environment, and providing labor protection equipment. The flexibility of the working environment to promote employee diversity as each employee has different abilities, health status, and has its own methods for a particular job. In fact, proper and efficient labor protection system provides workers with safe and healthy conditions at the workplace, reducing the possibility of accidents, preventing the occurrence of occupational diseases, prolonging the labor life, and allowing a full-value rest upon completion of work instead of treating injuries. Construction is considered one of the most dangerous sectors of the economy due to the number of accidents and as occupational diseases exceeds the average in Latvia (in the labor force). The most frequent mistakes occur due to inefficient organization, failure to follow instructions as well as considerable lack of time is observed. The most frequent risk factors are falling objects, falling and slipping, sharp objects and hand injuries. (Robertson et al., 2016) Throughout the European Union, the construction sector has the highest accident risk level, where workers are at risk of dying and at risk of serious injuries. After analyzing the data on accidents during the last eight years, more than 1,000 accidents in Latvia are officially registered each year with an increasing tendency. The main causes of construction accidents include: failure to observe labor safety regulations, inattentive attitude

of the employee when performing of his/her duties, incorrect use of working methods, and failure to use personal protective equipment. When moving heavy weights, the most commonly observed body position of the worker is slight leaning, small turns, weight close to the body and long travel distance. The most efficient way to reduce the musculoskeletal disorders is to avoid manual lifting and movement of weights. Transfer heavy weights with a load transfer cart. In order to promote safe lifting, provide personal protective equipment. Stressful conditions can cause psycho–emotional risks and serious problems such as headache, dizziness, concentration problems, eating disorders, stomach problems, insomnia, irritability, memory impairment, fatigue and other health disorders. (Liu et al., 2017) It is therefore pertinent to conduct employees' survey once a month to ensure information and education of employees about the impact of stress and its coping and to conduct regularly employee training. Reduce the hazardous chemical risks of work environment and the replacing them safer substances. Applying the solvent-based paints are replaced with water-based paints. Personal protective equipment (face mask with P3 type filter, protective goggles and latex gloves) should be used when carrying out painting works.

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