NOISE EXPOSURE TO THE WORKERS IN MALAYSIAN CONSTRUCTION INDUSTRY

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To my beloved father and mother, families, friends and Dr. Zaiton

They own my heart and my mind.

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ABSTRACT

Noise and construction are two things that mutually related. Previous studies showed that construction workers are likely exposed to high level of noise exposure when there is no appropriate measure is carried out. Almost all activities in construction generate noise that will affect workers health and well-being. This study is to compare the noise exposure level among workers in four construction sites. In addition, the research also was conducted to assess the noise exposure level produced from construction site activities and to explore the effect of noise exposure to the workers. Furthermore, the workers' level of awareness regarding noise exposure is being studied. Moreover, the perceptions of workers on noise exposure also were tested. Results showed that most of the activities in construction site produced noise exposure below the permissible noise exposure level of 90 dB (A) or first schedule of FMR 1989. However, one site in the study exceed the first action level of 80 dB (A) of current international standard. Consequently, almost half of the workers experienced tinnitus, depression and high blood pressure due to the noisy environment. It is suggested that both employers and workers employ preventive actions in order to reduce the noise exposure and to minimize the effect of noise to their health.

ABSTRAK

Bunyi dan pembinaan adalah dua perkara yang tidak boleh dipisahkan. Kajian terdahulu menunjukkan bahawa pekerja-pekerja pembinaan yang terdedah kepada tahap bunyi bising yang tinggi dimana tiada langkah sewajarnya diambil. Hampir semua aktiviti dalam pembinaan menghasilkan bunyi yang boleh menjejaskan kesihatan dan kesejahteraan pekerja. Kajian ini dijalankan untuk membandingkan tahap pendedahan bunyi bising di kalangan pekerja-pekerja di empat tapak pembinaan. Di samping itu, kajian ini juga dijalankan untuk menilai tahap pendedahan bunyi yang dihasilkan daripada aktiviti tapak pembinaan dan meneroka kesan pendedahan bunyi bising kepada pekerja-pekerja serta mengkaji tahap kesedaran pekerja mengenai pendedahan bunyi bising. Selain itu, persepsi pekerja terhadap pendedahan bunyi juga telah diuji. Hasil kajian menunjukkan bahawa kebanyakan aktiviti-aktiviti di tapak pembinaan menghasilkan pendedahan bunyi bising di bawah paras pendedahan bunyi yang dibenarkan iaitu 90 dB (A) atau jadual pertama yang dicadangkan oleh FMR 1989. Walau bagaimanapun, satu daripada empat tapak pembinaan di dalam kajian ini melebihi tahap tindakan pertama 80 dB (A) yang terdapat dalam piawaian antarabangsa. Hampir separuh daripada pekerja-pekerja pembinaan dalam kajian ini mengalami tinnitus, kemurungan dan tekanan darah tinggi disebabkan oleh persekitaran yang bising dihadapi mereka. Adalah dicadangkan agar kedua-dua majikan dan pekerja mengambil tindakan pencegahan yang sewajarnya untuk meminimumkan pendedahan bunyi bising dan mengurangkan kesan bunyi bising terhadap kesihatan mereka.

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LIST OF SYMBOLS

L_p	=	Sound pressure level
L_w	=	Sound power level
L_{Avg}	=	Average sound level
L_{asmx}	=	Maximum sound level
L_{asmn}	=	Minimum sound level
L_{cpk}	=	Peak sound level

LIST OF ABBREVIATION

DOE	=	Department of Environment
WHO	=	World Health Organization
dB(A)	=	Decibel
SPL	=	Sound pressure level
FMR	=	Factories Machinery Regulation

CHAPTER 1

INTRODUCTION

1.1 Overview

The Malaysian construction industry is generally separated into two areas. One area is general construction, which comprises residential construction, non-residential construction and civil engineering construction. The second area is special trade works, which comprises activities of metal works, electrical works, plumbing, sewerage and sanitary works, refrigeration and air-conditioning works, painting works, carpentry, tiling and flooring works and glass works.

Due to many activities that involve in construction, construction industry makes up an important part of economy in Malaysia. According to Bank Negara Annual Report 2012, construction industry has contributed 10.7% of the national Gross Domestic Product (GDP). Although relatively small, it is extensively linked with many other parts of the economy, particularly with metal product and electrical machinery industry. In the report also stated that construction industry employs 9.1% of the overall workforce in Malaysia.

However, construction industry also contributed to a negative impact especially to the human environment (Teixeira, 2005). Waste production, contamination of land and water, production of dust and muds, destruction of vegetation and noise pollution are the examples of negative impact causes by the construction industry.

Based on non-government employees report to the National Worker's Social Security Organization (SOCSO) in Malaysia on 2002-2006, it is reported that the overall incidence rate of occupational disease was 2.8 per 100,000 workers and the annual number and rates of occupational disease showed an increasing number over time. From the entire incidence reported, the most frequent conditions are hearing impairment (32%) and musculoskeletal disorder (28%) (Abas *et al.*, 2008).

1.2 Background of Study

The activities in construction industry involve heavy machineries such as heavy-duty bulldozer, vibrating road roller, crane and wheel loader that can create excessive noise to the surrounding. According to Suter (2002), the average daily noise exposure level by trade activity or equipment was approximately 99 dB (A). Therefore, workers in construction industry are exposed to high level of noise exposure.

Noise is one of pollution and hazard that generated by the construction industry (Chen *et al*., 2002). Past studies show that excessive exposure to noise can lead to health problem (Glorig, 1961; King and Davis, 2003) and psychological effects (Landstrom *et al*., 1995; Ibrahim and Richard, 2000) to human. Therefore, this problem can cause health hazard especially to the workers and to the community around.

As a developing country, Malaysia cannot run from this problem. Although some of the society has realized and aware about the dangers of this issue but no serious action has been taken. Since construction is one of the industry that generates high noise pollution, workers in construction should be aware with this situation because they are the nearest people that will be exposed to the noise.

1.3 Statement of Problem

In construction, engineers are more concerned on the safety aspect such as deflection or cracking of a building application. For architects, they might more interested on the aesthetics of the building design. Therefore seldom people will notice the importance of acoustic quality in the environment during construction stages especially the noise produced from the construction equipment. Moreover, most of them might think that it is unnecessary to have a good control on the acoustic quality in construction sites.

According to Malaysian Factories and Machinery (Noise Exposure) Regulations 1989, no employee shall be exposed to noise level exceeding equivalent continuous sound level of 90 db (A) or exceeding the limits specified in the First Schedule or exceeding the daily noise dose of unity. It also stated that no employee shall be exposed to noise level exceeding 115 dB (A) at any time. Therefore, the construction industry in Malaysia should ensure that the noise exposure level produced from construction activities or equipment are comply with the regulations set.

1.4 Aim and Objectives

This study was carried out to look the degree of noise exposure from the local construction sites and compare them to the regulation set by the government and regulatory bodies. In addition, the aim of study is to evaluate the awareness of construction workers on noise exposure.

The specific objectives of this research are as follows:

- To assess the noise exposure level from construction activities.
- To compare noise exposure level of four different sites.
- To study the perception of construction workers regarding noise exposure.

1.5 Scope of Study

This study will be limited to the real onsite measurement of noise exposure level produced by activities and machinery involve in construction. The measurement were focus on the noise exposure levels exposed to the construction workers in superstructure stage. In addition, the measurement were carried out on typical construction site in the state of Johor.

The measured noise exposure levels then were compared with noise exposure level in Factories and Machinery (Noise Exposure) Reguation 1989, Department of Occupational and Health 2004 and Health Safety Executive 2005.

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1.6 Significance of Study

The study is important and significant from both theoretical and practical aspects. The rationale and motivation for this research are:

- The study can be reference to the contractor about the noise exposure level produced by activities and machinery at the construction site.

- This study can be the benchmark about noise exposure level exposed to the workers in construction activities.

- This study also can be a reference to the public and private sector towards the awareness and perception of construction workers on noise exposure.

1.7 Definitions of Terms

- Decibel, dB: means a unit of measurement of sound level equal to 20 times the logarithm to the base 10 of the ratio of the pressure of the sound measured to the reference pressure of 20 micropascals (DOE, 2007).

- dB(A): means the decibel unit of measurement of sound level corrected to the 'A' weighted scale (DOE, 2007).

- Dose: Related to the Criterion Level, a dose reading of 100% is the maximum allowable exposure to accumulated noise (The edge user manual, 2013).

- Exchange Rate: refers to how the sound energy is averaged over time. (Also, referred to as Doubling Rate.) Using the decibel scale, every time the sound

energy doubles, the measured level increases by 3dB. This is the 3dB exchange rate that most of the world uses (The edge user manual, 2013).

- Lavg (Average Level): the average sound level measured over the run time (The edge user manual, 2013).

- Lep,d: Daily personal noise exposure level (The edge user manual, 2013).

1.8 Brief Methodology

The detail research methodology will be explained further in chapter 3, the research stages will cover as follows:

- Preliminary Stage of study
  The research methods used for this study purpose are the review of literatures including books, journals and information from Internet.

- Data Collection and Analysis
  On-site measurement and distributing questionnaires to the construction workers are the methods for data gathering. In addition, on-site observation also recorded in order to access worker's working environment.

- Conclusion Stage
  Based on the data obtained from the analysis, some recommendation has been made for further action. The recommendations are discussed in Chapter 5.

1.9 Organization of the Thesis

The approach in this study is based on a number of stages which are reflected in the titles of the chapters of the thesis. The introductory chapter summarizes the problems related with the excessive noise from construction site and the effects on workers and neighborhoods.

In chapter 2, the overview of construction noise characteristic, differentiation between sound and noise, effects of noise towards workers and the communities, the measurement of noise exposure levels, permissible noise exposures levels and the past studies about noise exposure in construction.

Chapter 3 describes the methodology to conduct the research regarding the measurements of noise exposure levels from construction site by using dosimeter and questionnaire distribution. The chapter also includes the methods of analysis to evaluate the noise exposure levels and the workers perception.

In chapter 4, the analysis of results from the onsite measurement is presented. The results also included the comparison between noise exposure level produced on four site with available regulations. The questionnaire analysis using statistical package for social science (SPSS) and Microsoft Excell also is discussed. Finally, the summary and conclusions derived from this study are presented in Chapter 5 together with recommendations for future research.

References

Abas, A. L., Said, A. R. M., Mohammed, M. A. A. and Sathiakumar, N. (2008): *Occupational Disease among Non-Governmental Employees in Malaysia: 2002-2006,* International Journal of Occupational Environmental and Health, 14:4, 263-271.

Aluclu, I., Dalgic, A., and Toprak, Z. F. (2008): *A Fuzzy Logic Based Model for Noise Control at Industrial Workplaces*. Journal of Applied Ergonomics, 39:3, 368-378.

Arezes, P. M., Bernardo, C. A.and Mateus, O. A. (2012): *Measurement Strategies for Occupational Noise Exposure Assessment: A Comparison Study in Different Industrial Environments.* International Journal of Industrial Ergonomics, 42, 172-177.

Asselineau, M. and Gaulupeau, A. (2009): *Measuring the Noise Exposure Level of Workers Using Standard ISO 9612: Case Study*, proceeding of Inter-Noise 2009, Ottawa, Canada. August 23-26.

Atmaca, E., Peker, i. and Altin, A. (2005): *Industrial Noise and Its Effects on Humans*, Polish Journal of Environmental Studies, 14:6, 721-726.

Baba, I., Ali, Z. M., Bakar, N. A. A. and Ramly, M. Z. (2011): *Determination of Noise Exposure Level at Construction Area*. Proceeding of the International Seminar on Application of Science Matehmatics 2011.

Ballesteros, M. J., Fernandez, M. D., Quintana, S., Ballesteros, J. A. and Gonzalez, I. (2010): *Noise Emission Evolution on Construction Sites. Measurement for Controlling and Assessing its Impact on the People and on the Environment.* Building and Environment, 45, 711-717.

Bank Negara Annual Report 2012, Bank Negara Malaysia.

Bruel, P. V. and Kjaer, V. (2000): *Environmental Noise Booklet*. Bruel & Kjaer Publication.

Budny, E., Chlosta, M., Meyer, H. J. and Skibniewski, M. J. (2009): *Construction Machinery*, Springer Handbook of Mechanical Engineering, 1149-1266.

Bukhart, G., Schulte, P. A., Robinson, C., Sieber, W. K., Vossenas, P. and Ringen, K. (1993): *Job Tasks, Potential Exposures and Health Risk of Laborers Employed in the Construction Industry*, American Journal of Industrial Medicine, 24:4, 413-425.

Bohm, A., Strachotta, O. and Irmer, V. (2013): *Construction Noise*, Handbook of Engineering Acoustics, Springer-Verlag Berlin Haidelberg, Berlin.

Cagno, E., Giulio, A. D. and Trucco, P. (2005): *Statistical Evaluation of Occupational Noise Exposure*. Applied Acoustics, 66, 297-318.

Chen, Z., Li, H., Wong, C. T. C. and Love, P. E. D. (2002): *Integrating Construction Pollution Control with Construction Schedule; an Experimental Approach*, Environmental Management and Health, 13:2, 142-151.

Cohen, A. (1974): *Industrial Noise and Medical Absence and Accident Record Data on Exposed Workers*. Noise as a Public Health Problem. 441-453.

Cranston, C. J., Brazile, W. J., Sandfort, D. R. and Gotshall, R. W. (2013): *Occupational and Recreational Noise Exposure from Indoor Arena Hockey Games*, Journal of occupational and Environmental Hygiene, 10, 11-16.

Cunniff, P. F. (1977): *Environmental Noise Pollution*. John Wiley and Sons, New York

Department of Environment (2007): *The Planning Guidelines for Environmental Noise Limits and Control*, Ministry of Natural Resources and Environmental Malaysia.

Department of Occupational Safety and Health (2004); *Guidelines on Occupational Safety and Health in the Service Sector 2004.* Ministry of Human and Resources Malaysia.

Edworthy, J. (1997): *Noise and Its Effect on People; an Overview*, International Journal of Environmental Studies, 51:4, 335-344.

Engel, Z., Augustynska, D., Koton, J. and Kaczmarska, A. (2006): *Noise: Definitions* International Encyclopaedia of Ergonomics and Human Factors, Second Edition. CRC Press.

Factories and Machinery (Noise Exposure) Regulations (1989). Law of Malaysia.

Fang, J., Zhou, Y., Hu, X. and Wang, L. (2009): *Measurement and Analysis of Exhaust Noise from Muffler on an Excavator*, International Journal of Precision Engineering and Manufacturing, 10:5, 59-66.

Fernandez, M. D., Quintana, S., Chavarria, N. and Ballesteros, J. A. (2009): *Noise Exposure of Workers of the Construction Sector*. Applied Acoustics, 70, 753-760.

Fleming, K., Weltman, A., Randolph, M. and Elson, K. (2009): Piling Engineering. Taylor & Francis, New York.

Gilchrist, A., Allouche, E. N. and Cowan, D. (2003): *Prediction and Mitigation of Construction Noise in an Urban Environment*. Canadian Journal of Civil Engineering, 20, 659-672.

Glorig, A. (1961): *The Effects of Noise on Hearing*, Journal of Laryngology and Otology, 447-478.

Grinshpun, S. A., Kim, J. and Murphy, W. J. (2012): *Noise Exposure and Control*, Occupational Ergonomics Theory and Application, CRC Press, 792-823.

Hager, L. D. (1998): *Sound Exposure Profiling; A Noise Monitoring Alternative*, American Industrial Hygiene Association Journal, 59:6, 414-418.

Haron, Z., Noh, h. M., Yahya, K. Omar, W. and Majid, Z. A. (2012): *Assessing Noise Emission Levels from Earthwork Construction Equipment*, Malaysian Journal of Civil Engineering, 24(1), 13-28.

Health and Safety Executive (2005): *The Control of Noise at Work Regulations.*

Ibrahim, Z. and Richard, H. K. (2000): *Noise Pollution at School Environment Located in Residential Area*, Journal of Civil Engineering, 12:2, 47-62.

International Standard (ISO) 9612 (2009); Acoustics – Determination of Occupational Noise Exposure – Engineering Method.

Johnson, D. L., Papadopoulos, P., Watfa, N. and Takala, J. (1995): *Exposure Criteria, Occupational Exposure Levels.* Consultation on Evaluation and Control of Noise Exposure in the Working Environment, WHO, Geneva, 25-27 September.

King, R. P. and Davis, J. R. (2003): *Community Noise: Health Effects and Management.* International Journal of Hygiene and Environmental Health, 206, 123-131.

Konig, O., Schaette, R., and Kempter, R. (2006): *Cause of Hearing loss and Occurrence of Tinnitus*, Hearing Research, 221:1-2, 59-64.

Koushki, P. A., Kartam, N. and Al-Mutairi, N. (2004): *Workers' Perceptions and Awareness of Noise Pollution at Construction Sites in Kuwait,* Civil Engineering and Environmental Systems, 21:2, 127-136

Koyasu, M. (1984): *Evaluation and Control of Construction Noise; the State-of-Art*, proceeding of Inter-Noise 1984, Honolulu, USA.

Kumar, R., (2005). *Research Methodology: A Step by Step Guide for Beginners*, Pearson Education, Singapore.

Landstrom, U. and Akerlund, E. (1995): *Exposure Levels, Tonal Components and Noise Annoyance in Working Environments*. Environment International, 21:3, 265-275.

Laroche, C., Quoc, H. T., Hetu, R. and Mcduff, S. (1991): *Detect sound; A Computerized Model for Predicting the Detectability of Warning Signals in Noisy Workplace.* Journal of Applied Acoustics, 32:3, 193-214.

Lee, P. J., Shim, and Jeon, J. Y. (2010): *Effects of Different Noise Combination on Sleep, as Assessed by a General Questionnaire*. Journal of Applied Acoustics, 71, 870-875.

Leech, J. F. and Squires, M. (1999): *Noise.* Clay's Handbook of Environmental Health, Taylor & Francis Group LLC.

Levy-Leboyer, A. and Moser, G. (1988): *Noise Effects on Two Industrial Tasks*. Noise as a Public Health Problem. 43-48.

Liu, D. H. F. and Roberts, H. C. (1999): *Noise Pollution,* Environmental Engineer's Handbook. CRC Press LLC.

Lord, H. L., Gatel, W. S., and Evensen, H. A. (1980): *Noise Control for Engineers*, McGraw-Hill, New York.

Parsons, K. C. (2000): *Environmental Ergonomics: A Review of Principles, Methods and Models.* Applied Ergonomics, 31, 581-594.

Passchier-Vermeer, W. (1994): *Noise-induced Hearing Loss from Daily Occupational Noise Exposure; Extrapolations to Other Exposure Patterns and Other population.* Noise as a Public Health Problem, 99-105.

Mikulec, A. A., Lukens, S. S., Jackson, L. E. and Deyoung, M. N. (2011): *Noise Exposure in Convertible Automobiles,* Journal of Laryngology and Otology, 125, 121-125.

Milz, S. A., Wilkins, J. R., Ames, A. L. and Witherspoon, M. K. (2008): *Occupational Noise Exposures Among Three Farm Families in Northwest Ohio*, Journal of Agromedicine, 13:3, 165-174.

Momtahan, K., Hetu, R. and Tansley, B. (1993): *Audibility and Identification of Auditory Alarms in the Operating Room and Intense Care Unit.* Journal of Ergonomics, 36:10, 1159-1176.

Occupational Safety and Health Act (1970), US Department of Labour-OSHA. www.osha.gove/pls/oshaweb/owadisp.show_document?p_table=STANDARD&p_id=10625. Retrieved on 26 November 2012.

Nadya, S., Dawal, S. Z., Ya, T. M. Y. S. T., Hamidi, M. (2010): *A Study of Occupational Noise Exposure among Toll Tellers at Toll Plaza in Malaysia.* Proceeding of the international Multi Conference of Engineers and Computer Scientists. Hong kong, March 17-19.

Neitzel, R., Seixas, N. S., Camp, J. and Yost, M. (1999): *An Assessment of Occupational Noise Exposures in Four Construction Trades*, American Industrial Hygiene Association Journal, 60:6, 807-817.

Rampal, K. G. and Nizam, J. M. (2006): *Developing Regulations for Occupational Exposures to Health Hazard in Malaysia*. Regulatory Toxicology and Pharmacology, 46, 131–135.

Sailer, U. and Hassenzahl, M. (2000): *Assessing Noise Annoyance: an Improvement-oriented Approach*, Ergonomics, 43:11, 1920-1938.

SCENIHR (2008); *Scientific Committee on Emerging and Newly Identified Health Risks report*. http://ec.europa.eu/health/ph_risk/risk_en.htm. Retrieved on 26 November 2012.

Smith, A. P. (1988): *Research on Noise and Sleep*, Noise as a Public Health Problem. 293-300.

Smith, A. P. (1990): *Noise, Task Parameters and Cognitive Vigilance Tasks.* Contemporary Ergonomics, Taylor and Francis, London. 98-103.

Suter, A. H. (2002): *Construction Noise: Exposure, Effects and the Potential for Remediation; A Review and Analysis*, AIHA Journal, 63:6, 768-789

Teixeira, J. M. C. (2005): *Construction site environmental impact in civil engineering education*, European Journal of Engineering Education, 30:1, 51-58.

The Edge User Manual for eg3/eg5 Personal Noise Dosimeter (2013), 3M Personal Safety Division, 3M Company, USA.

Vardhan, H. and Raj, M. G. (2008): *An Experimental Investigation of the Sound Level Produced by Bulldozers with Various Maintenance Schedules*, International Journal of Vehicle Noise and Vibration, 4:2, 107-122.

Wachasunder, S. (2004): *Assessment of Refinery Noise Impact on Workers – A Case Study*. International Journal Environment Studies, 61:4, 459 – 470.

Wilkins, P. and Martin, A. M. (1987): *Hearing Protection and Warning Sounds in Industry; A Review*. Journal of Applied Acoustics, 21:4, 267-293.

Zhao, Y. M., Zhang, S. Z., Selvin, S. and Spear, R. C. (1991): *A Dose-response Relation dor Noise-induced Hypertension*. British Journal of Industrial Medicine, 48, 179-184.