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Safety Engineering & Management
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Safety Engineering & Management - Science, Industry, Education
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FACULTY OF OCCUPATIONAL SAFETY

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SAFETY ENGINEERING & MANAGEMENT –
SCIENCE, INDUSTRY, EDUCATION (SEM-SIE 2023)

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PERSONAL NOISE EXPOSURE LEVEL AMONG EMPLOYEES IN SCHOOLS, AUTOMOTIVE AND MINING INDUSTRY

Abstract: *Occupational exposure to high noise levels is a problem in almost all industries, including the services sector. The exposure level varies depending on the noise sources. According to the available research studies, this problem often appears in industries like transportation, mining, production, and construction. The risk of negative health effects is proportional to the exposure level and the frequency of noise exposure. The negative effects of high noise exposure levels often include decreased concentration, risk of accidents, stress, and cardiovascular diseases. A noise exposure measurement in real-world conditions was carried out to determine the noise exposure level of the schoolteachers, as well as automotive and mining industry workers. The results of this research show that there might be a risk to workers' health and safety in three different workplaces, including both industry and education.*

Keywords: mining industry, automotive industry, schools, exposure level, noise measurements

INTRODUCTION

Exposure to high noise levels is often considered a cause of hearing problems. As noise intensity increases, so does the risk of damage to the sensory hair cells of the inner ear, which can result in permanent hearing loss (Mikulski & Radosz, 2011). The results from the literature on personal noise exposure show that high levels of exposure can cause tinnitus (Nelson et al., 2005).

Noise in industry is mainly generated by the machines and tools used in the production and maintenance processes. The worker operating a specific machine is exposed to the noise of the machine, but it also affects other workers nearby or in the entire workspace.

The various types of equipment used in the industry sector generate high noise levels due to many factors, such as the type of used equipment, operational life, and the operational speed of the machines. A large percentage of the labour force employed in the industry is exposed to noise. For this reason, improving workplace conditions in terms of noise control will have a positive effect on humans and their productivity.

The noise generated in schools is an important factor that has an impact on both the schoolteachers and the students. It affects the hearing organs and causes problems with speech reception and comprehension (Bradley & Sato, 2008; Kreisman et al., 2010). In some cases, it may impact not just the career but also the social life by reducing opportunities for employment or promotions (Alberti, 1998).

The purpose of this paper is to conduct a measurement of personal noise exposure levels in schools and industry and compare the obtained results. The overall aim is to determine whether the results are within the acceptable ranges and whether there is a risk of adverse effects on the workforce in these two distinct sectors - industry and education.

MATERIALS AND METHODS

The purpose of this study is to compare the personal noise exposure levels in three different places - an automotive plant, a mine and a school. For this purpose, noise level measurements were first performed. The national standard MKS EN ISO 9612: 2010 Acoustics - Determination of noise exposure in the working environment provides the basis to carry out noise measurements using the right approach and strategy.

The A-weighted equivalent-continuous sound pressure level (LAeq) was obtained during the measurements conducted with 3 schoolteachers, 3 mining workers, and 3 workers in an industrial plant. The unit of measuring the noise level is dB.

For successful measurement, equipment that complies with IEC 61762-1: 2002 instrument class 1 was used (Nesevski et al., 2022). Noise levels were captured with dosimeters and the results were downloaded with a software tool for noise data management. Dosimeters, small devices that contain a microphone to capture the level of personal noise exposure, should be placed near the exposed ear, usually on the shoulder, in order to capture the real exposure level.

CASELLA Dbadge2 is the type of dosimeter used for the measurements of personal noise exposure. The software tool for noise data management used in the research is NoiseSafe. The participants in the research were explained how to use the dosimeters during the working day, and what the purpose of this measurement equipment is.

After the measurements had been completed, an equation according to the MKS EN ISO 9612: 2010 was used for calculating the normalized 8-hour exposure ($L_{EX,8}$ h) level, equation (1):

$$L_{EX,\ 8h} = L_{Aeq,\ Te} + 10 \log T_e/T_0 \text{ dB} \quad (1)$$

T_e is the daily duration of the workforce exposure,

T_0 is 8 hours of reference time, and

$L_{Aeq,\ Te}$ is the equivalent noise level during T_e.

The exposure levels obtained with the research for schools and industry were compared to determine the difference in noise exposure due to the different noise sources in these sectors. The results are presented in the following section.

RESULTS AND DISCUSSION

Once the measurements were completed, a summary of the results was provided. The Occupational Health and Safety Regulations in North Macedonia outline exposure limit values and action values in relation to the daily noise exposure levels presented in the table below (Regulations for limits of the environmental noise levels, 2008).

The peak values of the sound pressure are presented in Table 1. The manufacturing companies must adopt the recommendations and maintain noise exposure levels under the limit values in accordance with the Rulebook.

Table 1. *Occupational Health and Safety Regulations in North Macedonia*

Exposure level	$L_{EX,8h}$ (dB)	$L_{p,\ Cpeak}$ (dB)	p_{Cpeak} (Pa)
Exposure limit values	87	140	200
Upper exposure level values	85	137	140
Lower exposure level values	80	135	112

The results of the schoolteacher's exposure level while performing the usual daily tasks are presented in Table 2. Results in Table 2 clearly indicate that the daily personal noise level exposure in schools is in line with the limit values outlined in the Regulations on Occupational Health and Safety and exposure to noise in North Macedonia (Hadzi-Nikolova et al., 2013).

Considering the fact that the daily 8-hour exposure level has to be a maximum of 85 dB, the exposure levels in Table 2 are close to the limit values. High noise levels in schools are typically observed during breaks and sports activities. In these periods, schoolteachers are exposed to noise levels above the limit value of 85 dB (Hadzi-Nikolova et al, 2013).

Table 2. *Personal noise exposure level of the employees in the schools*

Exposure level	Min (dB)	Max (dB)	$L_{EX,8h}$ (dB)
Measurement point S 1	77	85	78.8
Measurement point S 2	75	84	78.6
Measurement point S 3	74	83	77.5

The data displayed in the tables strongly suggest that an action plan must be implemented immediately. The high exposure level in schools requires further investigations into this problem, as well as the need to identify the sources and periods with the highest impact on the results. The absence of regular monitoring of the exposure level could lead to serious health consequences.

The second round of measurements was performed in an automotive plant. The main sources of noise in the industrial plant are machines and tools used in the production process. In addition, the results obtained for all the departments included in the research will be presented.

Table 3 shows the noise exposure levels in an automotive production plant. The measured noise levels do not exceed the limit values presented in the Occupational Health and Safety Regulations in the Republic of North Macedonia.

Anyway, the results indicate that there is a risk of exceeding the limit values. The daily tasks in the industrial plant require exposure to noise generated by the machines and equipment.

Table 3. Personal noise exposure *level of the employees in the automotive industry*

Exposure level	Min (dB)	Max (dB)	$L_{EX,8h}$ (dB)
Measurement point A 1	71	81.3	76.4
Measurement point A 2	71.9	79.9	74.2
Measurement point A 3	79.4	83.1	79.6

The third round of measurements was performed in the mining industry. The primary sources of noise in the mining industry are the machines and tools used, the mining process itself, and mining mechanization. The results obtained by these measurements will also be presented.

Table 4 shows the noise exposure levels in the mining industry. The measured noise level at one measurement point exceeds the limit values presented in the Occupational Health and Safety Regulations in the Republic of North Macedonia.

The results show that there is a risk of exceeding the limit values at the other measurement points as well. As a result, mining workers must wear personal protective equipment.

Table 4. *Personal noise exposure level of the employees in the mining industry*

Exposure level	Min (dB)	Max (dB)	$L_{EX,8h}$ (dB)
Measurement point M 1	83.2	85.5	84.7
Measurement point M 2	83.6	87.6	86.3
Measurement point M 3	73.7	882.2	80.4

The percentage of the labour force exposed to noise in industry is very high, and according to the literature research, a very huge portion of the industry generates noise that exceeds the limit exposure level, which on average ranges between 70-118 dB. There has been much debate and research into how the duration of noise exposure can affect employee performance and perception (Errett et al., 2006).

When the results obtained from the measurements in the three different sectors - automotive industry, mining industry and education - are compared, very similar exposure levels can be noticed. The highest $L_{EX,8h}$ value has been calculated in the mine, at measurement point M 1. However, constant high exposure levels can be observed in the school, almost the same at three different measurement points.

Noise can be a serious problem in many workplaces. However, there are three important steps that should be taken to reduce the risks associated with noise exposure:

1. Carry out a detailed risk assessment, identifying the sources and exposed workplaces
2. Design and implement an action plan to prevent or control the risks
3. Measure the effectiveness of the action plan.

CONCLUSION

Considering the results of the measurements, the noise exposure level among employees in three sectors - schoolteachers, mining workers, and automotive industry workers - is high but still within acceptable limits. s. Because of the high exposure level, Regular control measurements are necessary due to the high exposure level, as there exists a potential risk factor that could negatively impact the workers' health and safety. There can be very serious health consequences caused by noise exposure at the workplace in an industrial plant, mine, or school. In addition to affecting workers' health and safety, noise also has a socioeconomic impact. Exposure to high levels will result in hearing loss, cardiovascular disease, stress, and anxiety, affecting the social life of teachers and workers in industrial plants.

Implementing hearing conservation programs will mitigate or eliminate the health risk. In addition, performing regular measurements and risk assessments of personal noise exposure levels, as well as tracking the implementation of action plans will help maintain a safe and healthy work environment.

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