International Journal of Scientific & Technology Research

IJSTR >> Volume 8 - Issue 11, November 2019 Edition

International Journal of Scientific & Technology Research

Website: http://www.ijstr.org

ISSN 2277-8616

Occupational Health And Productivity In Noise Exposure And Room Layout

[Full Text]

AUTHOR(S)

A. Muhammad Idkhan, Fiskia Rera Baharuddin

KEYWORDS

Ergonomic, Human Factor, Pollution, Working in conditions, Work Environment

ABSTRACT

Comfort at work will significantly affect the level of productivity and personal health of workers or students. Research conducted comparing the phenomena that occur with the standard values issued by official institutions. The research was in the machine tool laboratory of the Engineering Faculty, Universitas Negeri Makassar. The research conducted is qualitative and quantitative. The parameters tested in the study are the noise level and room layout. Primary data obtained from the results of noise measurements with Sound Level Meters on average per 10 minutes later for room layout through direct measurement and then distribution of questionnaires to see the perception of the workers. Data needed in research analysis take and analyzed using the IBM SPSS Program. From the results of the study obtained an acoustic level (noise) with a value of 82.14 dB (A), while the ideal standard for space is 85 – 90dB (A), then the design of the room with the results of 41.48 square meters, while the ideal standard for each work unit ranges from 64 meters square. From these results it is necessary to check the noise threshold every year so that the comfort and health of the workers maintained. Room patterns that still tend to be narrow, not following applicable standards will indirectly reduce productivity at work, and there is a tendency to not pay attention to comfort and safety in the laboratory or workshop

REFERENCES

[1] P. Josephson, Industrialized nature: Brute force technology and the transformation of the natural world. Island Press, 2002.
[2] J. A. Veitch and R. Gifford, "Choice, perceived control, and performance

decrements in the physical environment," J. Environ. Psychol., vol. 16, no. 3, pp. 269–276, 1996.
[3] D. MacLeod, The ergonomics edge: improving safety, quality, and productivity. John Wiley & Sons, 1994.
[4] K. Murrell, Ergonomics: Man in his working environment. Springer Science & Business Media, 2012.
[5] S. Pheasant, Ergonomics, work and health. Macmillan International Higher Education, 1991.
[6] A. M. Idkhan and F. R. Baharuddin, "Comfort Temperature and Lighting Intensity: Ergonomics of Laboratory Room Machine Tools," Int. J. Environ. Eng. Educ., vol. 1, no. 2, pp. 53–58, 2019.
[7] J. A. E. Eklund, "Relationships between ergonomics and quality in assembly work," Appl. Ergon., vol. 26, no. 1, pp. 15–20, 1995.
[8] K. Krüger, C. Petermann, C. Pilat, E. Schubert, J. Pons-Kühnemann, and F. C. Mooren, "Preventive strength training improves working ergonomics during welding," Int. J. Occup. Saf. Ergon., vol. 21, no. 2, pp. 150–157, 2015.
[9] J. A. E. Eklund, "Ergonomics and quality management—humans in interaction with technology, work environment, and organization," Int. J. Occup. Saf. Ergon., vol. 5, no. 2, pp. 143–160, 1999.
[10] J.-M. Hoc, "From human–machine interaction to human–machine cooperation," Ergonomics, vol. 43, no. 7, pp. 833–843, 2000.
[11] M. Helander, A guide to human factors and ergonomics. Crc Press, 2005.
[12] A. Chapanis, Human factors in systems engineering. John Wiley & Sons, Inc., 1996.
[13] F. W. Taylor, Scientific management. Routledge, 2004.
[14] C. T. Thackrah, The effects of arts, trades, and professions on health and longevity. Science History Publications/USA, 1985.
[15] F. B. Gilbreth, Motion study: A method for increasing the efficiency of the workman. D. Van Nostrand Company, 1911.
[16] E. Mayo, The human problems of an industrial civilization. Routledge, 2004.
[17] F. E. Thurston, "The worker's ear: A history of noise-induced hearing loss,"Am. J. Ind. Med., vol. 56, no. 3, pp. 367–377, 2013.
[18] World Health Organization, The world health report 2006: working together for health. Geneva, Switzerland: World Health Organization, 2006.
[19] C. M. Mak and Y. P. Lui, "The effect of sound on office productivity," Build. Serv. Eng. Res. Technol., vol. 33, no. 3, pp. 339–345, 2012.
[20] R. K. Yin, Applications of Case Study Research. Thousand Oaks, California: Sage Publications, 2011.
[21] W. J. Gastmeier and J. L. Feilders, "ISO 1996" Acoustics-Description and measurement of environmental noise" round robin testing," Can. Acoust., vol. 29, no. 4, pp. 34–35, 2001.
[22] ANSI, "Quantities and Procedures for Description and Measurement of Environmental Sound—Part 4: Noise Assessment and Prediction of Long-term Community Response." American National Standards Institute New York, 2005.
[23] Badan Standarisasi Nasional, "SNI 7231:2009 Metoda pengukuran intensitas kebisingan di tempat kerja," Jakarta, Indonesia, 2009.
[24] R. Nester, "Occupational Safety & Health Administration," Workplace Health Saf., vol. 44, no. 10, pp. 493–499, 1996.
[25] M. J. Crocker, Encyclopedia of acoustics. John Wiley, 1997.
[26] B. M. Pulat, Fundamentals of industrial ergonomics. Waveland PressInc, 1997.
[27] N. Tahir, S. M. Aljunid, J. H. Hashim, and J. Begum, "Burden of noise induced hearing loss among manufacturing industrial workers in Malaysia," Iran. J. Public Health, vol. 43, no. Supple 3, pp. 148–153, 2014.
[28] R. S. F. Schilling, Occupational health practice. Butterworth-Heinemann, 2013.
[29] J. M. Harrington and F. S. Gill, Occupational health. Blackwell Scientific Publications, 1983.
[30] J. Fraden, Handbook of modern sensors: physics, designs, and applications. Springer Science & Business Media, 2004.
[31] P. A. Tipler and G. Mosca, Physics for scientists and engineers. Macmillan, 2007.
[32] O. Iwata, "The relationship of noise sensitivity to health and personality,"

Jpn. Psychol. Res., vol. 26, no. 2, pp. 75–81, 1984.
[33] I. Alimohammadi, S. Sandrock, and M. R. Gohari, "The effects of low frequency noise on mental performance and annoyance," Environ. Monit. Assess., vol. 185, no. 8, pp. 7043–7051, 2013.
[34] S. A. Stansfeld and M. P. Matheson, "Noise pollution: non-auditory effects on health," Br. Med. Bull., vol. 68, no. 1, pp. 243–257, 2003.
[35] M. Basner et al., "Auditory and non-auditory effects of noise on health," Lancet, vol. 383, no. 9925, pp. 1325–1332, 2014.
[36] O. Çelik, Ş. Yalçın, and A. Öztürk, "Hearing parameters in noise exposed industrial workers," Auris Nasus Larynx, vol. 25, no. 4, pp. 369–375, 1998.
[37] J. C. Vischer, "Towards an environmental psychology of workspace: how people are affected by environments for work," Archit. Sci. Rev., vol. 51, no. 2, pp. 97–108, 2008.
[38] S. A. Oyewole, J. M. Haight, and A. Freivalds, "The ergonomic design of classroom furniture/computer work station for first graders in the elementary school," Int. J. Ind. Ergon., vol. 40, no. 4, pp. 437–447, 2010.
[39] A. S. M. Hoque, M. S. Parvez, P. K. Halder, and T. Szecsi, "Ergonomic design of classroom furniture for university students of Bangladesh," J. Ind. Prod. Eng., vol. 31, no. 5, pp. 239–252, 2014.
[40] I. W. Taifa and D. A. Desai, "Anthropometric measurements for ergonomic design of students' furniture in India," Eng. Sci. Technol. an Int. J., vol. 20, no. 1, pp. 232–239, 2017.
[41] M. L. Resnick and A. Zanotti, "Using ergonomics to target productivity improvements," Comput. Ind. Eng., vol. 33, no. 1–2, pp. 185–188, 1997.
[42] S. Y. Lee and J. L. Brand, "Can personal control over the physical environment ease distractions in office workplaces?," Ergonomics, vol. 53, no. 3, pp. 324–335, 2010.
[43] W. T. Singleton and W. H. Organization, "Introduction to ergonomics," 1972.
[44] J. C. Vischer, "The effects of the physical environment on job performance: towards a theoretical model of workspace stress," Stress Heal. J. Int. Soc. Investig. Stress, vol. 23, no. 3, pp. 175–184, 2007.
[45] J. Shinn, K.-A. Romaine, T. Casimano, and K. Jacobs, "The effectiveness of ergonomic intervention in the classroom.," Work, vol. 18, no. 1, pp. 67–73, 2002.
[46] Gensler, "The Gensler Design + Performance Index: The US Workplace Survey," 2006.
[47] Q. Jin, M. Overend, and P. Thompson, "Towards productivity indicators for performance-based façade design in commercial buildings," Build. Environ., vol. 57, pp. 271–281, 2012.
[48] L. Shoshkes, Space planning: Designing the office environment. Architectural Record Books, 1976.

Occupational Health And Productivity In Noise Exposure And Room Layout

A. Muhammad Idkhan, Fiskia Rera Baharuddin

Abstract: Comfort at work will significantly affect the level of productivity and personal health of workers or students. Research conducted comparing the phenomena that occur with the standard values issued by official institutions. The research was in the machine tool laboratory of the Engineering Faculty, Universitas Negeri Makassar. The research conducted is qualitative and quantitative. The parameters tested in the study are the noise level and room layout. Primary data obtained from the results of noise measurements with Sound Level Meters on average per 10 minutes later for room layout through direct measurement and then distribution of questionnaires to see the perception of the workers. Data needed in research analysis take and analyzed using the IBM SPSS Program. From the results of the study obtained an acoustic level (noise) with a value of 82.14 dB (A), while the ideal standard for space is 85 – 90dB (A), then the design of the room with the results of 41.48 square meters, while the ideal standard for each work unit ranges from 64 meters square. From these results it is necessary to check the noise threshold every year so that the comfort and health of the workers maintained. Room patterns that still tend to be narrow, not following applicable standards will indirectly reduce productivity at work, and there is a tendency to not pay attention to comfort and safety in the laboratory or workshop

Index Terms: Ergonomic, Human Factor, Pollution, Working in conditions, Work Environment

---

1. INTRODUCTION

Industrialization will always followed by the application of high technology that is more complex but often hurts both humans and the environment [1]. In the workplace, there are several dangers affect the work environment, such as physical, chemical, biological, ergonomic and psychological factors. A right working environment is one of the supporting factors for worker productivity, which in turn has an impact on increasing the level of performance [2].The use of materials and equipment has become an essential requirement in various jobs. It means that equipment and technology is a necessary support to increase productivity for various types of jobs. Besides, on the other hand there will be negative impacts if we are less alert to face potential dangers that may arise. It will not happen if it can anticipate various risks that affect the lives of workers [3]. The various risks are the possibility of occupational health problems, work-related diseases and work-related accidents that can cause disability or death. Adjustments between workers, work processes and work environment must carry out as a precaution against events that will result from work.Work environment where workers do their daily work, working environment conditions significantly affect a person's performance at work, where there are several factors that affect namely physical conditions (lighting, temperature, noise, vibration, and pollution) and non-physical (in the form of psychological conditions of workers, work fatigue and tired of work) [4]. Safe working environment conditions where air quality, light quality, temperature, and noise are by established standards so that workers will do their work comfortably and if working conditions exceed the specified standards can cause illnesses and accidents on workers. A condition of the work environment to be excellent or appropriate if humans who are in it can carry out their activities optimally, healthy, safe, and comfortable [5]. Suitability of the work environment can have an impact in a long time, as well as a bad work environment will result in the difficulty of obtaining an effective and efficient work system [6].Working in conditions that are not ergonomic can cause various problems, one of which is neck muscle pain [7]. Working in a standing position that carried out continuously or for an extended period causes muscle tension and limitations of neck movements that cause the occurrence of neck muscle complaints become complaints that are often experienced by welding employees when doing welding with standing position for hours [8]. One effort to increase efficiency productivity is through the application of ergonomics. Ergonomics can define as a study of human aspects and the work environment that reviewed in anatomy, physiology, engineering, and management [9].Through the ergonomics approach in the design of the workplace is to be a harmony between humans and the work system (human-machine system), or it can say that the work system design must make the workforce work properly [10]. It requires expertise in design of tools and equipment, workspace layout, work organization so that workers can work well and efficiently. Understanding ergonomics is to increase labor productivity in an institution or company can achieve if there is a match between workers and their jobs. Moreover, through this understanding it hoped that workers could increase their knowledge about the importance of ergonomics in carrying out their work [11].Chapanis [12], mentioned ergonomics is the science to explore and apply information about human behavior, abilities, limitations, and other human characteristics to design equipment, machinery, systems, work, and environment to increase productivity, safety, comfort and effectiveness of work human. Ergonomics related disciplines in workplace design include a study of work methods, anthropometry, workspace layout and facilities, work physiology and biomechanics, occupational safety and health, maintainability, relations of human behavior, and work time management.Ergonomics began in 1949, but research activities related to it had sprung up decades before, as done by Frederick W. Taylor was an American engineer who applied scientific methods to determine the best way to do a job [13]. Furthermore, in a series of activities related to the uncomfortable work environment felt by the operators in the workplace. Thackrah [14], observes posture at work as part of health problems. At that time Trackrah observed a tailor who worked with the position and dimensions of chairs that were not anthropometrically suitable, as well as non-ergonomic lighting which resulted in bowing and visual sensory

- *A. Muhammad Idkhan, Associate Professor, Department of Mechanical Engineering Education, Faculty of Engineering, Universitas Negeri Makassar, E-mail: amuhidkhan@unm.ac.id*
- *Fiskia Rera Baharuddin, Lecturer, Department of Agricultural Technology Education, Faculty of Engineering, Universitas Negeri Makassar, E-mail: fiskia.rere@unm.ac.id*

irritation.Gilbreth [15], in the study, also observed and optimized the work method, in this case more detailed in the Analysis of the Movement compared with Frederick W. Taylor. In his book Motion Study shows how bending posture can overcome by designing a table system that can adjusted up and down (adjustable). Another study conducted by Elton Mayo, an Australian citizen, started several studies at an Electric Company. The purpose of the study is to quantify the effect of physical variables such as lighting and the length of rest time on the efficiency factors of the work operators in the assembly unit [16].Workers will work continuously on every workday in the workplace. Therefore, the design of the workplace becomes essential because the success or failure of the completion of a job is determined by the optimization of the workforce. The range of sound frequencies that can hear by the human ear is approximately 20 Hz to 20,000 Hz in general amplitude with variations in the response curve. A deafening sound causes damage to the hair cells because damaged hair cells cannot grow anymore so progressive hair cell damage can occur and hear loss. Noise is a source of danger from physical factors in the workplace, which sources of danger need to control to create a healthy, safe, comfortable and productive work environment for the workforce [17]. World Health Organization (WHO) [18], reported that in 2000 there were already 250 million (4.2 percent) of the world's population experiencing hearing loss from the effects of noise in various forms.Occupational health is an activity carried out to obtain the highest degree of health, both physical, mental, and social, for the working community and the working environment. Disturbances in health and working power due to various factors in work can avoided, if there is a willingness from the leadership of the company to prevent it. When heat production is out of balance with the heat released by the body, it will produce uncomfortable working conditions [19]. Likewise, with the level of noise caused by machines that operate, if it exceeds the threshold value of human hearing, it will cause hearing loss.

2. RESEARCH METHOD

2.1 Approach of Research

Following the purpose of the study which is to examine the condition of the lecture room facilities, this study including the observation field/case studies did not test the relationship between variables. This type of research is case study, which generally categorized as exploratory research [20].In the study, the researcher made a comparison of the status of the phenomenon with its standard, which is comparing the results of measurements in the field with the standard and the results of the calculation following its users. Before conducting research, researchers must prepare a solid foundation as a standard reference to measure the extent to which these measurements meet the standards.

2.2 Measurement Procedure

Noise measurements made with a Sound Level Meter. This tool consists of a microphone, circuit, and reading display. The microphone will detect air pressure that varies, which then, with a sound, will convert it into an electrical signal. This signal will then be processed by an electronic circuit. Readings will see in decibels (dB) [21].The standard operating procedures for noise measurement [22], [23] are as follows:

- Turn on the noise intensity meter.
- Check the battery condition, make sure the power is in good condition, and make sure the weighing scale.
- Adjust the weighting of the measuring instrument response time to the characteristics of the measured sound source (S for relatively constant sound sources or F for shock sources).
- Position the measuring instrument microphone as high as the position of the human ear at work. Avoid sound reflection from the body or sound source barrier.
- Navigate the measuring instrument microphone with the sound source following the characteristics of the microphone (microphone perpendicular to the sound source, 70 – 80degrees from the sound source).
- Select the sound pressure level (SPL) or the equivalent continuous sound pressure level (Leq) Adjust it to the measurement objective.

Sound Level Meter has a weighting or scales A, B, and C. For the measurement of noise levels used scale A. This scale is a noise scale that is sensitive to high frequencies and is best suited to human hearing. Scale B gives a good response for low frequencies, while for C scale provides the best response to low frequencies. Noise checked by measuring the sound pressure level dB (A) for 10 minutes for each measurement.

2.3Laboratory Layout

The research was in the machine tool laboratory of the Engineering Faculty, Universitas Negeri Makassar. The complete facilities and machine tools available at these locations are the reasons researchers set as research locations. Workshops, laboratories, and workshops are all available and still function properly. The layout of the research location can see in Figure 1 below.

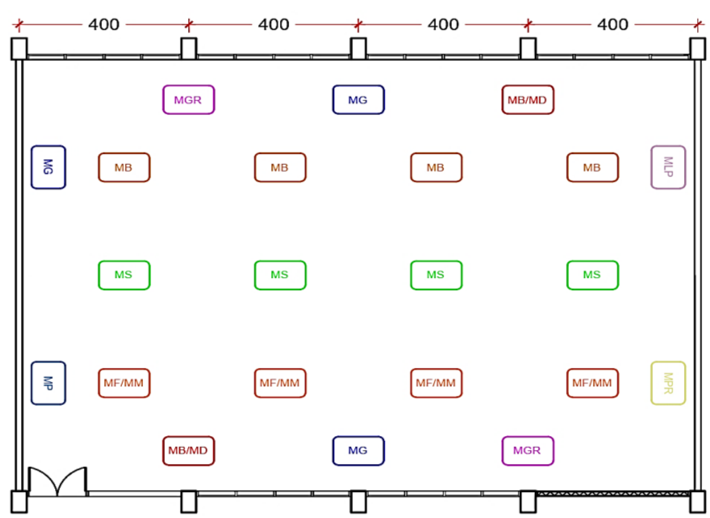

***Fig. 1**. Layout Laboratory Tooling Machine Unit (Research Location).*

MB	:	Lathe Machine
MS	:	Shipper Machine
MF/MM	:	Milling Machine
MD	:	Drilling Machine
MG	:	Grinding Machine
MP	:	Cutting Machine
MLP	:	Plate Folding Machine

MPR : Press Machine
MGR : Sawing Machine

2.4Data Collection and Analysis

This research conducted in four stages. The first step is to determine the area that will use as a sampling point. The second stage of measuring noise using a sound level meter. The third stage is the distribution of questionnaires to workers in each area. The fourth stage is the last stage, which is a combination of the previous stages, where the measurement results obtained compiled to obtain the value of noise intensity, measurement of laboratory space layout, and worker perceptions. The research conducted is qualitative and quantitative. Data needed in research analysis taken and analyzed using the IBM SPSS Program. To get the data, a sound level meter needed to calculate the average noise intensity value per 10 minutes and the distribution of questionnaires to processed using statistics.

3. RESULT AND DISCUSSION

3.1 Noise (Acoustic)

Noise occurs when annoying or unwanted sounds are intense and can affect human performance and health. Sources of work noise include the vibration of buildings, machinery, or engine components. The results of the noise measurements that have obtained can presented in the table below as follows.

Table 1.Noise measurement results (dB) of the Machine Tool Unit Laboratory

No	Observation Time	Observation Point (dB)				
		TP1	TP2	TP3	TP4	TP5
TT	07.30-08.00	83.60	83.20	83.50	83.80	83.90
TT	08.00-08.30	83.50	83.20	83.10	83.60	83.70
T1	08.30-09.00	82.70	82.50	82.30	83.40	82.90
T1	09.00-09.30	81.80	82.40	83.70	81.90	83.70
T2	09.30-10.00	82.10	82.40	82.70	82.80	82.10
T2	10.00-10.30	82.20	82.30	82.60	82.50	82.20
T3	10.30-11.00	80.90	80.80	80.40	79.80	84.40
T3	11.00-11.30	80.50	80.60	80.80	80.90	80.70
T4	11.30-12.00	80.30	80.10	82.00	80.20	80.00
T4	12.00-12.30	81.20	81.60	81.30	81.80	82.80

The Irish Occupational Health and Safety Authority (HSA) states that if someone has difficulty hearing people speak at two meters, this indicates that there is noise at the workplace. Noise can generate by the movement of workpieces that meet a cutting tool from a rotating machine. Occupational noise exposure assessed by measuring the allowable noise level obtained daily. The measurement point layout can see in Figure 2 as follows.

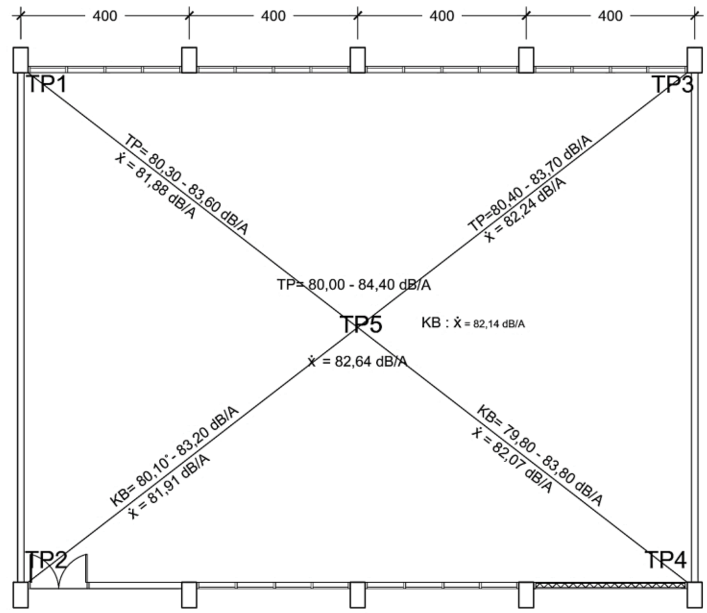

Fig. 2*.Noise measurement (dB) Layout of Machine Tool Unit Laboratory*

In Indonesia there are a number of laws that regulate the existence of a threshold value for Noise, namely the Decree of the Minister of Health of the Republic of Indonesia of 2004 concerning the Environmental Health Requirements of the Hospital stating that the noise quality standards contained in the hospital laundry room has a required value of 78 dB (A) with a condition of exposure time of 8 hours. According to the Decree of the Minister of Environment of 1996 concerning Noise Level Standards states that the noise level standard in the hospital environment is 55 dB (A), whereas according to the Regulation of the Minister of Health of the Republic of Indonesia of 1987 concerning Noise Related to Health states that hospitals are part of the zone A with a maximum noise intensity limit of 45 dB (A).Then the Decree of the Minister of Manpower and Transmigration for the allowable noise threshold value of 85 dB (A). If it has exceeded the threshold value, it required to use Personal Protective Equipment. This threshold value uses benchmarks of workplace noise that can be accepted by workers without causing illness or health problems in their daily work for a time not exceeding 8 hours a day or 40 hours a week. The US Department of Labor Occupational Safety & Health Administration (OSHA) Regulations on the protection of workers against noise exposure in factories state a permissible noise threshold of 90 dB (A). OSHA Occupational Noise Exposure states that workers who pass a certain threshold must protect by companies either through engineering or personal protection equipment [24]. Several countries have made provisions regarding normal noise thresholds in law, such as in the UK, West Germany, Yugoslavia, and Japan, setting a threshold value of 90 dB (A), Belgium and Brazilian 80 dB (A), Denmark, Finland, Italy, Sweden, Switzerland, and Russia 85 dBA.Based on the analysis of the measurements, it known that the average noise in the machine tool laboratory is 82.14 dB; this value is below the standard threshold value. Regulation of the Minister of Health of the Republic of Indonesia, states that a value that regulates average noise pressure or noise level based on the duration of exposure to noise, which represents the condition of almost all workers exposed to repeated noise without causing hearing loss and understanding normal speech.Noise occurs when annoying or unwanted sounds are intense and can affect human performance and health. Sources of work noise include the vibration of buildings, machinery, or engine components. Occupational noise exposure assessed by measuring the allowable noise level obtained daily. Uncontrolled and unexpected sound exposure can have stress side effects on behavior. Studies on work noise show that this is related to disturbance, health problems, work accidents, and reduced performance efficiency. It is working with a lathe that makes a loud enough sound, coupled with the sound of a rotating workpiece and the sound produced during the workpiece slicing process and the length of time working affect the auditory nerve at work so that it will create physical fatigue which can ultimately affect student performance at work.Uncontrolled and unexpected sound exposure can have stress side effects on behavior. Studies on work noise show that this is related to disturbance, health problems, work accidents, and reduced performance efficiency [25]. Noise effects other than hearing aids felt by workers exposed to loud noise complaining about nausea, weakness, stress, headaches and even increased blood pressure [26].Malaysia has an estimated 103,000 workers who potentially affected by hearing loss caused by noise (NIHL). A total of 18 industries exposed to noise levels of 86-90 dB (A) and eight industries in more than 91 dB (A) identified. There is a tendency that 89 percent of male workers exposed to higher risk compared to women who are only around 11 percent [27]. All industries in Malaysia provide regular training in the awareness of using hearing protection devices to their workers, but none of them apply it.Noise has several impacts on health. In addition to having an impact on hearing loss, high intensity noise can also result in loss of concentration, loss of balance and disorientation, fatigue, communication disorders, sleep disturbances, disruption of task performance, impaired physiology, as well as visceral effects, such as changes in heart frequency/increased pulse rate, changes in blood pressure and levels of perspiration [28], [29].The main negative impacts that arise because of noise, especially on aspects of health. A sudden, loud sound quickly followed by a muscular reflex in the middle ear, which will limit the amount of sound energy delivered to the inner ear. However, in such environments it is relatively rare. Most people who exposed to noise experience long-term exposure, which may be intermittent or continuous. Such energy transmission, if it is long enough and sharp will damage the cortical organs and subsequently can result in permanent deafness. In everyday life, the average level of human hearing during conversations is comfortable. The magnitude of this speech intensity level is 60 dB [30]. Usually, the threshold value of maximum noise exposure or the threshold of human hearing pain is 120 dB [31].The results of the study stated that people who exposed to noise tend to have unstable emotions. The emotional instability will cause stress. Stress that is long enough will cause narrowing of blood vessels so that the heart spurred to work harder to pump blood throughout the body [32], [33]. Noise causes various disruptions to the workforce, such as physiological disorders, psychological disorders, communication, and deafness disorders, or there are those who classify the disorder in the form of auditory disorders, for example, hearing and non-auditory disorders such as disrupted communication, safety hazards, decreased safety performance, fatigue and stress [34], [35].Other health problems besides hearing loss usually caused by high noise energy, which can cause physical effects, such as changes in heart frequency, changes in blood pressure, and levels of perspiration [36]. Besides, there are mild psychosocial and psychomotor effects when trying to work in a noisy environment. Noise in the workplace is often a problem for workers. Generally, comes from working machines, moving equipment, contact with metals, compressors, and so on. Unfortunately, many workers use to this habit, and even many workers do not want to wear protective equipment for the reason: do not understand, heat, tightness, not comfortable to wear, heavy, superiors also do not use. Although not complaining, health problems still occur in the future.

3.2 Layout Design

The design of a building or the right environment will cause people to feel more comfortable, safe, and productive, and vice versa, bad design will make a feeling of helplessness (powerless) and cause stress. The results of the measurement of the layout (area of space) that has obtained can be presented in Table 2 as follows.

Table 2. Layout Measurement of the Machine Tool Unit Laboratory

No	Observation Time	Observation Point (m^2)				
		TP1	TP2	TP3	TP4	TP5
TT	RP-A	41.33	42.23	42.40	41.28	41.25
TT	RP-B	42.30	41.25	41.35	40.00	42.60
T1	RP-C	41.20	41.53	41.28	41.25	41.25
T1	RP-D	42.40	41.34	40.00	42.60	42.30
T2	RP-E	41.35	40.12	41.25	41.25	41.20
T2	RP-F	41.28	40.00	42.60	42.30	42.23
T3	RP-G	41.45	41.25	41.25	41.20	41.25
T3	RP-H	41.34	42.60	41.53	42.40	41.53
T4	RP-I	41.23	42.34	41.33	41.35	41.34
T4	RP-J	41.32	41.32	42.30	41.28	40.12

The types of machines in laboratories and workshops whose layout is the object of research are as follows:

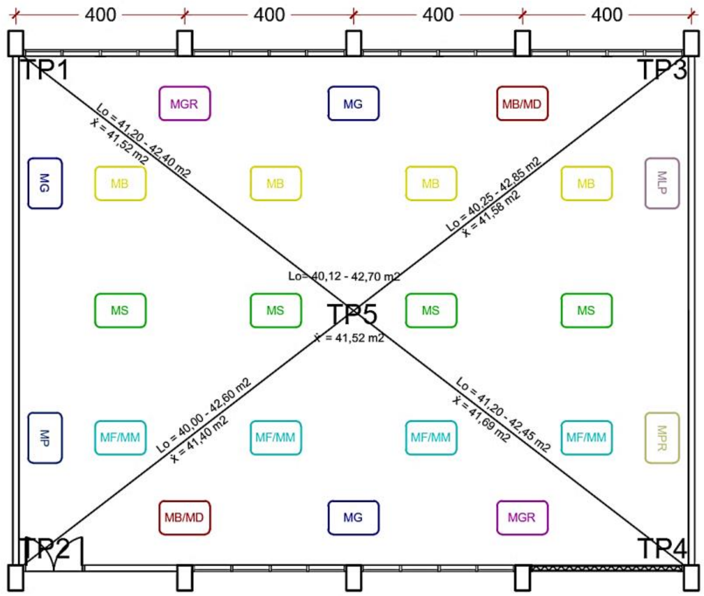

Fig. 3.*Layout Design of Machine Tool Unit Laboratory.*

Based on the analysis of the measurements, it is known that the common area of the room in the school workshop is 41.48 square meters. Regulation of the Minister of National Education of the Republic of Indonesia Number 40 of 2008 concerning laboratory facilities and infrastructure standards note that the minimum area for a lathe area is 64 square meters, and the ratio for a lathe is 8 square meters for one student.Workspace arrangements are relevant because they considerably affect the interaction of fellow workers in the environment. Workers will often interact more with other workers who are physically close. For this reason, the location or placement of machinery and equipment and workplaces can influence interactions with one another. Spaces that have walls, partitions, or other barriers have more privacy than spaces that do not have barriers [37]. In general students want a high level of privacy in their work. However, there are also some students who also want opportunities to be able to interact with colleagues, which limited by increased privacy. The desire for privacy is active in many people — privacy limits distractions, which mainly interfere with the concentration of students in performing complex tasks.The classroom is a room inside a school or campus building, which serves as a place for face-to-face activities in the teaching and learning process [38]. The classroom is also one of the factors that influence the learning process of students in receiving a lesson and influences the instructor in delivering a lesson. Creating a fun classroom will help the learning process. One element of class management is class structuring. Class structuring requires close attention and planning in the learning process. Classrooms arranged well, will make students comfortable, so concentrate on learning. Classroom structuring needs to done to create a comfortable classroom by paying attention to existing standards [39].A good classroom is a room that can use by students and lecturers to carry out teaching and learning activities comfortably so that this process also takes place successfully [40]. The comfortable conditions in question are the conditions of an ergonomic classroom. According to the Regulation of the Director-General of Elementary and Secondary Education of the Republic of Indonesia, classrooms must have a minimum size of 8 x 7 meters with several participants (students) of no more than 40 people to enable all students to move freely, not overcrowding and interfere with one student. With others when doing learning activities. In arranging seats and tables, it is vital to enabling face-to-face encounters so that the lecturer can control student behavior, also allows students to move freely. Not only that, ventilation, light regulation, temperature, and noise levels are essential assets that must considered for creating a comfortable learning atmosphere [41]. Ergonomic classrooms must design with an ergonomic approach as well, namely work attitudes and positions, anthropometry and dimensions of the workspace, working environment conditions, economic efficiency of movement and work facility management, and work energy consumed (Management, Technical work procedures). Physical working environment conditions such as temperature, lighting levels, and noise levels are among the factors that can affect one's comfort when working in a work station [42].When workers physically and emotionally have the desire to work, then the performance of workers will increase. It further stated that by having a suitable work environment, it could reduce absenteeism and ultimately can improve performance, which can ultimately increase worker productivity. Other studies have shown positive effects when applying adequate work environment strategies such as the design of placing machines, work design, environment, and facility design [43]. The design of a building or a pleasant environment will cause people to feel inside it will feel safe, comfortable, which will ultimately make people more productive, and vice versa bad design will make the feelings of people who are in it will be stressed and uncomfortable, likewise, with a work environment design [44]. A good work environment design will cause students to feel comfortable, safe, and productive.Adequate classroom standardization needs to established. It aims to increase comfort in learning because classrooms influence learning to achieve goals. Uncomfortable room, triggering the appearance of density. The density that occurs in the classroom has an impact that is quite influential [45]. If density decreases, physical and behavioral conditions in humans can be standard. Meanwhile, if the density increases, causing a decrease in physical condition resulting in loss of mood.A study conducted [46], in the United States workplace environment regarding work design, job satisfaction, and work productivity showed that almost 22 percent improvement in performance could achieved if their offices were well designed. Employees believe that the company wants to reduce costs so that it results in poor workplace design. They recognize that their performance is affected by the quality of their work environment [47]. A functional workspace is a comfortable workspace that meets ergonomic requirements. A good design for the most widely used workspace is an open model with insulation. Between workers limited by a dividing wall that is not too high, so that workers can still interact with other colleagues. However, the drawback of this form of workspace model is that workers no longer have privacy, experience concentration disturbances when colleagues next to them speak loudly on the phone. When compared to the closed model workspace where workers are given a separate room, workers will feel faster to get tired and bored, in addition to the funds and a large enough place needed to support it. So that this cubicle workspace model more widely used in offices today [48].

4 CONCLUSIONS

Noise occurs when annoying or unwanted sounds are intense and can affect performance and health. The laboratory is a room that uses for purposes. There are procedures and regulations for accessing the laboratory. A suitable laboratory must equip with various facilities to facilitate laboratory users in carrying out their activities. There are facilities in the form of public facilities (utilities) and exceptional facilities. Likewise, for the arrangement of laboratories that cannot be origin in the arrangement. Like a place to live, laboratories in the manufacture must have a unique design that makes it comfortable when using, fascinating insight and, most importantly is safe for safety when used.

ACKNOWLEDGMENT

The research fully funded through the Non-Tax State Revenue Research Program at Universitas Negeri Makassar Postgraduate Program with Contract Number 2566/ UN36/LT/2018.

REFERENCES

[1] P. Josephson, Industrialized nature: Brute force technology and the transformation of the natural world. Island Press, 2002.
[2] J. A. Veitch and R. Gifford, “Choice, perceived control, and performance decrements in the physical environment,” J. Environ. Psychol., vol. 16, no. 3, pp. 269–276, 1996.
[3] D. MacLeod, The ergonomics edge: improving safety, quality, and productivity. John Wiley & Sons, 1994.
[4] K. Murrell, Ergonomics: Man in his working environment. Springer Science & Business Media, 2012.
[5] S. Pheasant, Ergonomics, work and health. Macmillan International Higher Education, 1991.
[6] A. M. Idkhan and F. R. Baharuddin, “Comfort Temperature and Lighting Intensity: Ergonomics of Laboratory Room Machine Tools,” Int. J. Environ. Eng. Educ., vol. 1, no. 2, pp. 53–58, 2019.
[7] J. A. E. Eklund, “Relationships between ergonomics and quality in assembly work,” Appl. Ergon., vol. 26, no. 1, pp. 15–20, 1995.
[8] K. Krüger, C. Petermann, C. Pilat, E. Schubert, J. Pons-Kühnemann, and F. C. Mooren, “Preventive strength training improves working ergonomics during welding,” Int. J. Occup. Saf. Ergon., vol. 21, no. 2, pp. 150–157, 2015.
[9] J. A. E. Eklund, “Ergonomics and quality management—humans in interaction with technology, work environment, and organization,” Int. J. Occup. Saf. Ergon., vol. 5, no. 2, pp. 143–160, 1999.
[10] J.-M. Hoc, “From human–machine interaction to human–machine cooperation,” Ergonomics, vol. 43, no. 7, pp. 833–843, 2000.
[11] M. Helander, A guide to human factors and ergonomics. Crc Press, 2005.
[12] A. Chapanis, Human factors in systems engineering. John Wiley & Sons, Inc., 1996.
[13] F. W. Taylor, Scientific management. Routledge, 2004.
[14] C. T. Thackrah, The effects of arts, trades, and professions on health and longevity. Science History Publications/USA, 1985.
[15] F. B. Gilbreth, Motion study: A method for increasing the efficiency of the workman. D. Van Nostrand Company, 1911.
[16] E. Mayo, The human problems of an industrial civilization. Routledge, 2004.
[17] F. E. Thurston, “The worker’s ear: A history of noise-induced hearing loss,”Am. J. Ind. Med., vol. 56, no. 3, pp. 367–377, 2013.
[18] World Health Organization, The world health report 2006: working together for health. Geneva, Switzerland: World Health Organization, 2006.
[19] C. M. Mak and Y. P. Lui, “The effect of sound on office productivity,” Build. Serv. Eng. Res. Technol., vol. 33, no. 3, pp. 339–345, 2012.
[20] R. K. Yin, Applications of Case Study Research. Thousand Oaks, California: Sage Publications, 2011.
[21] W. J. Gastmeier and J. L. Feilders, “ISO 1996" Acoustics-Description and measurement of environmental noise" round robin testing,” Can. Acoust., vol. 29, no. 4, pp. 34–35, 2001.
[22] ANSI, “Quantities and Procedures for Description and Measurement of Environmental Sound—Part 4: Noise Assessment and Prediction of Long-term Community Response.” American National Standards Institute New York, 2005.
[23] Badan Standarisasi Nasional, “SNI 7231:2009 Metoda pengukuran intensitas kebisingan di tempat kerja,” Jakarta, Indonesia, 2009.
[24] R. Nester, “Occupational Safety & Health Administration,” Workplace Health Saf., vol. 44, no. 10, pp. 493–499, 1996.
[25] M. J. Crocker, Encyclopedia of acoustics. John Wiley, 1997.
[26] B. M. Pulat, Fundamentals of industrial ergonomics. Waveland PressInc, 1997.
[27] N. Tahir, S. M. Aljunid, J. H. Hashim, and J. Begum, “Burden of noise induced hearing loss among manufacturing industrial workers in Malaysia,” Iran. J. Public Health, vol. 43, no. Supple 3, pp. 148–153, 2014.
[28] R. S. F. Schilling, Occupational health practice. Butterworth-Heinemann, 2013.
[29] J. M. Harrington and F. S. Gill, Occupational health. Blackwell Scientific Publications, 1983.
[30] J. Fraden, Handbook of modern sensors: physics, designs, and applications. Springer Science & Business Media, 2004.
[31] P. A. Tipler and G. Mosca, Physics for scientists and engineers. Macmillan, 2007.
[32] O. Iwata, “The relationship of noise sensitivity to health and personality,” Jpn. Psychol. Res., vol. 26, no. 2, pp. 75–81, 1984.
[33] I. Alimohammadi, S. Sandrock, and M. R. Gohari, “The effects of low frequency noise on mental performance and annoyance,” Environ. Monit. Assess., vol. 185, no. 8, pp. 7043–7051, 2013.
[34] S. A. Stansfeld and M. P. Matheson, “Noise pollution: non-auditory effects on health,” Br. Med. Bull., vol. 68, no. 1, pp. 243–257, 2003.
[35] M. Basner et al., “Auditory and non-auditory effects of noise on health,” Lancet, vol. 383, no. 9925, pp. 1325–1332, 2014.
[36] O. Çelik, Ş. Yalçın, and A. Öztürk, “Hearing parameters in noise exposed industrial workers,” Auris Nasus Larynx, vol. 25, no. 4, pp. 369–375, 1998.

[37] J. C. Vischer, “Towards an environmental psychology of workspace: how people are affected by environments for work,” Archit. Sci. Rev., vol. 51, no. 2, pp. 97–108, 2008.

[38] S. A. Oyewole, J. M. Haight, and A. Freivalds, “The ergonomic design of classroom furniture/computer work station for first graders in the elementary school,” Int. J. Ind. Ergon., vol. 40, no. 4, pp. 437–447, 2010.

[39] A. S. M. Hoque, M. S. Parvez, P. K. Halder, and T. Szecsi, “Ergonomic design of classroom furniture for university students of Bangladesh,” J. Ind. Prod. Eng., vol. 31, no. 5, pp. 239–252, 2014.

[40] I. W. Taifa and D. A. Desai, “Anthropometric measurements for ergonomic design of students’ furniture in India,” Eng. Sci. Technol. an Int. J., vol. 20, no. 1, pp. 232–239, 2017.

[41] M. L. Resnick and A. Zanotti, “Using ergonomics to target productivity improvements,” Comput. Ind. Eng., vol. 33, no. 1–2, pp. 185–188, 1997.

[42] S. Y. Lee and J. L. Brand, “Can personal control over the physical environment ease distractions in office workplaces?,” Ergonomics, vol. 53, no. 3, pp. 324–335, 2010.

[43] W. T. Singleton and W. H. Organization, “Introduction to ergonomics,” 1972.

[44] J. C. Vischer, “The effects of the physical environment on job performance: towards a theoretical model of workspace stress,” Stress Heal. J. Int. Soc. Investig. Stress, vol. 23, no. 3, pp. 175–184, 2007.

[45] J. Shinn, K.-A. Romaine, T. Casimano, and K. Jacobs, “The effectiveness of ergonomic intervention in the classroom.,” Work, vol. 18, no. 1, pp. 67–73, 2002.

[46] Gensler, “The Gensler Design + Performance Index: The US Workplace Survey,” 2006.

[47] Q. Jin, M. Overend, and P. Thompson, “Towards productivity indicators for performance-based façade design in commercial buildings,” Build. Environ., vol. 57, pp. 271–281, 2012.

[48] L. Shoshkes, Space planning: Designing the office environment. Architectural Record Books, 1976.