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Ergonomic Study of the Physical Environment: The Problem of Noise in Industrial and Non-Industrial Sectors

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Abstract: Research on noise studies informs that noise disturbance is caused by many sources which can come from industrial and non-industrial categories. Noise is a study in the realm of ergonomics, so development to take an important role in knowing the handling and preventing health problems in the future is needed. A data collection of several journals indexed by Scopus and registered with Google Scholar with a total of 40 articles on noise has been carried out with a period of publication over the last decade, 2011-2021. The results of the analysis found that air pollution is part of the dominant noise effect from the non-industrial sector rather than the industrial sector in ratio. Among the non-industrial categories include traffic density, airport activity, train noise, and others. Meanwhile, industrial activities generally originate from the sound of machines that produce or operate for the duration of the work. All sources of noise must be reduced as they can cause hearing loss.

Keywords: Noise, Industrial, Non-industrial.

1. INTRODUCTION

Research on noise in everyday life from both the industrial and non-industrial sectors is relatively small in Indonesia. Noise is part of air pollution which may cause hearing loss. Sources, measurement methods, and good handling methods in reducing noise are very important for further research. Excessive noise levels can have a very dangerous negative impact in many ways, including health effects, namely damage to the sense of hearing, and also from a psychological and technical perspective, namely emotional disorders [1]. In the industrial sector, noise studies are needed to be a benchmark for reducing the effects of noise for workers and the surrounding residential community. The World Health Organization (WHO) reports that hearing loss due to work noise is the second most common work-related accident where one of them can be said to be a permanent disability. The number of workers with hearing loss is estimated at 360 million (5.3%) in the world, of which Indonesia is one of 4 countries with a fairly high prevalence of deafness, which is 4.6% [2]. One of the many major problems is the source of noise caused by industrial activities [3].

1.1 Noise

Noise is unwanted sound or sound that may interfere with health, comfort and cause deafness and interfere with comfort levels, expressed in decibels [1] [2]. Noise is also defined as “sound that appears at the wrong place and time”, and the fact that noise is a potential health hazard that results in damage to human hearing [3]. Noise is part of air pollution that arises from two sources, namely the industrial sector and the non-industrial sector. [4].

Industrial noise is a problem for the workforce. This noise usually arises from working machines, generators, and various equipment that moves and is in contact with metal, compressors, or high-pressure gases, liquids, or vapors involved in industrial processes [5][6]. A machine, namely a ring blower that is used in the powder, pulp, and paper/tissue industry for the transportation of materials for use and functions as an air supply or air

provider, can cause noise due to load and speed as well as component disturbances which in turn can cause inconvenience to the workers environment [7]. The effect of industrial noise on workers' health has been a topic of debate among scientists for several years. Many studies discuss the level of noise in various industries. Atmaca et al., in his research, found that the noise level in several industries, including the textile industry was around 75-99 dBA, the iron and steel industry was 77-100 dBA, the cement industry was around 70-106 dBA, the Traverse Concrete Industry was around 80-107 dBA, and the cement industry was around 80-107 dBA rubber around 100-104 [4].

The noise from the non-industrial sector was found to be very diverse, ranging from the construction in residential areas causing uncomfortable sounds, heavy traffic on the highway, the taking off and landing of planes at the airport, to the problem of trains running close to residential areas. The globalization of socio-economic processes and urbanization increase the mobility of the population which is facilitated by the widespread use of transportation. As a result of the operation, construction, or expansion of these transportation facilities, disturbances to the environment arise, such as non-fulfillment of environmental standards related to noise and environmental damage which will harm health and welfare. [8] In recent years, noise has been recognized as one of the main concerns affecting the quality of life in urban areas around the world as urban areas are rapidly developing where traffic noise pollution is becoming increasingly serious. Exposure to noise levels in urban areas that cause public health problems is associated with various parameters that make up the urban structure, such as construction density, open space, physical shape and position of buildings, type of hallway and population distribution, etc. [9].

Environmental noise management is part of environmental impact studies and guidelines for urban development in various countries. To develop measures related to noise management and control, it is important to conduct noise mapping. Developing countries such as Brazil, India, and China, are examples of large urban populations living with severe social and environmental problems of noise pollution [10].

2. RESEARCH METHOD

The research method was carried out by searching for scientific articles on noise disturbance in international journals and national journals with a period spanning 2011-2021. The analysis of scientific articles in international journals is selected based on Scopus indexed elimination (www.scopus.com), while for scientific articles in national journals, articles that are published and registered with Google Scholar (https://scholar.google.co.id/). The basis for this application is to improve the quality of the review journal that will be made. All articles obtained will be recorded as much as possible related to noise, both noises originating from the industrial and non-industrial sectors. The articles used include the causes/sources of noise, the magnitude of the noise level, the effects of noise, to the handling of noise.

3. FINDING AND DISCUSSION

The search results for both international and national journals informed several criteria that were included in the noise problem in the industrial and non-industrial sectors. The elimination results show that noise journals originating from non-industries are more dominant than noise journals originating from the industry. The selection of journals is also more inclined to writers from Indonesia and some have objects of study in Indonesia.

Table 1. Scopus indexed and Google Scholar Noise articles listed

International Journal	Publication	National Journal	Publication
Sewage Disposal And Air Pollution Engineering [5]	Environmental Engineering (Vol. II) Khanna Publishers	Analysis of engine room noise levels on ships [1]	***WIJAYAKUSUMA National Seminar Proceedings***
Measurement of Noise Level in Enumeration Station in Rubber Industry [4]	IOP Conf. Series: Materials Science and Engineering	Factors causing hearing loss of workers in the production division of PT. Adi Satria Abadi, Yogyakarta [2]	Indonesian Public Health Publication Journal
Airport noise compensation: real estate perspective [8]	Emerald Group Publishing Limited	The correlation between noise intensity and blood pressure in workshop area workers [6]	MEDICAL ZONE
Hierarchal assessment of noise pollution in urban areas – A case study [9]	Published by Elsevier Ltd.	Noise characteristics of ring blowers due to changes in rotating speed [7]	Proceedings of SNRT (National Seminar on Applied Research)
Noise mapping at different stages of a freeway redevelopment project – A case study in Brazil [10]	Published by Elsevier Ltd.	Noise Level Improvements in Yessy's Production Room Collection with Ergonomic Approach [39]	Journal of UNS Performance
Environmental noise [11]	Published by Elsevier Ltd.		Journal of UNS Performance
Spatio-temporal patterns of road traffic noise pollution in Karachi, Pakistan [12]	Published by Elsevier Ltd.		
Noise and emission characterization of off-grid diesel-powered generators in Nigeria [13]	Management of Environmental Quality: An International Journal		

Evaluation of environmental noise based upon the percentage of dissatisfied [14]	Emerald Group Publishing Limited	Analysis of railway noise level against the level of disruption of communities living in the area around the railway in the Semarang city [27]	IOP Journal of Physics: Conference Series
A psycho acoustical approach to resolving office noise distraction [15]	Emerald Group Publishing Limited	Methods to reduce noise level due to environmental changes: A case study in Universitas Gadjah Mada[28]	IOP Journal of Physics: Conference Series
Comparing high and low performers for noise control [16]	Emerald Group Publishing Limited	Monitoring of Noise Contour Mapping and Hearing Conservation Program of Rice Milling Workers in Griyan Karanganyar[29]	EDP Sciences
ICBEN review of research on the biological effects of noise 2011-2014[17]	Noise & Health NCBI	Noise investigation in a small muffler industry in Purbalingga, Indonesia[30]	IOP Journal of Physics: Conference Series
Noise Effects on Health in the Context of Air Pollution Exposure [18]	Int. J. Environ. Res. Public Health MDPI	Noise Sources and Control, and Exposure Groups in Chemical Manufacturing Plants [31]	Appl. Sci. MDPI
Auditory and non-auditory effects of noise on health[19]	NIH-PA Author Manuscript	Outdoor traffic noise effect in indoor sound distribution [32]	IOP Journal of Physics: Conference Series
Analysis of Air, Water, and Noise Level Quality Due to Industrials Activities in Aceh Province [20]	Published by Elsevier Ltd.	Enhancing the management of the noise level using six sigma method: a case study on the machining industry[33]	IOP Conf. Series: Materials Science and Engineering
Modeling of Woodworkers' Exposure to Occupational Noises by Integrating Frequency Spectra Generated by Power Tools: A Pilot Study[21]	Appl. Sci. MDPI	Road Traffic Noise Analysis at the U-Turn in Makassar City [34]	Springer Nature Singapore Pte Ltd
Work Rotation to Reduce the Effect of Noise Exposure for Operators in SugarFactory[22]	IOP Conf. Series: Materials Science and Engineering	Risk analysis of hearing loss among the employees in ceramics sanitary industry [35]	IOP Conf. Series: Earth and Environmental Science
Survey of People Perception on the Resulting Noise from the Sultan Ismail Petra Airport, Kelantan, Malaysia[23]	IOP Conf. Series: Earth and Environmental Science	A Path Analysis: Study of Correlation Between Noise Intensity and Quality of Life of Workers In Textile Industry [36]	IOP Journal of Physics: Conference Series
Mapping of noise levels made by drilling machines on project x using contour zone method[24]	IOP Conf. Series: Materials Science and Engineering	The development of compressor noise barrier in the assembly area (Case study of PT Jawa Furni Lestari)[37]	Published by Elsevier Ltd.
Investigating the Noise Barrier Impact on Aerodynamics Noise: Case Study at Jakarta MRT [25]	Springer Nature Singapore Pte Ltd	Work Rotation to Reduce the Effect of Noise Exposure for Operators in Sugar Factory[38]	IOP Conf. Series: Materials Science and Engineering

Noise-Induced Hearing Loss in Ground Handling Workers at Juanda Airport Surabaya[26]	Korean J Otorhinolaryngol-Head Neck Surg

A total of 40 journals were selected and some were used in this noise study, including international journals and national journals. The discussion of noise generally comes from many factors and various types of noise sources.

In a country with a developing economy, an increase in noise level is associated with accelerated urban growth and an increase in the circulation of automotive vehicles so that increased mobility will cause air pollution which is considered dangerous [10]. Noise can cause complaints and disturbances for people who are exposed to it in the long term, namely in the form of health impacts. General traffic noise is the dominant noise source in urban areas [11]. In Pakistan, noise exposure due to road traffic is generally higher in the morning and evening due to the travel patterns of the population in the country [12]. Settlements located in the airport area as far as 500 meters away are greatly disturbed by the noise of aircraft activities which can cause permanent hearing damage and stress for residents [23]. Noise that occurs on trains above the threshold requires optimization by installing barriers to reduce noise [25]. The Semarang train station area is known to have a maximum noise of 67.3 dba, causing stress to the surrounding community, both physiologically and psychologically [27]. Physical and managerial changes inroads in an area will affect the distribution of sound levels which can be known through noise level mapping. Thus, the strategy taken to reduce the noise rate is to make special rules such as the obligation to have a card or ticket for colors who want to access the road [28].

In the industrial sector, the biggest source of noise is diesel engine generators. This creates polluting emissions that interfere with indoor activities including the operator who monitors the running of the machine [13]. In the wood industry, operators are exposed to noise due to using the tool for a long time. For this reason, efforts are needed to improve the quality of the engine and replace the old engine with a new product with a lower noise level due to good damping [21]. In the Sugar Industry, workers are exposed to the noise of the grinder which makes them have to speak loudly. This can be handled through a rotation schedule with a maximum of hours of specified duration [22]. Several policies to reduce the impact of noise on the exhaust industry are redesigning the production layout, production scheduling, and technological changes in the exhaust production process [30]. In the ceramic industry in the factory area, the noise that occurs is known to have exceeded the set threshold so that the side effects are in the form of hearing loss, easy fatigue, and also headaches experienced by workers when compared to workers in quiet areas [35]. Noise intensity and age increase hearing loss and reduce the quality of life of textile industry workers where employers are required to carry out hearing conservation programs [36]. In the furniture industry, various efforts have been made to reduce noise levels by providing an effective barrier to reduce compressor noise and relocating the compressor to an open area [37].

Noise in the field of work safety is a big concern for business actors in the industrial sector. There are many obstacles in implementing OSH by management due to a lack of knowledge and intervention from Industry bodies [16]. The Hearing Conservation Program (HCP) method is considered less effective in reducing the impact of noise so that the industrial sector must improve worker safety by providing personal protective equipment in the form of earplugs and creating more barriers between workers and machines [29]. The Six Sigma method is a systematic method and can solve the noise level problem. This method will be more effective by integrating other methods in the implementation of the noise level management plan designed to investigate noise level management efforts [33]. Noise level management can be carried out using administrative control methods, such as worker rotation where operators who have been exposed to noise for the maximum duration will be transferred to other stations that are less noisy [38]. Noise control efforts that are expected to be implemented in the Shoe Craft Industry are engineering control, administrative control, and the use of PPE, namely by isolating machines, maintaining or modifying machines. Administrative control, in this case, is carried out by holding work rotations, while the use of PPE is carried out by wearing ear protective equipment [39]. At stations with noise above the threshold, noise control measures that can be applied are to provide workers with ear protection devices in the form of earmuffs [40].

Hearing loss caused by occupational noise exposure is a public health threat. Efforts to reduce noise exposure will ultimately help to reduce the number of distractions resulting in a lower, better learning environment for children, improved sleep quality, and others [19].

Research says that there is no relationship between the effect of traffic noise and changes in indoor noise levels because each is influenced by different noise sources, where traffic noise is caused by vehicles and indoor noise is caused by human activities in buildings [32].

4. CONCLUSION

The intensity of the noise level generated by the industrial and non-industrial sectors has different criteria and handling methods. In industries with noise levels above the threshold due to machines, it is necessary to implement standard operating safety procedures by providing workers with personal protective equipment in the form of earplugs to reduce the impact of permanent hearing loss. However, it is necessary to consider the existence of a rotation system carried out by management. For non-industrial sources such as road disturbances and the presence of airports near residential areas, efforts that can be made to reduce them are by making house dampers installed on windows. Meanwhile, the way to overcome the noise due to train can be done by providing a barrier with a further review.

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