EXTERNAL COST OF NOISE EFFECT ON CONSTRUCTION WORKERS USING IMPACT PATHWAY APPROACH

AIFI ANDRICE IZHAR ISWANDI

UNIVERSITI TEKNOLOGI MALAYSIA

EXTERNAL COST OF NOISE EFFECT ON CONSTRUCTION WORKERS USING IMPACT PATHWAY APPROACH

AIFI ANDRICE IZHAR ISWANDI

A thesis submitted in fulfilment of the
requirements for the award of the degree of
Master of Engineering (Construction)

Faculty of Civil Engineering
Universiti Teknologi Malaysia

JUNE 2013

To my beloved family

My Father Iswandi H Basri and Mother Ismiati Damis

My Sister Alfinella Izhar Iswandi

My Brother Ivan Rizano Iswandi and Alvin Rizano Iswandi

ACKNOWLEDGEMENT

In the name of Allah the Most Gracious and the Most Merciful. Alhamdulillah Thanks to God for His Blessing

I would like to express my gratitude to my thesis supervisor DR Khairulzan Yahya and DR Zaiton Haron for their guidance and encouragement in completing this work.

My sincere thank also goes to Universiti Teknologi Malaysia, Research Management Centre - UTM and Puan Siti Hawa Omar from SOCSO Kuala Lumpur for supporting this study, researchers, and academicians for their contribution towards my understanding and thoughts.

I express my gratitude to Lili Ayu Wulandhari, Nadya Fabarani, Mirza Ardella Saputra, Ibu Ellyyanti, Persatuan Pelajar Indonesia – UTM and all lab mates, for their advice and understanding, for their support and helps.

.

ABSTRACT

Noise from construction activities are often be associated with the use of equipments and machineries. The noise from the construction activities could potentially have a negative impact to the construction workers and publics. The negative effect can also be seen in terms of the cost to be borne by the workers and publics. The cost is known as *external cost* or *externality cost*. The costs are the result of the actions from economic actors that can influence the well-being of others that has nothing to do with the activity. This study was carried out to examine and evaluate the external costs borne by the affected construction site workers due to the construction sites noise generated from the use of equipments and machineries. Impact Pathway Approach (IPA) was used in this study. IPA was conducted in three main steps, (i) measuring volume level of sound generated from the equipments and machineries used in construction site (ii) determine the impact of noise to the construction site workers and (iii) evaluate the effects of noise in term of the costs incurred by the affected employees. The data used in this study was obtained from the recorded noise levels of machineries used during the activities of building sub-structure works at few construction sites in Johor Bahru. *External costs* data were extracted from a series of claims made by affected workers for the compensation of hearing loss through the Malaysian Social Security Organisation (SOCSO). Besides, market surveys for the cost of hearing aids were also conducted as part of the estimation the *external costs*. The results showed that the *external costs* borne by the affected workers are high. Estimated external costs were varies in between RM151, 321.36 to 908,701.44 depending on several factors such as the levels of hearing loss and age of the affected workers.

ABSTRAK

Kebisingan dari aktiviti-aktiviti pembinaan seringkali dikaitkan dengan penggunaan peralatan dan jentera yang digunakan. Kebisingan ini berpotensi memberi kesan negative kepada orang-ramai terutamanya pekerja-pekerja binaan ditapak projek tersebut akibat terdedah kepada pencemara bunyi tersebut. Kesan negative ini juga boleh dilihat dari segi kos yang perlu ditanggung oleh pekerja-pekerja yang terlibat yang dikenali sebagai *kos luaran* atau *externality cost*. Kos ini adalah hasil tindakan dari pelaku ekonomi yang boleh mempengaruhi kesejahteraan orang lain yang tiada kaitan langsung dengan aktiviti tersebut. Kajian ini dijalankan adalah bertujuan untuk mengkaji serta menilai *kos luaran* yang ditanggung oleh pekerja-pekerja yang dikenalpasti telah terkesan akibat kebisingan di tapak bina. *Impact Pathway Approach* (IPA) telah digunakan dalam kajian ini. IPA dijalankan dalam tiga langkah utama, iaitu (i) menentu tahap kekuatan bunyi dari peralatan dan jentera yang digunakan dalam pembinaan (ii) menentukan nilai impak kebisingan dan (iii) menilai kesan kebisingan dari sudut kos yang ditanggung oleh pekerja-pekerja yang diterlibat. Data yang digunakan dalam kajian ini diperolehi dari dari pencerapan paras bunyi jentera yang digunakan bagi kerja-kerja sub-struktur bangunan di tapak bina sekitar Johor Bahru. Data-data kos diperolehi daripada tuntutan bagi pampasan kehilangan tahap pendengaran pekerja pembinaan diperolehi dari Pertubuhan Keselamatan Sosial Malaysia (SOCSO). Kajian tinjauan pasaran bagi alat bantu pendengaran turut dijalankan bertujuan untuk menganggarkan kos yang harus ditanggung oleh pekerja-pekerja yang terlibat. Keputusan kajian menunjukkan bahawa *kos luaran* yang ditanggung oleh pekerja-pekerja yang terlibat adalah tinggi. Anggaran kos luaran yang direkodkan adalah diantara RM151,321.36 sehingga 908,701.44. *Kos luaran* ini bergantung kepada beberapa faktor individu pekerja-pekerja yang terlibat seperti faktor tahap kehilangan pendengaran dan faktor umur.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

LIST OF ABBREVIATION

IPA	-	Impact Pathway Approach
NIHL	-	Noise Induced Hearing Loss
NIOSH	-	National Institute for Occupational Safety and Health
SLM	-	Sound Level Meter
L_{ep}	-	Noise Exposure
TTS	-	Temporary Threshold Shift
WHO	-	World Health Organization
SOCSO	-	Social Security Organization
VED	-	Value of Environmental Engineering
DFA	-	Damage Function Approach
COI	-	Cost of Illness
C_{wc}	-	Total Cost of Waste Control
C_{wd}	-	Total Cost of waste Disposal
C_{ep}	-	Total Cost of Eco Policy
C_{e}	-	Total Cost of Energy
C_{rr}	-	Total Cost of Saving of Recycling and Re-use
C_{i}	-	Total Cost of Impact
C_{em}	-	Total Cost if Emission from Equipment
C_{de}	-	Total Cost of Depreciation of Equipment
C_{lab}	-	Total Cost Relate to Labor

HL - Hearing Loss

icvlphm - Value of Loss Time due to Heightened Morbidity

icvllthm - Value of Lost Leisure Time due to Heightened Morbidity

CHAPTER 1

INTRODUCTION

1.1 Introduction

In many countries, construction activities become more dynamic and complicated due to the increase of population in line with the economic growth. However, construction activities is also found as one of the major contributors to the environmental impacts, such as air pollution, waste pollution, noise pollution and water pollution.

Workers in construction industry are at particular risk of the impact from that pollution. Noise pollution is one of the significant impacts to the workers. Impact from noise pollution cause the economic problem in the same sense with air and water pollution. Noise pollution has the most limited effect, as it disappears soon after the emission source has disappeared. However, after pollution or noise have dissolved, the impacts of the exposure, may occur several years after the exposure. Of course, the instruments for internalisation of these externalities have to reflect the character of the effect that is subject to internalisation (Bugriarello, 1976; Ricci and Friedrich, 1999).

Some of literatures on noise pollution highlight a wide range of cost related with loss of amenity, adverse health impacts, slower learning rates in children and irritation and effects on local ecology. Based on the empirical evidence, an initial estimate of the costs of noise pollution are £3 - £5 billion in annoyance costs, £2 - £3

billion in health cost, and other £2 billion n productivity losses (Delucci and Hsu, 1996; DEFRA, 2008).

1.2 Background Of Study

Estimating the cost of noise emission is not a new concept. Globally, a number of estimate noise effect studies have been undertaken in the last two decades in UK, Switzerland, US, Canada, Australia, Japan, Germany etc. Different concepts, methodologies and assumption for valuation have been used. So far, almost all the studies conducted are limited to valuation of road, traffic and aircraft noise exposure.

Ricci and Friedrich (1999) conducted a study to estimate environmental cost of transportation using Impact Pathway Approach (IPA). Meanwhile, Dai (2002) employed the statistical and contingent valuation methods on economic valuation caused by noise pollution at airport. European Commission (2003) had also estimated an external cost on society environmental damages due to electricity and transport by using IPA.

Gautama and Sulataksana (2004) conducted an economic valuation to examine noise from machineries. Brown et al (2004) carried out a study about a cost benefit analysis of O'Hare International Airport Noise Pollution. IPA was also used by Yahya and Boissabaine (2006) to estimate eco-costing of building construction wastes in UK.

1.3 Statement of the Problem

Similarly with traffic and airport noise exposure, noise from construction could also gives negative impact to the environment and cause external cost. Study

carried out by DEFRA (2008) stated that noise pollution can adverse health impacts especially hearing problem. Eaton (2000) reported that 8% of hearing loss claims are attributed from construction sector comparable to the heavy manufacturing group. While Wan Mahmood (2009) on his study stated that construction industry contributes 16% for Noise Induced Hearing Loss (NIHL). However, all of the costs are need to be to be borned by the sufferer called external cost.

In Malaysia, there is a lack of data regarding external costs of noise from construction. So far, study related with external cost is only at initial stage. Meanwhile, there is no comprehensive methodology and established guideline that can be used as references.

Ever since European Commission developed Impact Pathway Method (IPA) methodology to estimate external cost on, many of studies about external cost adopts this method. So far the adoption of this methodology is limited to estimating of road, traffic noise and aircraft exposure. This research emphasizes on estimating external cost to the workers caused by noise from construction equipment at construction site.

1.4 Aims and Objective of the Study

The research aims to estimate the external cost of noise generated at the construction site caused by noise from construction equipment to the workers. In order to reached the above aims, several objective has been established:

1. To determine noise effect exposure from equipment to workers hearing problem.
2. To assess the level of noise from construction equipment.
3. To investigate method of assessing the impact of noise from construction equipment.
4. To calculate external costs due to the impact of noise from construction equipment.

1.5 Scope of this Study

The limitation of this research related the earthworks stages of construction activity. This is due to the fact that earthwork stage is the noisiest stage which produced high noise level and directly linked to the equipment (Haron et al, 2012). In order to assess noise levels from an equipment only time, duration and distance of noise will be considered. For the purpose of quantification noise exposure and monetary valuation, it only will consider the effect on hearing of the workers at the earthwork stages. The data used in this study are elaborated from the sound power level of equipment at construction site during the stages at sites around Johor Bahru. Noise exposure impact (hearing problem) to construction workers were based on claims made at the SOCSO Office in Kuala Lumpur. The market survey was used to obtain market price associated with the cost.

1.6 Significance of the Study

This research focuses on specific environmental issues which is noise at construction site and to estimate the external cost of the noise impact to the workers. IPA applied to calculate external cost of noise. The impact of noise due to noise exposure from construction equipment calculated using IPA and then translated into monetary valuation. The finding of this study could be used to monitor and control the noise to avoid the cost in the future. It may also used to suggest how to prevent cost from noise exposure impact to the workers from construction equipment for the future research.

3.3 Top-down Approach

While the most recent estimates of the externalities were often based on a bottom-up approach and focus to marginal cost theory, Lindberg (2003) used top-down approach to estimate external cost due to road transport. In contrast with the marginal cost theory the estimate both external and marginal with stronger in economic theory, the top-down approach starts with an estimate of total (external) cost. The total cost is then allocated to different modes or vehicle categories and finally divided with the traffic volume to express the cost per kilometre driven. While in the bottom-up approach, the starting point is the detailed databases which are analysed basically with econometric methods to derive functions and subsequently marginal cost estimates.

4.0 Conclusion

The uncertainties of estimating the externalities cost are still relatively high due to following reasons, 1. variable inherent in any set of input data used for estimating external cost, 2. extrapolation of data, 3. extrapolation of exposure response data or result from contingent valuation studies from one geographical location to another, 4. assumptions regarding threshold conditions, 5. lack of detailed information with respect to human behaviour and 6. assumptions like the selection of discount rate. In conclusion, IPA (bottom-up approach) is found to be the most common and applicable method to estimate externalities likes noise pollution.

REFERENCES

Bickel and Friedrich (2001). Estimating the Environmental Cost using Impact Pathway Approach. University Stuttgart. Germany

Buchari (2007). Kebisingan Industri dan Program dan Hearing Conservation Program. Universitas Sumatera Utara

Bugriarello et al (1976). The Impact of Noise Pollution : A Socio Technological Introduction. Pergamon Press. New York

Dai (2002). *Valuasi Ekonomi Dampak Kebisingan terhadap Gangguan Kesehatan Masyarakat dan Lingkungan Fisik*. Universitas Indonesia. Master

DEFRA (2008). An Economic Valuation of Noise Pollution. Developing a Tool for Policy Appraisal. United Kingdom

Ståle Navrud (2002). The State of Art on Economic Valuation of Noise, Department of Economics and Social Sciences, Agricultural University of Norway

European Commission (2003). External Cost. Research Result on Socio Environmental Damage due to Electricity and Transport

Gautama and Sutalaksana (2004). Economic *Value Examination of Machinery Noise at Utilities Facility at PT XYZ*. Institut Teknologi Bandung. Master

Goodwin, N.R and T. Tietenberg (2008). Essential of Economics Encyclopedia of Earth. Washington DC

Linberg (2003). Estimating External Cost. IMPRINT

Mankiw, N.G. Essential of Economics. Fourth Edition. Thompson South Western.

Ricci and Friedrich (1999). Calculating Transport Environmental Cost. Final Report of Expert Advisors to The High Level Group on Infrastructure Charging.

Studies, S.C (2009). Methods for Calculating Externalities. Athens University of Economics and Bussiness.

Vernard and Johannes (2002). *Analisa Dampak Negatif Proyek terhadap Lingkungan. Universitas Kristen Petra*. Degree

WHO (1999). Guidelines for Community Noise. Geneva

Workers Compensation Board (2000). Construction Noise. Enggineering Report. Canada