

OCCUPATIONAL EXPOSURE DETERMINATION AND IMPROVEMENT OF MPS- PRODUCTION QUALITY IN THE GARMENT INDUSTRY

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Abstract

The development of garment industry has been inconsistent in the last few years in Estonia. Small companies are fighting for survival in the market, trying to offer outsource work possibilities to EU companies.

The garment industry has preferably invested in the equipment rather than the companies' premises. The modern industrial building design has been mainly used by wood and metal industries. Occupational exposure assessments and measurements in various industrial companies revealed that there are problems with different forms of work and workplace locations in the industry. For example, in the new wood production building, in which the assembly of details, painting and packing are situated in the same large workroom, all the workers are suffering from the exposure to chemicals and dust. These hazards, originated from the production, are spread over the whole large workroom. Microclimate factors such as temperature, relative humidity and air velocity are also much less controlled than in separate workspaces. The indoor air quality in manufacturing companies might be an important disturbing factor that influences people's health and well-being. This paper has studied the chemical (like dust) and physical hazards (like noise and lighting) in a medium-sized garment industry building, where small groups of employees (7 to 12 sewing machine operators) are located in the work areas separated by walls. This kind of group work in the garment industry is named Modular Production System (MPS). Sewing machine operators are working as a team fully responsible for the production, quality and well-being at their workplace. Thermal comfort, prevention of static postures, and pauses during working hours have to be followed by the whole team.

Key words: garment industry, well-being at work, microclimate, lighting, noise, dust

1. INTRODUCTION

Sewing machine operators spend over 90% of their time indoors and over 30% of their time at work. Due to this reason, the quality of indoor air is very important for the work environment. The quality of indoor climate is equally affected by heating, ventilation and air conditioning equipment, construction engineering, building materials and maintenance of the building as well. Many tasks in garment manufacturing require repetitive motions and musculoskeletal disorders are diagnosed (Remeza & Shestakova 2005; Vezina, Tierney & Messing 1992), also allergic responses depending from the composition of sewing materials (Milczarek & Szczecinska 2006). To prevent ergonomic injuries, workers should be encouraged to switch tasks or take frequent, short breaks to stretch and relax muscles (Reinhold 2005).

The target group of this work composed of 130 workers from the garment industry in North-East Estonia. The anonymous e-questionnaire was carried out to analyse the main individual and work environment related factors. The response rate was over 35%. The labour force of garment industry is mainly female and most of them go home after work and deal with household. From the health perspective, they spend too much time indoors.

The colour of the light is also very important in the garment industry. The problem is that many light panels have been replaced with light emitting diodes (LEDs). Since some of the light panels are old and some are new, there is a problem of mixed lighting. Study results showed that the blue LED light keeps

people more active in the work environment compared to those treated with the red LED light (Brainard & Hanifin 2014).

The garment industry companies have contributed to the improvement of the work environment less than other industries. The main changes take place with the production arrangement in old Soviet-era industrial buildings, where the ventilation and air conditioning equipment is out of date or with defects. These are the main reasons for the unsatisfactory work environment. This raises the question whether there are problems only with the old construction engineering plants.

Research and practice have shown that the occupants are too often unsatisfied with the building. Complaints concerning modern buildings regarding health and comfort are common everywhere (Schneider, Skov & Valbjørn 1999). Problems with indoor climate may be caused by the buildings themselves but some of them are caused by actions of the occupants or operation and maintenance of the buildings.

In the present study, old industrial buildings are compared with new construction buildings, taking into account the interior design of working areas. All employers face work environment risks in those workrooms where all activities are performed in a large production area. When carrying out measurements in the wood or metal industry, the problem is easy to spot (Fig.1). As you can see, there are separate small workshops without walls in a large production bay like polishing, painting and packing areas. Workers in the painting area are suffering from the exposure to chemicals and dust, which spreads easily over the large workspace. In a large production bay, keeping under control the main hazards like noise, dust, and draught is more complicated than in small separate rooms.

In this study, labour organisation in the old-school building is presented, which contains a lot of small rooms, with surface area about 60 m². The construction has not changed, the walls have not been torn down, but suitable industrial engineering according to the building construction has been adapted (Fig. 2). It is called MPS-production and it is suitable for the garment industry. Sewing machine operators are working as a team fully responsible for the production, quality and well-being at work.

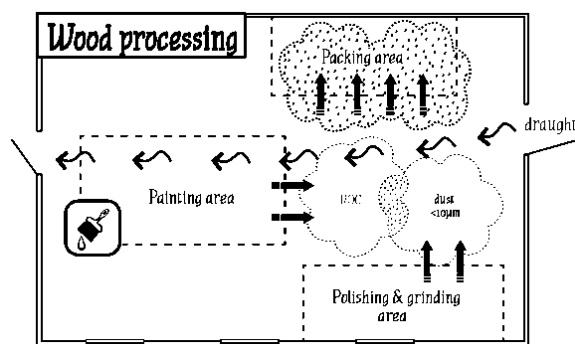


Fig 1. Main hazards of the work environment spread over the production bay

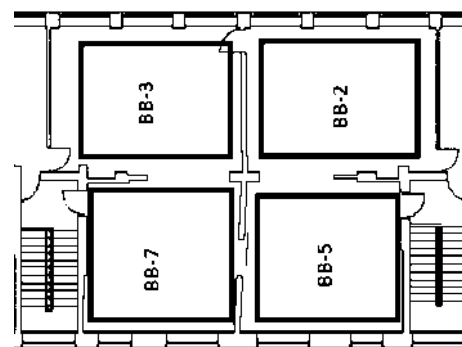


Fig 2. Labour organisation in the old-school building in small groups, called MPS

To estimate the physical and chemical hazards in the clothing industry, the measurements of noise, microclimate, lighting, dust concentration and the content of certain chemicals in the air were surveyed in five sewing enterprises during the last three years. Results were assessed using the norms of the Estonian Occupational Health and Safety Act. The examined physical and chemical hazards were selected considering the most common occupational hazards, building construction and maintenance of the building in the area of industrial sector in Estonia (Reinhold & Tint 2007). Important determinants of work-related exposure were identified, verified and evaluated. Tasks and jobs were also classified on the basis of raw materials, products, and tools used by the employees. According to last years' surveys, there are still a lot of uncomfortable static postures in sewing machine operators' work. Sewing companies have exchanged older equipment but there are several new special machines, where the

operator has to keep hands away from her body in 45° angle. This kind of compulsory sitting posture causes strain to the neck, shoulders and the whole spine. The second main problem is that the sewing operator's chair often does not support the back during the sewing procedure.

To estimate work-related and individual factors together, an online questionnaire was carried out. 48 sewing machine operators in total answered several questions about disturbing problems at their work stations and during their leisure time. Figure 3 presents the results of the online questionnaire.

2. MATERIAL AND METHODS

To measure physical and chemical hazards in the present case study, international methods according to Estonian legislation were used. The number of measurement points was selected according to the surface area of premises. The first measurements were performed in the big production hall as a part of new construction. This surface area was over 200 m². Consequently, 16 measuring points were selected in the area, where the distance between two points did not exceed 10 meters. The other rooms were less than 100 square meters, so measurements were made in 4 measuring points in these areas. Microclimate measurements were performed for heights of 0.1 m and 1 m with COMET S3120. Light measurements were made only for 1 m height with TES 1335. Noise measuring TES-1358 Sound meter was placed in a vertical position, and set up to measure the noise equivalent in ten seconds. At the same time, the persons conducting the test were not allowed to talk to each other. Anemometers measured in the direction of the air velocity. Measurement results were shown in three directions x, y, z. During the measurements, surveyors were standing still, the results of the measurement should be accurate. Data according to the thermo-hygrometer, which included air temperature, relative humidity and level of CO₂, was recorded at all points and the conductor let the result stabilise before moving to the next point. The dust was measured using aerosol-spectrometer Grimm 1.108, the height of the measurement was set at 1 m. Total dust was measured in the space of six points in the big hall (U.S. Department of Health & Human Services 2003). Other smaller areas were measured for the amount of dust in the air from one point only. For noise measurements, three dosimeters were used, fastened to the shoulder of the employee close to the ear for the whole workday (8 hours).

The existing risk assessment models (BS8800:2004) contain the matrix to determine the probability of the occurrence and the severity of consequences of the influence of hazardous factors on workers.

The health risk assessment model for industrial rooms (Fig. 3) has been developed at Tallinn University of Technology, based on the model presented by Reinhold et al (2006), previous empirical research, literature review and on the relevant legislation and standards (Reinhold, Tint & Kiivet 2006).

In the current study, it is suggested to use HRA (Health Risk Assessment) model as a tool to assess and evaluate the health risk levels and preventive measures in work areas. Considering the risk levels and health complaints can be a basis to choosing the right protective equipment and the frequency of medical examination (ME) of workers (Traumann 2014).

The aim of the anonymous online questionnaire was to identify and measure workers' satisfaction with the working conditions. Also, to evaluate individual factors, which might be causing negative health risks in conjunction with the work environment. Physical overload has been added on the HRA model (Fig. 3) as the main stressor in the work area of operators as well as ergonomic comfort.

3. RESULTS

In this study, chemical hazards (dust and carbon dioxide) and physical hazards (microclimate, noise and lighting) were collected from various types of workplaces. Five different workspaces were investigated during the summer and winter period. Four rooms BB-2, BB-3, BB-5 and BB-7 (Tab.1) are located in the old part of the building, where the working areas are separated by walls and sewing machine operators are working in small groups (7-12 employees in a group). This production system is called MPS (Modular Production System), where sewing machine operators work as a team. The teams are fully responsible for the quality and production, also well-being at work. For example, the prevention

of static postures and pauses during working hours have to be respected and observed by the whole team. The measured values are compared to the data of the large hall (Tab.1). This hall is in the new part of the building, where the sewing machine operators are working in one big group, sewing machines are arranged in lines, as we have usually seen in big sewing industries.

Table 1. Results of the measurements in small rooms and in the large hall

Room type	T, °C Cold/warm season U=0.5°C	R, % Cold/warm season U=2.0%	L, lx U=10.4%	CO ₂ , ppm Cold/warm season U=10%	D, mg/m ³ Cold/warm season U=10%	AV, m/s Cold/warm season U=10%	N, dB(A) U=10%
BB-2	22-23/24-25	31.6/39.0	962-1021	1186/1304	0.09/0.11	0.08/0.19	78.2
BB-3	21-22/23-24.5	28.4/34.5	1143-1231	1246/1398	0.06/0.09	0.09/0.19	76.5
BB-5	21-22/23-24	29.8/38.6	1070-1102	1041/1245	0.07/0.09	0.07/0.21	75.3
BB-7	22-23.5/23.5-25	31.1/39.2	882-950	1043/1265	0.07/0.1	0.08/0.19	78.8
Hall	24-25.5/25-28.5	21.5/35.5	1070-1648	2024/2258	0.18/0.31	0.03/0.10	83.1

U- the uncertainty of measurements; T- temperature of the air; R-relative humidity; L-lighting; CO₂- concentration of carbon dioxide in the air; D- dust concentration in the air; AV- air velocity; N- noise

After analysing the completed questionnaires, it resulted that most of the respondents complained about the temperature being too hot in the workstation in summer and the air inflow being too scarce during winter. The simplest solution to both problems is that operators can open windows to ventilate the working area. It is much easier to do that in a small workroom, where operators can arrange the ventilation during short pauses, when they are sitting in the resting area and drinking coffee. Technology and machinery in the clothing industry have been developed greatly during the past few years, unfortunately there are still problems with ergonomics. The latest international studies have highlighted musculoskeletal disorder (MSD) risk factors associated with the clothing industry and sewing operators' workstations because of repetitive work in awkward and static postures (Polajnar, Leber & Vujica Herzog 2010; Lugay & Matias 2015). If the muscular system is strained, then injuries caused by draught in the working area are much more dangerous for workers' health.

To find out workers' satisfaction with the work environment, anonymous online questionnaires were carried out. The evaluation of problems at workstations were made according to Likert-type scale, where the severity of the statement has higher rating (Fig 3).

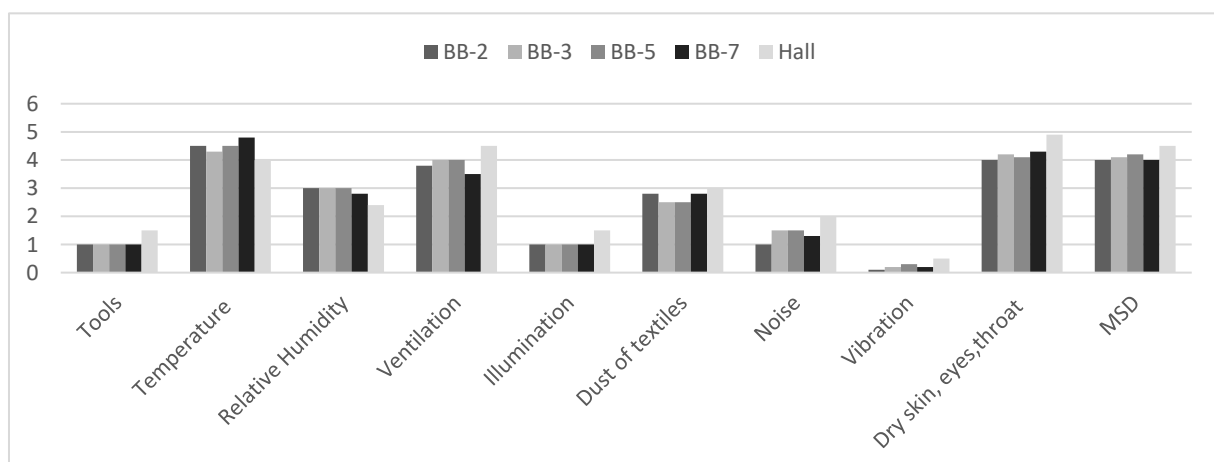


Fig 3. Workers' estimation of hazards at workstations

According to Figure 3, the main problems are with ventilation, temperature and dry skin, eyes and throat. These hazards are mutually connected. There are possible to better regulate microclimate conditions when the sewing operators work in small groups in smaller work rooms. As you can see in Figure 3, the sewing operators experience high dissatisfaction in the large workroom hall as well.

4. DISCUSSION

Measurement values of microclimate take into account the cold season and warm season norms, which are in correspondence to moderate physical work (II a – moderate physical load) (Estonian Standardization Board 2007). The results were compared to the upper and lower limits of permanent jobs during eight hours per day and forty hours per week. According to the data of relevant legislation and standards, the suggested criteria for risk levels of occupational hazards are presented in Figure 4.

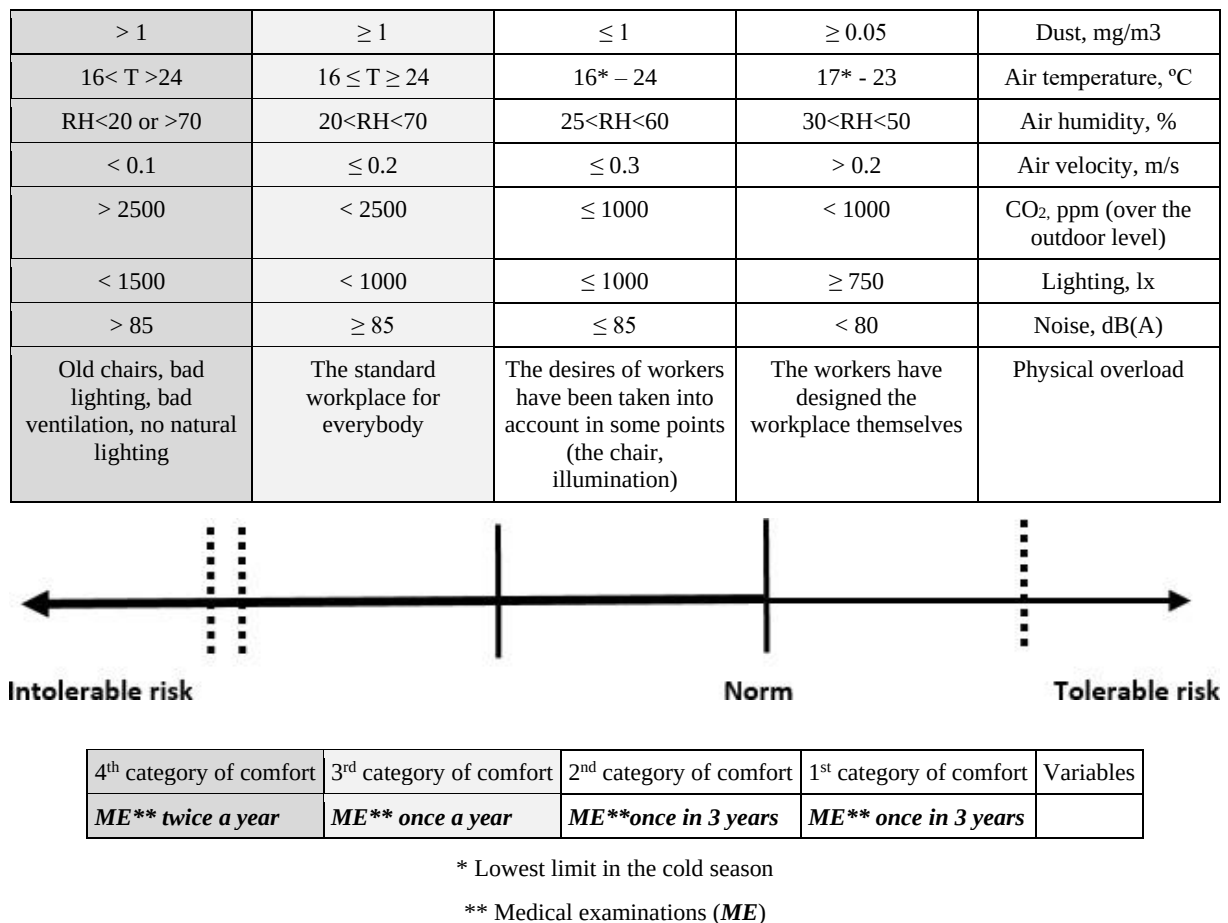


Fig 4. Determination of health risk levels related to physical and chemical hazards

In the investigated examples of the garment industry, most of the hazards are under control, except insufficient ventilation during the cold season, which causes lack of air, especially in the large hall work areas. The vent-holes are closed because otherwise the sewing operators would experience the effect of draught in the neck and shoulder area. It was stated that temperature is too high in some workplaces, exceeding 24 °C, and relative humidity is too low, under 25%.

Typical indoor CO₂ concentrations range between 700 and 2000 ppm, but can exceed 3000 or even 5000 ppm in crowded and under-ventilated rooms (Laht 2010). The American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) standard sets 2500 ppm as the upper limit for indoor CO₂ concentration, but 1000 ppm is the recommended maximum (Feng & Lee 2002).

Taking into consideration the lighting intensity, distribution and type of illumination should prevent excess straining of eyes. Lights in the garment industry must ensure a smooth performance of the production process throughout the work day. Illumination values for dark sewing materials is 600 to 1000 lx and for lighter materials it is 500 to 750 lx (Colovic 2011). The problem is that some of the light panels are old and some are new (LEDs), hence, the problem of mixed lights. Illumination was homogeneous in small work areas (BB-2, BB-3, BB-5, BB-7) because all the old lamps had been replaced. Average value of illumination was 1178 lx in the small rooms. Dust concentration was low, under 0.1 mg/m³, the limit of textile dust is 1.0 mg/m³. The noise didn't exceeded the limit 85 dB(A), it was measured mostly 78.2 dB(A) and 78.8 dB(A) in small rooms BB-2 and BB-7. In the large hall, the noise was higher, 83.1 dB (A). Vibration was not measured because according to the online questionnaire, the sewing operators do not consider it a great hazard.

There were not any problems with occupational exposure limit of dust in textile industry according to the chemical norms in the Estonian legislation (Resolution of the Estonian Government 2007). But most of the sewing operators sense this hazard. The employer has given face masks as well as personal protection equipment to the workers. Previous studies in Lithuania discovered that over 58% of workers, who started working in the textile garment industry, started to feel irritation and redness of eyes, a sore throat, a dry cough and different skin complaints (Naruševiciute-Skripkiene et al. 2015).

It appears from this study that we have to turn attention to an additional factor - the work force in the clothing industry is mainly older people. Around 80% of the sewing operators in this company were over the age of 40. Because of that, dissatisfaction with the microclimate conditions could be related to age. Musculoskeletal disorders (MSD) of sewing operators are definitely caused by the work environment but it can also be connected to the risk factors of aging.

5. CONCLUSIONS

As a result of this study, it turns out that there are less problems with physical and chemical hazards in the old type industry building because there are small rooms separated by walls. Comparing the large hall and small work areas within the same company, we can conclude the following aspects in favour of small space areas and work groups:

1. It is easier to achieve the regulation of the mechanical ventilation in a small room, where smaller groups of workers are situated.
2. Workers often use natural ventilation through opening windows.
3. It is easier to achieve suitable microclimate for all workers.
4. Chemical hazards like dust and carbon dioxide are lower.
5. Illumination aspects like intensity and distribution are better achieved.
6. Small work groups implement the correct ergonomic work postures.
7. Each supervisor of MPS helps to motivate and train their team together and at the same time to perform physical activities that can improve the work posture and achieve higher safety level of the company.

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