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INFLUENCE OF NOISE ON THE WORKERS' PERFORMANCE IN AN LPG-REFILLING SITE: SOME PROPOSALS

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Abstract— **One environmental aspect that poses concerns to safety and health is occupational noise exposure among factory workers. Constant exposure to environmental stressors like noise at work can harm workers' comfort and performance since they interfere with their ability to focus. As observed in a refilling site in Dunggo-an, Danao City, Cebu, noise is noticeable and prevalent. Thus, the researchers evaluated the relationship of workplace noise to the performance of workers in the refilling plant. This study used a quantitative approach through observation in evaluating the relationship of workplace noise level to the performance of workers in the refilling site. The collected data from the production were gathered with the use of a sound level meter and a stopwatch and analyzed with Pearson Product-Moment Correlation Coefficient and t-Test to know the significant relationship between performance and noise level, and the significant difference of work performance with and without earmuffs, respectively. The study was conducted for only one day. The results showed that there is a significant relationship between levels of noise and the workers' performance at the LPG-refilling site. This revealed that the duration of completing a task takes longer as levels of noise in the workplace increase. Thus, there is a need to implement the proper utilization of earmuffs to reduce the noise level received by workers and improve their performance, and to further save costs for the next production. From the findings, the researchers formulated an action plan and recommendations to minimize noise exposure in workplace.**

Keywords— **Loud sound, Machine noise, Production noise, Productivity, Work effectiveness**

I. INTRODUCTION

Noise is an undesirable and unpleasant sound that can interfere with people's activities and lower their quality of life by interfering with their natural psychological, physiological, or social functions. Noise could come from occupational and outside noise (Dulay et al., 2018)[1]. One environmental aspect that poses concerns to safety and health is occupational noise exposure among factory workers (Said et al., 2021)[2]. According to estimates from the National Institute for Occupational Safety and Health (NIOSH), 22 million workers are exposed to hazardous noise annually, and 4.1 million workers are exposed to higher than the recommended exposure of 85 dBA for 8 hours of work noise levels daily (Sayler et al., 2020)[3].

Workplace noise is rising in many developing nations as economies move from an agrarian to a more industrial base, despite some research suggesting that occupational noise exposure may be lowered gradually in certain industrialized countries (Themann et al., 2019)[4]. Workers' exposure to noise in the workplace rises as nations grow, and due to the unnoticed impacts of noise pollution, awareness of it has always been low. However, as urbanization has increased in recent years, noise has become a more significant social, environmental, and health issue (Dulay et al., 2018)[1].

Full-time workers in the Philippines experienced hearing damage from noise exposure in enclosed facilities, such as steel plants and textile mills, where noise levels ranged from 86 to 119 dBA. Additionally, production businesses have decreased productivity and increased disciplinary proceedings, absenteeism, and accidents due to noise exposure between 80 and 99 dBA (Mancilla, 2021)[5].

Constant exposure to environmental stressors like noise at work can harm workers' comfort and performance since they interfere with their ability to focus. The latter is highly concerning because it impacts a worker's productivity and efficiency, which results in a loss in profit for any business or industry. Companies nowadays often use an open layout to foster teamwork, productivity, and communication, yet, studies by experts show that these available, interactive areas increase workplace noise (Al-Omari et al., 2017)[6].

Occupational noise in the manufacturing sector is frequently seen in the field. Production establishments in industrialized locations produce noise that impacts work performance among employees (Kumie et al., 2016)[7]. As observed in the LPG-refilling site in Dunggo-an, Danao City, Cebu, noise from the machines and other noise-inducing activities is noticeable and prevalent. Completing a specific task for workers, such as

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filling up a 170-gram LPG canister and capping 40 LPG canisters, requires great focus to achieve the target production. Thus, the researchers aimed to evaluate workplace noise's relationship to workers' performance in terms of their duration in completing a task in production. This study also examined how employing earmuffs to block out noise affects how long it takes to complete a task. Using the study's findings as a guide, the researchers formulated an action plan to reduce worker exposure to machine noise that interferes with their ability to perform appropriately.

II. RESEARCH METHODOLOGY

This part presents the research process flow, environment, respondents, instruments, procedures of data gathering, treatment of data, and definition of terms. This study used Experimental and Quantitative research designs. The primary tool in data gathering was observations and experimentation in the filling and capping of the LPG Canister using and not using earmuffs.

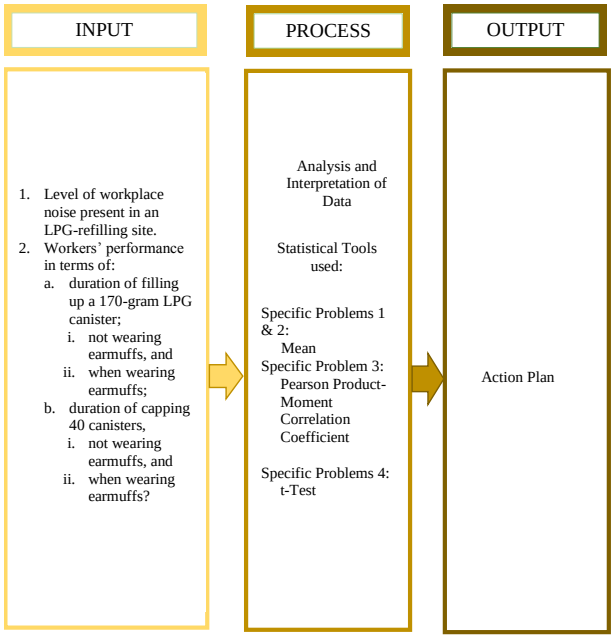

Figure No. 1

Figure No. 1 shows the flow of the research that serves as a guide throughout the study. The research process is composed of three sections. Section A shows the basis to determine the relationship between workplace noise level and performance (1) the level of workplace noise in the site, and (2) the workers' performance in terms of the duration of completing a task without and with earmuffs. Section B shows the process and computation of the data based on section A using statistical tools. Mean was used in specific problems 1 and 2. For particular problem 3, the statistical tool used was Pearson Product-Moment Correlation Coefficient; for specific problem 4, the statistical tool used was a T-test. Section C is the output or the final result of the study.

This study is conducted through observation in the LPG-refilling site, located in Dunggo-an, Danao City, 2.1 kilometers from the National Highway Road. It has 98 employees, with 92 production workers and six maintenance employees. The operation started in 2019. The refilling site is located at the edge of the Dry Dock and surrounded by mangroves and sea. The area outside the plant has only one convenience store that makes insufficient noise to distract the production. Horns from the ships are sometimes audible in the site relative to their distance from the site. The area where production happens is a closed facility, designed with open space where machines are not isolated. No intermittent noise is present from the neighboring establishments, roads, or even houses near the area. Hence, the noise intensity produced by machines is audible to the production workers.

The research respondents are the production workers of the LPG-refilling site. The total population of production workers in the plant is 72. Only the 36 production workers present during the observation were considered respondents, and they all agreed to participate in this study. Hence, other employees and production workers who were absent during that day were not considered respondents.

This study was conducted through observations to collect primary data from the production. The instruments used during the observation were a stopwatch, a sound level meter, and earmuffs.

At the beginning of the study, consent was given by the school administrator. An inquiry was made to the LPG-refilling site to conduct the study on their employees. The refilling plant asked for a consent letter signed by the research adviser, Engr. Delfa G. Castilla, then complied by the researchers before data gathering. Afterward, the Plant Supervisor notified the employees that the researchers would conduct an observation during the site visit. The researchers manually wrote the gathered data on the prepared observation sheet. During the observation, the tasks were two - filling the LPG canisters and putting caps in each canister to secure the product's safety.

Throughout the study, a stopwatch was used to record the duration of a worker completing a task without earmuffs as a measure of performance. One of the tasks was filling up a 170-gram canister with LPG, which was recorded three times. Another task was putting caps on 40 canisters, which was recorded three times. Each production worker performs a specific task. The same stopwatch was also used to record the duration of a worker in completing a specific task with earmuffs. Simultaneously, a sound level meter was also used to measure the noise level in the area. In measuring the noise level present in the workplace, the researchers recorded the noise level near where the worker is positioned during his work. The collected data were analyzed and calculated with the use of statistical tools.

The data gathered from the observation were analyzed using appropriate statistical tools, specifically Mean, Pearson

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Product-Moment Correlation Coefficient, and t-Test. Mean was used to identify the central measure of the workplace noise level and the work performance (duration of completing a task). Pearson Product-Moment Correlation Coefficient was used to determine the significant relationship between the workplace noise level in the LPG-refilling site and workers' performance in terms of the duration of completing a task, such as filling up a 170-gram canister with LPG and capping 40 canisters. The t-Test was used to determine the significant difference in workers' performance in completing a task, such as filling up a 170-gram canister with LPG and capping 40 canisters, with and without earmuffs.

III. PRESENTATION, INTERPRETATION, AND ANALYSIS OF DATA

The data presented, analyzed, and interpreted in this chapter pertain to the relationship between the workplace noise level and workers' performance in the LPG-refilling site, as well as the significant difference in workers' performance with and without earmuffs. The results were derived through observation and analyzed with appropriate statistical tools.

3.1 Workplace Noise Level

Table I
Average Workplace Noise Level in Different Areas Where Tasks are Executed

Variable	Mean (dB)	Standard Noise Level (dB)
Area of filling up a 170-gram LPG canister	94.03	85
Area of capping 40 LPG canisters	93.58	

Table No. 1 shows the average noise level in decibels (dB) present in the work areas where they execute production tasks. The table shows that the intermediate noise level of filling up a 170-gram LPG canister is 94.03 dB. An average noise level of 93.58 dB is present in the same production of capping 40 LPG canisters. The results above correlate to the study of Owoyemi et al. (2016), revealing that equipment in manufacturing factories generates noise levels that cause environmental, health, and safety concerns[8]. Biabani et al. (2017) also strengthened the study mentioned above, revealing that sources of high noise levels in industrial facilities are associated with the machinery used on the site[9]. According to the National Institute for Occupational Safety and Health (NIOSH), the recommended exposure limit for workers is 85 dB for 8 hours of work, as indicated in other research and reinforced in Sayler et al. (2020)[3]. Results from data suggest that the noise level present in the LPG-refilling site is higher than the recommended workplace noise exposure for workers.

As mentioned in the study of Józwik et al. (2018), the permissible noise levels in the work environment, especially the industry that needs that proper hearing protection, should not exceed 85 dB for an 8-hour working day[10]. Hence, the above data is concerning for work safety and health.

3.2 Work Performance

Table II
Average Duration of Filling Up 170-Gram Lpg Canister with And Without Earmuffs

Duration of filling up a 170-gram LPG canister (seconds)	
Variable	Mean
Without Earmuffs	5.19
With Earmuffs	3.99

Table 2 presents the workers' performance regarding the average duration of filling up a 170-gram LPG canister with and without earmuffs in seconds. Filling up a 170-gram LPG canister without earmuffs takes 5.19 seconds. Visible in the last row of Table No. 4, the duration of filling up a 170-gram LPG canister with earmuffs is 3.99 seconds. The decrease in the duration of filling up a 170-gram LPG canister when using earmuffs is a piece of evidence that hearing protectors are proven to be effective in reducing the workers' exposure to high levels of noise which increases production, as mentioned in the study of Kim et al. (2019). The results above exhibited the advice from Kozlowski et al. (2019) that hearing protection is the only way to lessen employees' noise exposure. A study by Leshchinsky (2018) also revealed that not wearing hearing protectors can lead to hearing loss, negatively affecting overall productivity[11]. As a result, the findings imply that employees should use hearing protection to improve work performance among manufacturing workers.

Table III
Average Duration of Capping 40 Canisters With and Without Earmuffs

Duration of capping 40 LPG canisters (seconds)	
Variable	Mean
Without Earmuffs	39.26
With Earmuffs	30.04

Showed in Table No. 3 is the workers' performance in terms of the average duration of capping 40 canisters with and without earmuffs in seconds (s). The average period of putting a cap to 40 LPG canisters without earmuffs is 39.26 seconds. Meanwhile, placing a cap on 40 LPG canisters with earmuffs has an average duration of 30.04 seconds.

According to Kim et al.'s (2019) study, using hearing protectors has been shown to help minimize employees' exposure to loud noise, which increases performance[12]. One

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indication of this concept in this study is the reduced time in capping 40 LPG canisters. The findings corroborate Kozlowski et al. (2019)'s recommendation that the solution to reduce the amount of employee noise exposure is by wearing hearing protection[13]. According to a study by Leshchinsky (2018), not wearing hearing protection might cause hearing loss, which has a detrimental impact on productivity[11]. Thus, based on the findings above, it is necessary to wear hearing protection to improve production workers' work performance.

3.3 Relationship between Noise Level and Performance of Workers

Table IV
Pearson Product-Moment Correlation Coefficient for The Relationship of Noise Level and Duration of Filling Up LPG Canister

Variable	Mean	r-tabulated value	r-computed value
Noise Level (dB)	94.03	0.4227	0.608777308
Duration of filling up a 170-gram LPG canister (s)	5.19		

Table No. 4 illustrated the relationship between workplace noise level and duration of filling up a 170-gram LPG canister using the appropriate statistical tool, Pearson Product-Moment Correlation Coefficient (r). From the table, the r-computed value (0.608777308) is greater than the r-tabulated value (0.4227), which means that the null hypothesis should be rejected. The decision indicates a significant relationship between the noise level present in the workplace and the duration of filling up a 170-gram LPG canister. The positive value of r = 0.608777308 implies a moderate significant relationship between the noise level and the task duration; as the noise level increases, the task completion period increases. This result is related to the study of Khajenasiri et al. (2016), revealing that noise exposure is considered one of the significant environmental factors that stress workers, which affects their cognitive function, especially in their manual tasks at work[14]. Research by Themann et al. (2019), which found that excessive noise levels are associated with a considerable decline in life quality that impacts a person's commitment to duties and performance, is congruent with this result[4]. Similar results were also revealed in the study of Lu et al. (2020), indicating the negative impacts of increased noise levels, which consequently affect workers' overall performance[15]

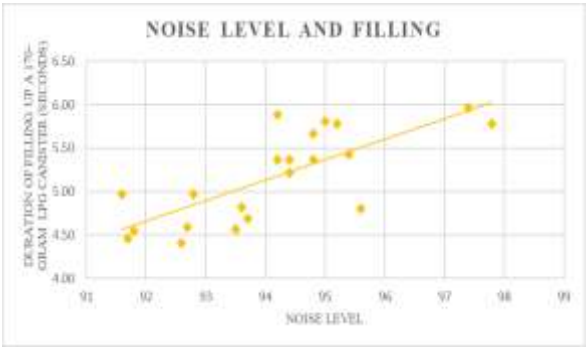

Figure No. 2 - Trend of The Noise Level and The Duration of Filling Up A 170-Gram LPG Canister

Figure No. 2 illustrates the trend of the noise level and the duration of filling up a 170-gram LPG canister. The graph shows a positive inclination indicating a significant relationship between the noise level and the task duration. The trendline implies that the time to perform the task increases as the noise level increases. The result means that the higher the noise level, the lower the workers' performance, which takes longer to fill up a 170-gram LPG canister.

Table V
Pearson Product-Moment Correlation Coefficient for the Relationship of Noise Level and Duration for Capping

Variable	Mean	r-tabulated value	r-computed value
Noise Level (dB)	93.58	0.5324	0.858239741
Duration of capping 40 LPG canisters (s)	39.26		

Table No. 5 used the appropriate statistical instrument, the Pearson Product-Moment Correlation Coefficient (r), to illustrate the relationship between workplace noise level and the duration of time spent capping 40 LPG canisters. Since, as shown in the table, the r-computed value (0.858239741) is greater than the r-tabulated value (0.5324), the researchers reject the null hypothesis. The decision indicates a significant relationship between the noise level present in the workplace and the duration of capping 40 LPG canisters. The positive value of r = 0.858239741 implies a strong significant relationship between the noise level and the task completion time; as the noise level increases, the task duration increases. This finding is connected to the Khajenasiri et al. (2016) study, which showed that noise exposure is one of the significant environmental stressors for workers since it impacts their cognitive performance, mainly when doing manual duties at work[14]. A recent study by Lu et al. (2020) similarly revealed that increasing noise level has detrimental

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effects on people's performance and health. This result also correlates with the research of Themann et al. (2019), stating that high noise level is linked to a significant decrease in the quality of life that concerns a person's responsibilities and performance[15].

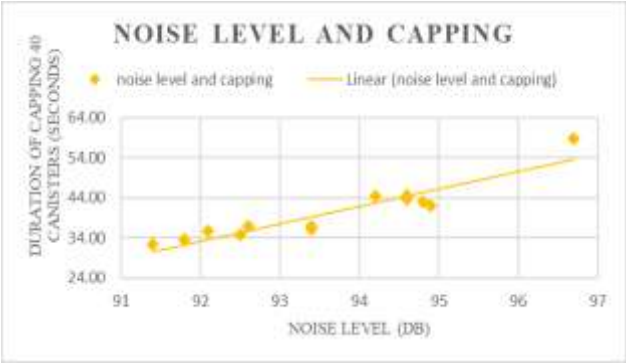

Figure No. 3 - Trend of The Noise Level and the Duration of Capping 40 Canisters

The time of capping 40 canisters and the trend in noise level is shown in Figure No. 3. The graph indicates a positive inclination, showing a significant correlation between the task's duration and the noise level. The trendline suggests that the job takes longer to complete as the noise level rises. The results reveal that workers perform poorly in capping 40 canisters at increased noise levels.

3.4. Significant Difference between Performance of Workers with and without Earmuffs

Table VI
T-Test for the Difference Between the Duration of Filling Up LPG Canister With and Without Earmuffs

Duration of filling up 170-gram LPG canister (s)					
Variable	Mean	df	α	Lower Critical Value	t-computed value
Without Earmuffs	5.19	39	0.05	-2.0227	-8.4707
With Earmuffs	3.99				

Table No. 6 shows the t-Test to analyze the significant difference between the duration of filling up a 170-gram LPG canister with and without earmuffs. From the table, the t-computed value (-8.4707) is less than the lower critical value (-2.0227) which means that the null hypothesis should be rejected. The decision indicates that there is a significant difference between the duration of filling up a 170-gram LPG canister with and without earmuffs. Based on the mean column, it is evident that the duration of filling up a 170-gram LPG canister without earmuffs (5.19) is higher than with earmuffs (3.99), implying that completing a task with earmuffs in an environment where noise is present is faster than not wearing it. Results correlate to the study of Kim et al. (2019) which proved that hearing protectors (earplugs/earmuffs) are beneficial for reducing worker exposure to noise, which will improve performance and lower the incidence of stress-related illnesses that affect overall productivity. According to a separate study by Kozlowski et al. (2019), reducing the amount of noise that employees are exposed to through the use of engineering interventions like hearing protection is the best strategy to improve work performance[13]. The findings supported the study of Leshchinsky (2018), which recommends the use of hearing protection when noise is prevalent at work[11].

Table VII
T-Test for the Difference Between the Duration of Capping Canisters With and Without Earmuffs

Duration of capping 40 LPG canisters (s)					
Variable	Mean	df	α	Lower Critical Value	t-computed value
Without Earmuffs	39.26	22	0.05	-2.0739	-3.6810
With Earmuffs	30.04				

Table No. 7 shows the t-Test to analyze the significant difference between the duration of capping 40 LPG canisters with and without earmuffs. Since the t-computed value (-3.6810) is less than the lower critical value (-2.0739), the null hypothesis should be rejected.

The decision indicates that there is a significant difference between the duration of capping 40 LPG canisters with and without earmuffs. From the mean column, it is clear that capping 40 LPG canisters took longer without earmuffs (39.26) than it did with them (30.04), which suggests that wearing earmuffs can speed up a process in a noisy environment.

The 5 findings are in line with the study of Kim et al. (2019), which demonstrated the value of hearing protectors (earplugs/earmuffs) for lowering worker noise exposure. This will improve performance and reduce the likelihood of stress-related illnesses, which have a negative impact on overall productivity[12]. Another study from Kozlowski et al. (2019) shows a correlation to the findings of this study, wherein the way to increase work performance is to lessen the amount of noise received by workers with the use of engineering interventions like hearing protection [13]. The results agreed to the study of Leshchinsky (2018) that encourages the utilization of hearing protectors when noise is present in the workplace [11].

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3.5 Cost Savings of Using Earmuffs

Table VIII
Cost Savings of Using Earmuffs in an 8-Hour Production

8-hour Production Cost Savings					
Average duration of producing a filled and capped 170-gram LPG canister without earmuffs (s)	Average duration of producing a filled and capped170-gram LPG canister with earmuffs (s)	Cost of a 170-gram canister (Pesos)	Revenue without earmuffs (Pesos)	Revenue with earmuffs (Pesos)	Difference in Revenue (Cost savings of using earmuffs in Pesos)
6.17	4.74	11.20	42,470.40	55,283.20	12,812.80

Table 8 shows the cost savings of using earmuffs in an 8-hour production of 170-gram LPG canisters. The table presents the average duration of producing a filled and capped 170-LPG canister with and without earmuffs derived from the combined mean duration of completing a task (filling and capping) to a single canister.

The third column presents the refilling plant's selling price for a filled and capped 170-gram canister. For an 8-hour production, the site's revenue if production workers are not wearing earmuffs is 42,470.40 pesos. On the other hand, the revenue of the refilling site in an 8-hour shift where workers wear earmuffs is 55,283.20 pesos. The result means that the difference in revenue when using and not using earmuffs is 12,812.80 pesos, implying there will be a cost savings of 12,812.80 pesos if the production uses earmuffs.

This finding indicates that earmuffs are substantial in producing more outputs in production. Hence, there will be an increase in revenue when using earmuffs, which creates cost savings for the subsequent cost of production.

IV. FINDINGS

This study found out that the level of noise present in the production workplace of an LPG-refilling site is higher than the recommended level of workplace noise exposure of workers. From the gathered data, it was also found out that the duration of filling up a 170-gram LPG canister not using earmuffs is lesser than wearing earmuffs; hence, there is a low performance when earmuffs are not used in noisy workplace. Similarly, capping 40 canisters when earmuffs are not used revealed a lower performance in terms of its duration of performing the task than executing the task with earmuffs. Statistically, the results show a significant relationship between workplace noise level and workers' performance. A positive value of r signifies a significant relationship between the noise level present in the workplace and the time it takes to fill a 170-gram LPG canister. The results similarly revealed the significant relationship between the noise level present in the workplace and the duration of capping 40 LPG canisters. Thus, when the noise level increases, the task duration also increases. This generally implies that workers' performance declines as the level of noise increases in the workplace. This study also found that there is a significant difference between the duration of completing the task, capping and filling, with and without earmuffs. This finding revealed that completing a task with earmuffs is faster than not wearing them in an environment where a high level of noise is present. Protective gear such as earmuffs increase work performance and protect production workers from any related hearing accidents. This study further found out that the revenue when earmuffs are used in the production increases; hence, the use of earmuffs creates cost savings of 12,812.80 pesos for the subsequent cost of production.

V. CONCLUSION

The researchers concluded that there is a significant relationship between noise levels and workers' performance at the LPG-refilling site in Dunggo-an, Danao City. This means that the duration of completing a task takes longer as levels of noise in the workplace increase. It is also concluded that it is substantial to implement the proper utilization of earmuffs to reduce the noise received by the workers and to improve their performance in terms of the duration of completing a task.

VI . REFERENCE

[1] Dulay, L. E., Galvan, M. D., Puyaoan, R. J., Sison, A. A., Natanauan, N. S., & Hernandez, P. M. (2018). Occupational Noise Exposure of Traffic Enforcers in Selected Streets in the City of Manila. Manila: Acta Medica Philippina.

[2] Said, M. A., Wellun, Z., & Khami, N. K. (2021). Effects of Noise Hazards towards Physiology Especially Heart Rate Performance among Worker in

Manufacturing Industry and Their Prevention Strategies: A Systematic Review. Iran J Public Health. doi:10.18502/ijph.v51i8.10251P.

[3] Sayler, S. K., Rabinowitz, P. M., Galusha, D. H., Sun, K., & Neitzel, R. L. (2020). Hearing Protector Attenuation and Noise Exposure Among Metal Manufacturing Workers. Ear Hear. doi:10.1097/AUD.0000000000000650

[4] Themann, C. L., & Masterson, E. A. (2019). Occupational noise exposure: A review of its effects, epidemiology, and impact with recommendations for reducing its burden. The Journal of the Acoustical Society of America. Retrieved from https://doi.org/10.1121/1.5134465J. Eggers, J. Su and B. Girod," Robustness of a Blind Image Watermarking Scheme", Proc. IEEE Int. Conf. on Image Proc., Vancouver, 2000.

[5] Mancilla, O. M. (2021). Impact Assessment of Workers on Short Term Exposure within the Recommended Permissible Noise Exposure Limit (85 - 90 dBA). Dasmariñas: Scientific Research. doi:10.4236/oalib.1106770

[6] Al-Omari, K., & Okasheh, H. (2017). The Influence of Work Environment on Job Performance: A Case Study of Engineering Company in Jordan. Research India Publications. Retrieved from http://www.ripublication.com

[7] Kumie, A., Amera, T., Berhane, K., Samet, J., Hundal, N., Michael, F. G., & Gilliland, F. (2016). Occupational Health and Safety in Ethiopia: A review of Situational Analysis and Needs Assessment. Ethiopian Journal of Health Development.

[8] Owoyemi, M. J., Falemara, B., & Owoyemi, A. J. (2016). Noise pollution and control in wood mechanical processing wood industries.

[9] Biabani, A., Aliabadi, M., Golmohammadi, R., & Farhadian, M. (2017). Individual fit testing of hearing protection devices based on microphone in real ear. Safety and health at work, 8(4), 364-370.

[10] Józwik, J., Wac-Włodarczyk, A., Michałowska, J., & Kłoczko, M. (2018). Monitoring of the noise emitted by machine tools in industrial conditions. Journal of Ecological Engineering, 19(1), 83-93.

[11] Leshchinsky, A. (2018). The Impact of Annual Audiograms on Employee's Habits and Awareness Regarding Hearing Protection and Noise Induced Hearing Loss, On and Off the Job. Retrieved from https://journals.sagepub.com/doi/epub/10.1177/2165079917743020

[12] Kim, J., Yang, S., Chung, I., & Lee, M. (2019). The effect of earplug training on noise protection. Retrieved from https://synapse.koreamed.org/articles/1138913

[13] Kozlowski, E., & Mlynski, R. (2019). Selection of Earmuffs and Other Personal Protective Equipment Used in Combination. Int. J. Environ. Res. Public Health.

[14] Khajenasiri, F., Zamanian, A., & Zamanian, Z. (2016). The Effect of Exposure to High Noise Levels on the Performance and Rate of Error in Manual Activities. Retrieved from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4844473/

[15] Lu, S., Huang, Y., & Lin, K. (2020). Spectral Content (colour) of Noise Exposure Affects Work Efficiency. Retrieved from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7986458/