Jurnal Teknologi

Full paper

Construction Noise Annoyance among the Public Residents

Nadirah Darus*, Zaiton Haron, Siti Nadia Mohd Bakhori, Lim Ming Han, Zanariah Jahya, Mohamad Fauzi Abdul Hamid

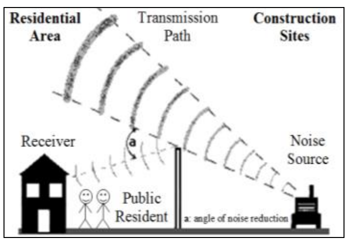
Faculty of Civil Engineering, Universiti Teknologi Malaysia, 81310 UTM Johor Bahru, Johor, Malaysia

*Corresponding author: nddarus@yahoo.com

Article history

Received: 10 November 2014
Received in revised form:
23 January 2015
Accepted: 12 April 2015

Graphical abstract



Source-path-receiver concept

Abstract

Construction activities generate construction noise may cause noise annoyance among the public residents. The aim of this study is to investigate the noise annoyance level due to the sound pressure levels and the distances from the construction sites. Three public resident areas around Johor which located near to the construction sites have been selected. Two important indicators such as sound pressure levels and distances between the receiver and the noise sources were measured. 42 questionnaires were randomly distributed to the public residents who live near to the construction sites. The results showed that all respondent have different annoyance levels due to the construction noise. The sound pressure levels received by the public residents are increasing with the decreasing of the distance between the receiver and the noise sources. Thus, the relationship of noise annoyance levels is directly proportional to the sound pressure levels produced from construction sites. Meanwhile, the noise annoyance levels are decreasing with the increasing of the distances. As a conclusion, the public residents who live nearer to the construction sites suffered from a high noise annoyance level as expected.

Keywords: Construction noise; sound pressure level; noise annoyance; public resident

1.0 INTRODUCTION

Physically, there is no distinction between sound and noise. However, these two terms have own definition and description. Sound can be defined as a sensory perception or an element created by a vibrating object where vibrations are transmitted in the form of pressure waves to the surrounding.[1-2] These pressure waves can be measured where sound will produce when their frequency and intensity are within specified ranges. Based on previous study,[3] sound will propagate and its propagation may be affected by several factors such as reflections, absorptions and other affecting factors. Meanwhile, noise is an unwanted sound or an audible acoustic polluting element which has been considered as the most physical urban pollution in our environment.[4-7] On top of that, excessive noise exposure is one of the common construction safety hazards and ergonomic risk factors.[8-10]

The frequencies of sound that can be the detected by 'threshold of hearing' (the intensity of sound just barely detected by an average human ear) are vary in the range between 20 Hz to 20000 Hz and depending on individual.[11] As the sound intensity increased for a given frequency range, the hearing sensation becomes painful and the 'threshold of pain' is reached. Decibel (dB) is the most suitable unit used for sound pressure level by square the sound level. The higher decibel indicates a high sound level that can be heard by human and it can be very dangerous. A-weighted sound level is the low level sensitivity that can be heard by human ear that usually used for environmental and industrial noise.[12]

Construction activities are the major sources of community annoyance and may induce damages to the surrounding.[13] There are three main elements of construction noise such as noise source, transmission path and receiver (Figure 1).[14-15] Basically, the receivers are construction workers and public residents who exposed to construction noise because they are working in the noisy environment and passing by or living near to the construction sites respectively. There are several effects of construction noise such as annoyance, disturbances of growth, functions and immune system of the body, fatigue, sleepless, stress, distraction or concentration loss, temporary and permanent hearing loss (deafness), productivity loss, general reduction in life quality and comfort.[16-19]

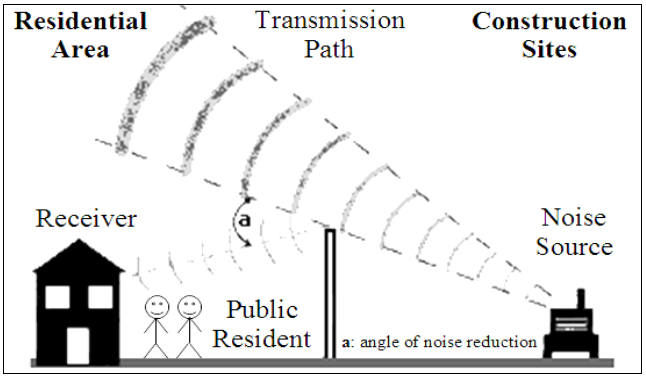


Figure 1 Source-path-receiver concept

Noise annoyance can be defined as an undesired, disturbance, interference, interruption, nuisance or displeasure of sound in daily activity due to high noise exposure level where a person may feel stressed, depressed, tired or fatigued.[20-24] The maximum permissible sound levels for residential are 90 dB A for daytime and 85 dB A for nighttime.[25] Excessive noise exposure in long term period may affect the human hearing mechanism in term of hearing impairment (Figure 2).[26] Usually, annoyance due to noise exposure leads to noise complaint from the public resident to the local authority. In January to November 2013, there are 54 complaints of noise annoyance have been reported and half of the complaints are due to construction noise.[27]

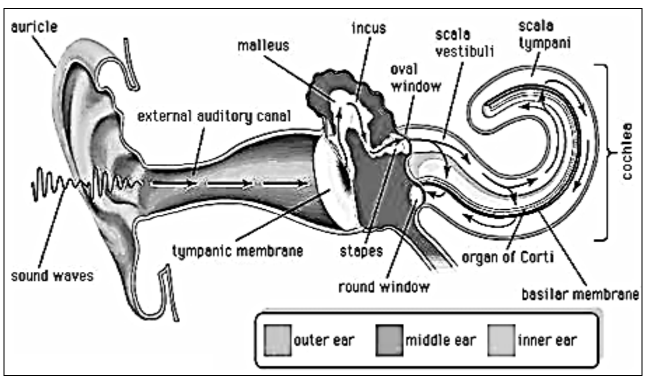


Figure 2 Human hearing mechanism

Other than that, similar complaints were also reported in some newspapers.[28-30] The public residents were affected in term of their health and comfort of daily life due to excessive construction noise exposure levels. The situation has resulted in noise annoyance among the public residents. Therefore, the aim of this study is to investigate the noise annoyance level due to the sound pressure levels and the distances from the construction sites. In order to achieve this aim, the objectives of this study are to identify the noise annoyance level among the public residents, to measure the sound pressure level generated from construction sites and the distance between the public resident from the construction site and to determine the relationship between noise annoyance level with the sound pressure level and the distance.

2.0 METHODOLOGY

2.1 Identification of Construction Noise Annoyance Level

In order to identify the noise annoyance level among the public residents due to the noise exposure from construction sites, 42 questionnaires were randomly distributed to the public residents who live near to the construction sites. The respondents were randomly selected with different genders and ages. The questionnaires were distributed randomly by hand to the respondents and they were given few minutes time to answer the questionnaires. The questions were designed using five scales of Likert-scale. The scales to indicate the construction noise annoyance levels were not annoy at all, not much annoy, sometimes annoy, annoy and extremely annoy. In analyzing the data, the number represents the frequencies of response from the respondents.

The questionnaires were designed into three sections which include Section A, Section B and Section C. Section A was related to the demographic background of the respondents such as genders and ages. Meanwhile, Section B was related to the noise annoyance from construction sites which include the perception on construction noise, construction activities working time, construction noise annoyance levels and construction noise complaints. In Section C, the respondents were asked about their comments and suggestions regarding the noise annoyance problems due to noise exposure from construction sites. Relative Importance Index (RII) and Cronbach's Alpha methods were used to calculate the frequency of respondent's answers into one value and to assess the reliability of the scales respectively.

By using the RII method, the relative ranking and the scores of every respondent can be calculated by using the formula (Equation 1). The values of RII were classified into their own level of affecting (Table 1). Meanwhile, by using Cronbach's Alpha method, the most common reliability test, the internal consistency of scale correlation of each variable were known. The purpose of reliability test using Cronbach's Alpha (α) method is to determine the reaction of the same respondents whether their reaction were the same or vice versa if they were given the same questions. If the respondents give the constant and reliable response when the questionnaires were re-administer, the variables of the questionnaire were said to be reliable.[31] The internal consistency of every value of α were calculated by using Statistical Package for Social Science (SPSS) software (Table 2).

$$\text{Relative Importance Index (RII)} = (\textstyle\sum w)/AN \qquad (1)$$

Where, w = the weightage given to each respondents
A = the highest weightage (5-in this study)
N = the total number of sample

Table 1 Classification of RII values

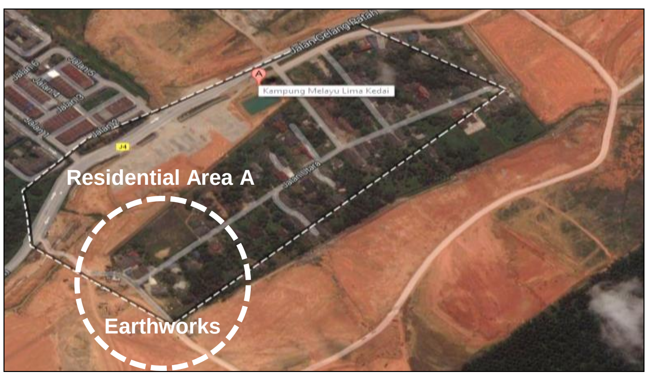
Scales	Level of annoyance	RII
1	Not annoy at all	0.0<RII≤0.2
2	Not much annoy	0.2<RII≤0.4
3	Sometimes annoy	0.4<RII≤0.6
4	Annoy	0.6<RII≤0.8
5	Extremely annoy	0.8<RII≤1.0

Table 2 Internal consistency of cronbach's alpha

Cronbach's alpha (α)	Internal consistency
α≥0.9	Excellent (High-stakes testing)
0.7≤α<0.9	Good (Low-stakes testing)
0.6≤α<0.7	Acceptable
0.5≤α<0.6	Poor
α<0.5	Unacceptable

2.2 Measurement of Sound Pressure Level and Distance

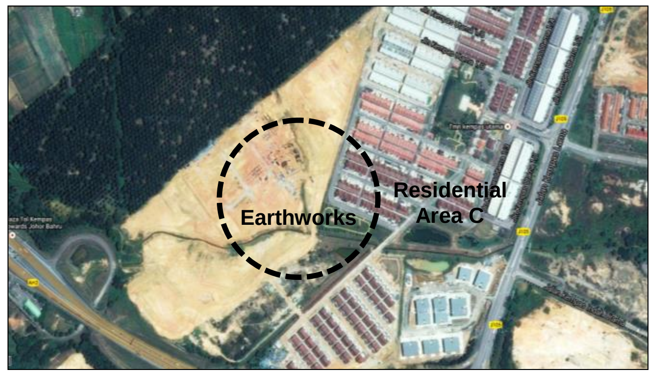
Three public residential areas located near to construction sites were selected for this study. The selected areas were Kampung Melayu Lima Kedai (earthworks), Kg. Melayu Lima Kedai (piling works) and Taman Kempas Utama (earthworks) (Figure 3). The substructure works were selected for this study because this stage of construction generates highest noise level.[32-34] The measurements of sound pressure levels and the distances were carried out by using sound level meter Type 2 and distometer respectively (Figure 4). The sound pressure levels of construction activities were measured at the border of respondents' houses and the distances were measured from the construction noise sources and respondents' houses. All the measurements were taken three times and average values were calculated.



a) Kampung Melayu Lima Kedai (earthworks)

b) Kampung Melayu Lima Kedai (earthworks)

c) Kampung Melayu Lima Kedai (piling works)



d) Taman Kempas Utama (earthworks)

e) Taman Kempas Utama (earthworks)

Figure 3 Selected residential areas and construction sites

a) Sound level meter – Type 2

b) Distometer

Figure 4 Required instruments for measurements

The 3M sound level meter–type 2 gives advance sound level monitoring which ensure ease of use and accuracy of measured sound pressure levels. This instrument was hand-held with some features such as menu driven user interface and quick keypad calibration. Other than that, it also can be used for occupational noise evaluations, environmental noise assessments, noise ordinance enforcement and legal metrology, general sound and frequency analysis, vehicle noise evaluations, building acoustic and mobile equipment evaluations. Meanwhile, Leica Disto D5, the laser distance meter with a digital point finder was simple, light and easy to be carried out with maximum distance of 200 meter. A precise distance appeared on the screen when it was pointed to the targeted object.

2.3 Determination of Construction Noise Annoyance Level with Sound Pressure Level and Distance

All the measured data of sound pressure level and the distance between the residents' houses and construction sites were tabulated into tables to show the value obtained from each measurement point. The data were tabulated according to each measurement area and were plot into a scatter graph to show the relationship of annoyance level from respondent‘s mean value with the sound pressure level and the distance measured. From the scatter graph, the equation of y=ax 2+bx+c and the value of R2 Quadratic is determined. The value of R2 Quadratic is the relative power of a quadratic model, varies between 0 and 1. The closer the value to 1, the plot was more accurate. This value indicates the percentage of scatter dot that touches the line plotted on the scatter graph. All data were tabulated into table and analyzed using SPSS software and Microsoft Excel.

■3.0 RESULTS AND DISCUSSION

3.1 Demographic Background of the Respondents

The respondents were randomly selected during the questionnaires distribution based on different genders and ages (Figure 5). The total of overall respondents was 42 persons where Residential A, Residential B and Residential C consist of 15, 15 and 12 persons respectively. The percentage of male and female respondents at Residential A and Residential B were 46.7% and 53.3% respectively. Meanwhile, at Residential C, the percentage of male respondents was 66.7% and the rest was the percentage of female respondents. In term of ages of the respondents, the majority age for respondents at Residential A was less than 25 and for respondents at Residential B and C was between 26 to 45 years old. Other than that, there were no respondents with age between 46 to 55 years old at Residential B and no respondents with age less than 25 years old at Residential C.

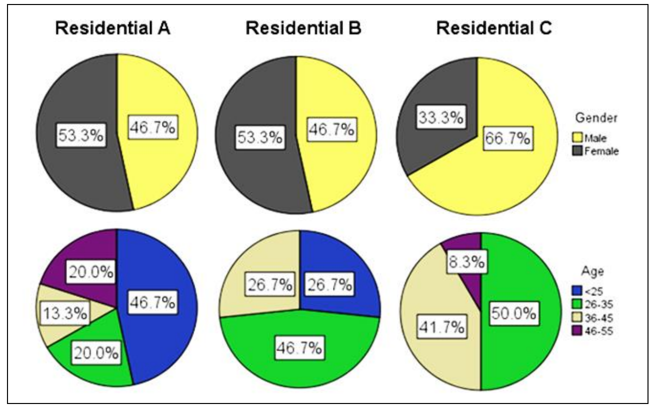


Figure 5 Demographic backgrounds of the respondents

3.2 Perception of the Respondents on Construction Noise

Based on the results obtained, more than half of the respondents from three residential areas were claimed (somewhat: 40%, 40% and 25% and extremely: 26.7%, 26.7% and 66.7%) construction noise generated from the nearby construction sites as a problem (Figure 6). The highest percentage of respondents who claimed construction noise as an extreme problem was at Residential C (66.7). However, minority of the respondents at Residential A were claimed construction noise was not at all and not much a problem to their daily life (6.7% respectively). There were no respondents from Residential B and C claimed the construction noise as not at all and not much a problem.

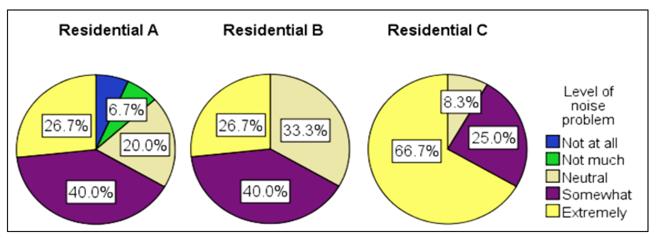


Figure 6 Perception of the respondents on construction noise

3.3 Construction Activities Working Time

Based on the results obtained, most of the respondents of all residential areas (73% from Residential A, 67% from Residential B and C) claimed that between 8 a.m to 12 p.m highest highest construction noise levels were generated (Figure 7). This was due to the most of construction operations started at around 8 a.m and continuously until 12 p.m. there were also some respondents claimed the noise annoyance starts at 1 p.m to 4 p.m and 4 p.m to 8 p.m because some of them were working in the morning and they suffered from evening shift of construction operations. Besides that, construction operations were also continued at 8 p.m because some of the activities were carried out during night time. Only 7% of respondents from Residential A claimed that the construction activities were started before 8a.m and no respondents from Residential B and C claimed as Residential A.

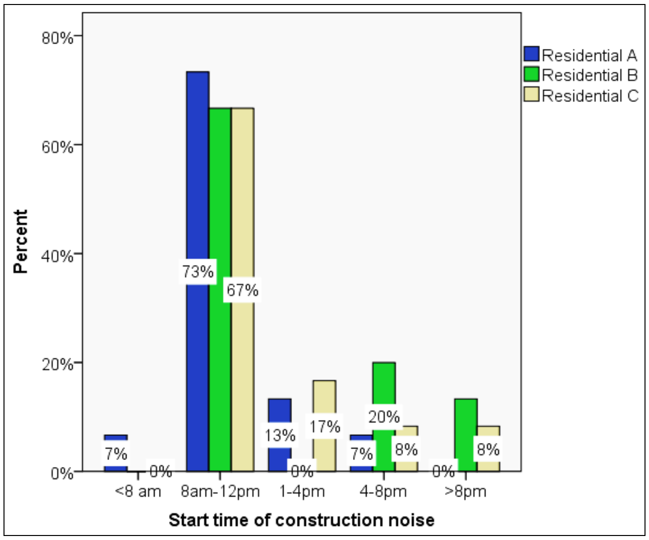


Figure 7 Construction activities working time

3.4 Construction Noise Annoyance Levels

Half of the respondents from all residential areas were annoyed by the noise generated from the nearby construction sites (annoyed: 13.3%, 40.0% and 50.0% and highly annoyed: 26.7%, 13.3% and 16.7%) (Figure 8). There were 26.7% respondents from Residential A and B who claimed that they were not much annoyed with the construction noise from the nearby construction sites. The total percentage of sometimes annoyed respondents was 33.3% from both Residential A and C. Their daily activities, health and psychology were continuously interrupted for every day except Sunday since Sunday is an off day for all construction sites. Absent of any hoarding or noise barrier placement between the construction sites and residential areas became one of the causes of construction noise annoyance among the respondents. Every respondent have different calculated RII values which indicate the difference in noise annoyance levels (Table 3). There were differences in noise annoyance levels due to the difference in distances of respondents' houses to the construction sites. Therefore, every respondent have their own awareness and sensitivity towards the construction noise that cause them to have different noise annoyance levels.

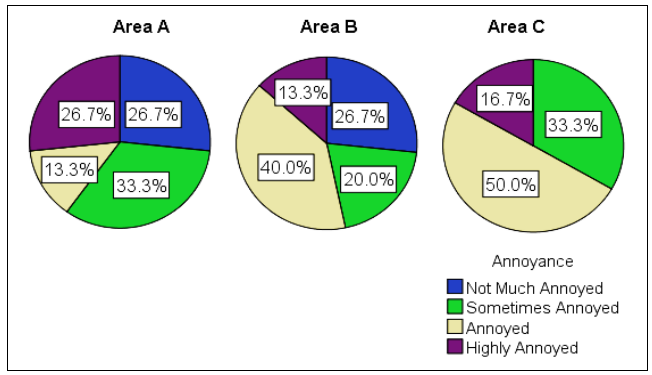


Figure 8 Construction noise annoyance levels among the respondents

Table 3 Construction noise annoyance levels among the respondents

Resident A	Annoyance level	Resident B	Annoyance level	Resident C	Annoyance level
1	Highly annoyed	16	Annoyed	31	Annoyed
2	Annoyed	17	Highly annoyed	32	Highly annoyed
3	Annoyed	18	Highly annoyed	33	Highly annoyed
4	Highly annoyed	19	Annoyed	34	Highly annoyed
5	Highly annoyed	20	Annoyed	35	Annoyed
6	Highly annoyed	21	Annoyed	36	Annoyed
7	Annoyed	22	Not much annoyed	37	Highly annoyed
8	Annoyed	23	Sometimes annoyed	38	Highly annoyed
9	Annoyed	24	Highly annoyed	39	Highly annoyed
10	Annoyed	25	Not much annoyed	40	Annoyed
11	Not much annoyed	26	Not much annoyed	41	Annoyed
12	Sometimes annoyed	27	Highly annoyed	42	Annoyed
13	Not much annoyed	28	Highly annoyed	-	-
14	Sometimes annoyed	29	Highly annoyed	-	-
15	Not much annoyed	30	Annoyed	-	-

The reliability of the scales in the questionnaires has been tested using most common reliability test, Cronbach's alpha (α) method (Table 4). The obtained value from the test was 0.948 which is more than 0.9 indicates that there was excellent internal consistency of scale correlation (high-stakes testing). Thus, the scale of the data was reliable.

Table 4 Cronbach's alpha (α)

Case processing summary			Reliability statistics	
	N	**%**	**Cronbach's alpha**	**N of items**
Valid	42	100.0	0.948	42
Cases excluded[a]	0	.0		
Total	42	100.0		

3.5 Construction Noise Complaints

More than half of the respondents from Residential A (60%) made complaints regarding the construction noise annoyance from the beginning of project execution in 2011 (Figure 9). According to the affected respondents, the complaints have been made to their village headman and the headman has reported to the local authority. This shows that the residents at Residential A were affected and aware to the construction noise annoyance. Meanwhile, only 13.3% of the respondents from Residential B who have made the complaints about the construction noise generated from the piling works. The complaints were made only by the residents who live too close to the piling works area. For

Residential C, 33.33% of the respondents have made the complaints regarding construction noise annoyance.

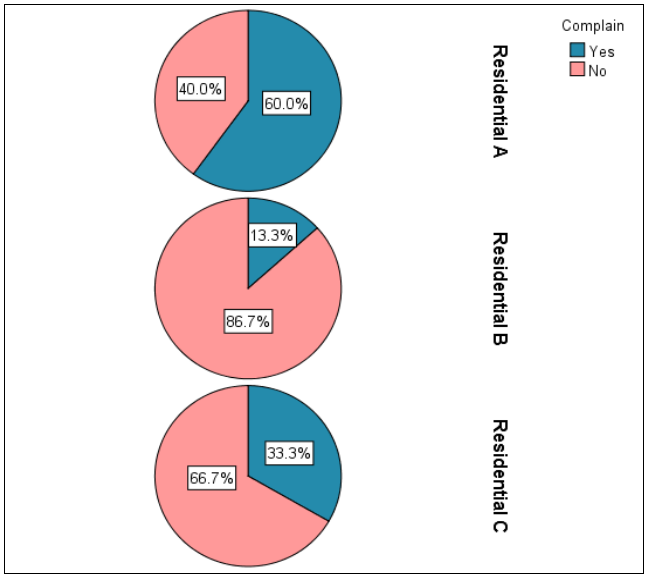


Figure 9 Construction noise complaints

3.6 Sound Pressure Levels and Distances

Earthworks were carried out near to the Residential A whereas piling works at Residential B. Both activities were under a same project but located at different locations and the measurements were not taken concurrently. Meanwhile, earthworks were also carried out near to Residential C but different location as Residential A. The highest sound pressure levels measured at Residential A, B and C were 80.3 dB, 70.3 dB, and 72.3 dB respectively. The closest distances between the respondents' houses and construction sites for all residential areas were 6.80m, 14.3m and 23.7m respectively (Table 5). The measurements of sound pressure level at Residential A were carried out when there is no ongoing piling works at the construction site near to the Residential B in order to avoid any disturbance during the sound pressure levels measurements at the respected residential areas.

Table 5 The summary of measurements

Residential areas	Construction activities	Number of respondent (n)	Highest sound pressure levels (dB)	Closest distances (m)
A	Earthworks	15	80.3	6.8
B	Piling works	15	70.8	14.3
C	Earthworks	12	72.3	23.7

3.7 Relationship between the Sound Pressure Levels and Distances

At Residential A, B C, the closest and farthest distances were 6.8m (80.3dB) and 93.7m (57.6dB), is 14.3 m (70.8dB) and 185.1m (45.0dB) and 23.7m (72.3dB) and 108.23m (52.8dB) respectively. The graph shown that the sound pressure level was decreases with the increasing of distance (y=72.7+-0.23*x+4.44E-4*x^2, R^2 Quadratic=0.682) (Figure 10). Therefore, the residents who live near to the construction site have received high sound pressure level as compared to the residents who stay farther from the construction sites. This was due to the sound that travels through the air took longer time to travel to farthest person and some of sound energy was dissipated and resulted in lower sound pressure level.

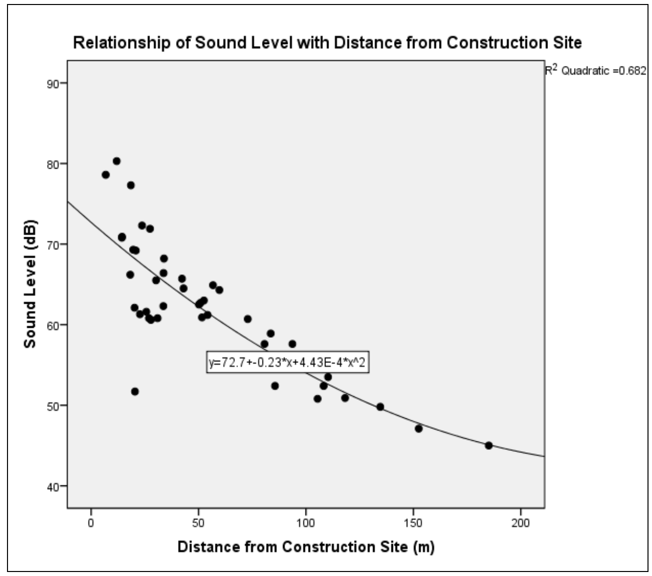


Figure 10 Sound pressure level-distance quadratic graph

3.8 Relationship between the Noise Annoyance Levels and Sound Pressure Levels

Based on previous studies on the relationship between the noise annoyance levels and sound pressure levels generated from airports, roadways and wind turbines it was found that, the annoyance levels increases as the sound pressure levels increase.[35-36] In this study, the noise annoyance levels of the residents who live near to the construction sites were also increased with the increasing of the sound pressure levels from the construction site (y=-1.11+0.04*x+-2.03E-4*x^2, R^2 Quadratic=0.515) (Figure 11). From the figure, the point represents the value of sound pressure levels and annoyance levels for each measurement point at three residential areas. It shows that the respondents who have received high sound pressure levels suffered a high noise annoyance level whereas the respondents who have received low sound pressure levels experienced lower noise annoyance level as expected.

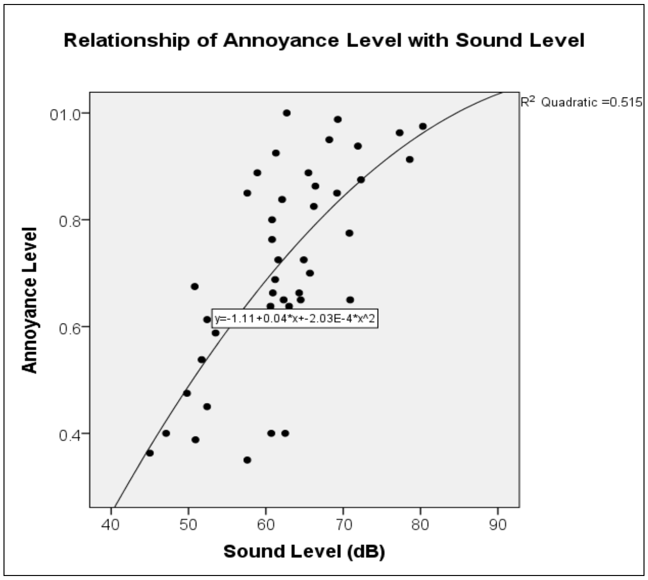


Figure 11 Noise annoyance level-sound pressure level quadratic graph

3.9 Relationship between the Noise Annoyance Levels and Distances

Based on previous study, it was found that noise annoyance level was increased as the distances decrease.[37] For this study, the relationship of noise annoyance level due to the distance between the construction site to the residential areas have shown in the quadratic graph (Figure 12 and Figure 13). The noise annoyance levels of all respondents were decreased as the distance between the respondents and construction sites was farther (y=0.91+-4.28E-3*x+7.24E-6*x^2, R^2=0.463). The sound was transmitted to the receiver through the propagation in the air and the distance is one of the factors that affected this phenomena. The longer the distance that should be travelled by the sound to reach the receiver, the higher the dissipation of sound into the air cause the sound to decreased its energy and cause the sound level to decrease. Therefore, the respondents who live farther from construction site suffer a lower noise annoyance level.

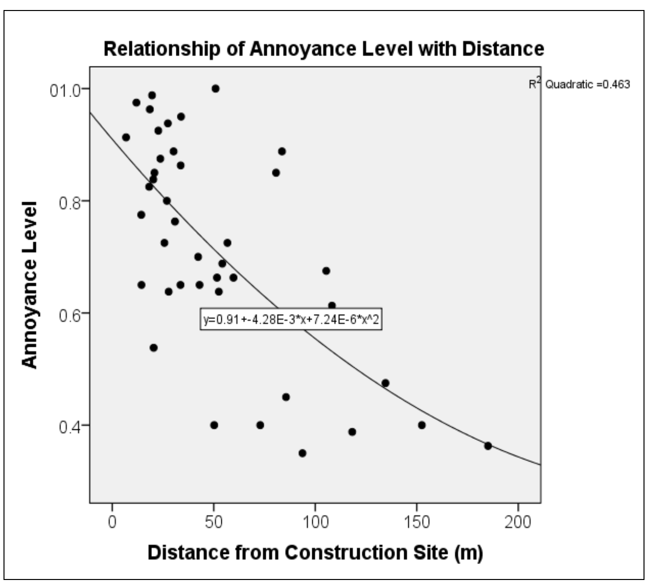


Figure 12 Noise annoyance level-distance quadratic graph

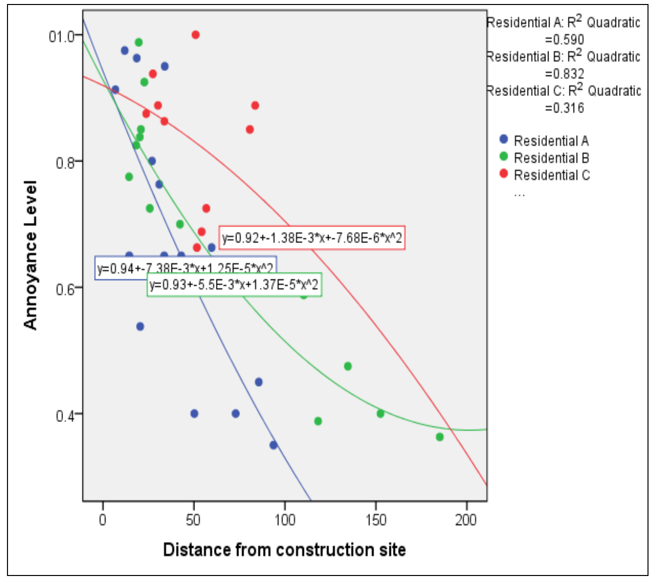


Figure 12 Noise annoyance level-sound pressure level quadratic graph (based on residential areas)

4.0 CONCLUSION

In conclusion, all respondents were affected by the construction noise since there were no respondents who were not annoyed at all. Every respondent have their own annoyance mean value which indicate the noise annoyance levels due to construction works. The different noise annoyance levels were due to the different sound pressure levels and distances between the respondents' houses to the construction sites. As expected, the respondents who live near to the construction sites exposed to a high sound pressure levels and suffered a high noise annoyance levels. Their daily life was disturbed due to the noise form construction sites. The respected parties must be responsible and control the noise generated from construction sites. Other than that, the respected parties must control the noise emission by installing appropriate noise barriers, using quieter machineries or any other suitable noise mitigation measures.

Acknowledgement

This research was funded by Universiti Teknologi Malaysia (UTM) GUP no. Q.J130000.2522.03H43, and special thanks to UTM Zamalah and MOHE for financial supports.

References

[1] Berglund, B., Lindvall, T. and Schwela, D. H. (Eds.). 1999. *Guidelines for Community Noise*. London: World Health Organization (WHO).
[2] Luxon, L. M. and Prasher, D. (Eds.). 2006. *Noise and Its Effects*. England: Whurr Publishers Limited.
[3] Duerden, C. 1970. *Noise Abatement*. London: Butterworth & Co. (Publishers) Ltd.
[4] Hamoda, M. F. 2008. Modeling of Construction Noise for Environmental Impact Assessment. *Journal of Construction in Developing Countries*. 13(1): 79–89.
[5] Zhou, J., Li, Y. and Ma, H. 2012. Study on Prediction and Assessment of Noise Environment Impact during the Construction Period. *International Journal of Advancements in Computing Technology (IJACT)*. 4(6): 1–9.
[6] Ng, C. F. 2000. Effects of Building Construction Noise on Residents: A Quasi- Experiment. *Journal of Environmental Psychology*. Academic Press.

[7] Zolfagharian, S., Nourbakhsh, M., Irizarry, J., Ressang, A. and Gheisari, M. 2012. Environmental Impact Assessment on Construction Sites. *Construction Research Congress 2012*. 1750–1759.

[8] Toghabeh, Z., Hosseinian, S. S. and Reesang, A. 2013. Risk Assessment of Ergonomic Risk Factors at Construction Sites. *Applied Mechanics and Materials*. 330: 857–861.

[9] Toghabeh, Z., Hosseinian, S. S. and Reesang, A. 2013. Relative Importance of Hazards at Construction Sites. *Applied Mechanics and Materials*. 330: 867–871.

[10] Zolfagharian, S., Irizarry, J., Ressang, A., Nourbakhsh, M. and Gheisari, M. 2014. Automated Safety Planning Approach for Residential Construction Sites in Malaysia. *International Journal of Construction Management*. 14(3): 134–147.

[11] Field, H. L. and Solie, J. B. 2007. *Introduction to Agriculture Engineering Technology–A Problem Solving Approach*. 3rd ed. New York: Springer Science + Business Media, LLC.

[12] Hansen, C. 2005. *Noise Control: from Concept to Application-USA and Canada*. Canada: Taylor and Francis Inc.

[13] Vaucher de la Croix, D. and Freneat, C. 2013. Permanent Vibration and Noise Monitoring as a Valuable Tool to the Construction Industry. *Acoustical Society of America*. 19: 1–5.

[14] Davis, B. 2002. Reducing Noise from Forges and Foundries-The Handbook of the Black Country Forging and Foundry Project (Part 4). The United Kingdom: ISVR University of Southampton.

[15] Bies, D. A. and Hansen, C. H. 2009. *Engineering Noise Control: Theory and Practice*. 4th ed. The United States of America: Spon Press.

[16] Edworthy, J. 1997. Noise and Its Effect on People: An Overview. *International Journal of Environmental Studies*. 51: 335–344.

[17] Gannoruwa, A. and Ruwanpura, J. Y. 2007. Construction Noise Prediction and Barrier Optimization Using Special Purpose Simulation. *Simulation Conference*, *2007 Winter*. 9–12 December. Washington, DC. 2073–2081.

[18] Muzet, A. 2007. Environmental Noise, Sleep and Health. *Sleep Medicine Reviews*. 11: 135–142.

[19] Koushki, P. A., Al-Saleh, O., and Ali, S. Y. 1999. Traffic Noise in Kuwait: Profiles and Modeling Residents' Perceptions. *J. Urban Plann. Dev*. 125(3): 101–109.

[20] Vastfjall, D. 2002. Influences of Current Mood and Noise Sensitivity on Judgments of Noise Annoyance. *The Journal of Psychology: Interdisciplinary and Applied*. 136(4): 357–370.

[21] Paunovic, C. K., Jakorljevic, B. and Bolejevic, G. 2009. Predictors of Noise Annoyance in Noisy and Quiet Urban Streets. *Journal of Science of the Total Environment*. 407: 3707–3711.

[22] Laszlo, H. E., McRobie, E. S., Standsfeld, S. A., and Hansell, A. L. 2012. Annoyance and other Reaction Measures to Changes in Noise Exposure - A Review. *Science of the Total Environment*. 435–436: 551–562.

[23] Karami, K. and Frost, S. 1995. Traffic Noise and Annoyance. *Environmental Management and Health*. 6(4): 29–31.

[24] Pedersen, E. and Larsman, P. 2008. The Impact of Visual Factors on Noise Annoyance among People Living in the Vicinity of Wind Turbines. *Journal of Environmental Psychology*. 28: 379–389.

[25] Department of Environment (DOE). 2007. *The Planning Guidelines for Environmental Noise Limits and Control*. 2nd ed. Malaysia: Department of Environment.

[26] Daniel, E. 2007. Noise and hearing loss: A review. *Journal of School Health.* American Health School Association. 77(55).

[27] Majlis Perbandaran Johor Bahru (MBJB). 2013. *Sistem Pengurusan Aduan-Ringkasan Aduan Mengikut Jabatan.* Johor: MBJB.

[28] New Straits Times (NST). 2012. *Sleepless Nights Due to Construction*. Retrieved from www.nst.com.my/streets/northern/sleepless-nights-due-to-construction-1.46668 on 7th July 2013.

[29] The Star. 2012a. *Construction Works Beyond Permitted Hours Irks Resident.* Retrieved from www.thestar.com.my on 6th July 2013.

[30] The Star. 2012b. *Kiara Hill Residents are Troubled by Noise from Construction Site*. Retrieved from www.thestar.com.my on 6th July 2013.

[31] Santos, J. R. 1999. Cronbach's Alpha: A Tool for Assessing the Reliability of Scales. *Journal of Extension.* 37. Retrieved from http://www.joe.org/joe/1999april/tt3.phpon 8th September 2013.

[32] Fernandez, M. D., Quintana, S., Chavarria, N. and Ballesteros, J. A. 2009. Noise Exposure of Workers of Construction Sector. *Applied Acoustics*. 70: 753–760.

[33] 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.

[34] Haron, Z., Mohd Noh, H., Yahya, K., Omar, W. and Abd Majid, Z. 2012. Assessing Noise Emission Levels from Earthwork Construction Equipment. *Malaysian Journal of Civil Engineering*. 24(1): 13–28.

[35] Di, G., Liu, X., Zheng, Y and He, L. 2012. The Relationship between Urban Combined Traffic Noise and Annoyance: An investigation in Dalian, North of China. *Science of the Total Environment*. 432: 189–194.

[36] Pierette, M., Marquis-Farre, C., Morel, J. Rioux, L. Vallet, M., Viollon, S. and Moch, A. 2012. Noise Annoyance from Industrial and Road Traffic Combined Noises: A Survey and a Total Annoyance Model Comparison. *Journal of Environmental Psychology*. 32: 178–186.

[37] Bangjun, Z., Lili, Shi. and Guoqing, D. 2003. The Influence of the Visibility of the Source on the Subjective Annoyance due to its Noise. *Applied Acoustic*. 64: 1205–1215.