RELATIONSHIP BETWEEN INDUSTRIAL NOISE LEVEL AND COMMUNITY SUBJECTIVE RESPONSE

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The objectives of this study were to determine the relationship between industrial noise levels from wood furniture factories and community subjective response and to propose a guideline for annoyance noise from wood furniture factories. Ten wood furniture factories in Bangsue District, Bangkok Metropolis and 198 respondents living nearby the factories were included in this study.

Community noise levels were measured in terms of one and 24 hr equivalent continuous sound pressure level, (L_{eq}1 hr, L_{eq}24 hr), and background noise level (L_{90}). Rating level (L_r), average maximum noise level (L_{10}), noise pollution level (L_{np}), and difference between rating level and background noise level (L_r-L_{90}) were then calculated. Subjective noise perceptions were evaluated by interviewing the respondents using a noise survey questionnaire.

The results suggested a significant linear relationship between percentage of highly annoyed respondents and L_r, L_{10}, L_{np} and L_r-L_{90} (r = 0.73-0.96, p-values = 0.017–0.0001). At 20 percent of highly annoyed respondents, the value of L_r, L_{10}, L_{np} and L_r-L_{90} were 65.0, 67.0, 73.4 and 11.5 dB(A), respectively. It was found in this study that the relationship of the value of difference between rating level and background noise level (L_r-L_{90}), and percentage of highly annoyed respondents was highly significant (p-value = 0.0001) with correlation coefficient of 0.96.

Based on published British Standard, BS4142:1990, the value of difference between rating level and background noise level (L_r-L_{90}) of 11.5 dB(A) is proposed as a guideline value for annoyance noise in mixed residential and wood furniture industrial areas.

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จำนงค์ ธนะภพ : การศึกษาความสัมพันธ์ระหว่างเสียงรบกวนจากโรงงานอุตสาหกรรมกับการตอบสนองของประชาชนในชุมชน (RELATIONSHIP BETWEEN INDUSTRIAL NOISE LEVEL AND COMMUNITY SUBJECTIVE RESPONSE) คณะกรรมการควบคุมวิทยานิพนธ์: ปรีชา ลอเสรีวานิช, Ph.D., เฉลิมชัย ชัยกิตติภรณ์, Dr.P.H., วิทยา อยู่สุข, D.Eng., เพียงจันทร์ โรจนวิภาต, M.H.S.(Bios.). 126 หน้า. ISBN 997-663-373-2

การศึกษานี้เป็นการศึกษาภาคตัดขวางในกลุ่มประชาชนที่อาศัยอยู่ใกล้โรงงานผลิตเฟอร์นิเจอร์ไม้ โดยมีวัตถุประสงค์เพื่อศึกษาความสัมพันธ์ระหว่างเสียงรบกวนจากโรงงานผลิตเฟอร์นิเจอร์ไม้กับการตอบสนองของประชาชนในชุมชน และนำผลที่ได้เสนอเป็นแนวทางในการกำหนดมาตรฐานเสียงรบกวนที่เกิดจากโรงงานดังกล่าว โรงงานที่ได้คัดเลือกมาศึกษามีทั้งหมด 10 โรงงาน ตั้งอยู่ในเขตบางซื่อ กรุงเทพมหานคร

การตรวจวัดเสียงในชุมชน ทำการวัดเสียงในรูปของระดับเสียงเฉลี่ยเทียบเท่าแบบต่อเนื่อง 1 ชม.(Leq 1 hr) ตลอดระยะเวลาการผลิตของโรงงาน (08.00-17.00 น.) ระดับเสียงเฉลี่ยเทียบเท่าแบบต่อเนื่อง 24 ชม.(Leq 24 hr) ระดับเสียงพื้นฐาน(L_{90}) และทำการคำนวณระดับเสียงเป็นค่าดัชนีต่างๆ ได้แก่ ค่าระดับเสียงรบกวน(L_r) ระดับเสียงเปอร์เซ็นต์ไทล์ที่ 10 (L_{10}) ระดับมลพิษทางเสียง (L_{np}) และผลต่างของระดับเสียงรบกวนกับเสียงพื้นฐาน(L_r-L_{90}) ในขณะที่ทำการตรวจวัดเสียงในชุมชน ได้สัมภาษณ์ประชาชนที่อาศัยอยู่รอบๆ โรงงาน จำนวน 198 คน ด้วยแบบสอบถามเพื่อประเมินการถูกรบกวน

ผลการศึกษาพบว่าความสัมพันธ์ระหว่างร้อยละการรบกวนของผู้ให้สัมภาษณ์ กับค่าดัชนีเสียงดังกล่าว มีความสัมพันธ์ในเชิงเส้นตรงด้วยค่าสัมประสิทธิ์สหสัมพันธ์ 0.73-0.96 ที่ระดับความเชื่อมั่นมากกว่าร้อยละ95 (p-value = 0.017-0.0001) ค่าระดับเสียงที่ร้อยละ 20 การรบกวนของผู้ให้สัมภาษณ์ พบว่า ระดับเสียงรบกวนมีค่า 65 dB(A) ระดับเสียงเปอร์เซ็นต์ไทล์ที่ 10 มีค่า 67 dB(A) ระดับมลพิษทางเสียงมีค่า 73.4 dB(A) และผลต่างระหว่างเสียงรบกวนกับระดับเสียงพื้นฐานมีค่า 11.5 dB(A) ซึ่งความสัมพันธ์ระหว่างร้อยละการรบกวนของผู้ให้สัมภาษณ์กับผลต่างดังกล่าว มีค่าสัมประสิทธิ์สหสัมพันธ์และระดับความเชื่อมั่นสูงสุด (r = 0.96, p-value = 0.0001)

จากผลการศึกษาดังกล่าว จึงเสนอแนะค่าผลต่างระหว่างเสียงรบกวนกับระดับเสียงพื้นฐานของชุมชนที่ 11.5 dB(A) เป็นค่ามาตรฐานสำหรับประเมินเสียงรบกวนจากโรงงานเฟอร์นิเจอร์ไม้

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INTRODUCTION

1.1 Background and rationale

Thailand's continuous social and economic development over the last decade has resulted in the expansion of industry and transportation, increase of urban population and technology applications in daily life without consideration of effect on environment. This has given rise to problems of air pollution, water pollution, land pollution and noise. Among these problems, noise is one of the most concerned problems in community. Table 1-1 showed that noise had been the top rank among the several causes of nuisance in Bangkok from 1993 to 1995 (1). The percentage of complaints due to noise was 33.39%.

Table 1-1 Causes of annoyance reported in Bangkok from 1993 to 1995

Types of annoyance	Number of complaints			Total	Percent
	1993	1994	1995		
1. Noise	838	862	895	2,595	33.39
2. Offensive odor	796	770	741	2,307	29.69
3. Wastewater	272	272	254	798	10.27
4. Dust	273	253	262	788	10.14
5. Solid waste	89	74	65	228	2.93
6. Toilet	66	56	66	188	2.42
7. Farming	28	36	32	96	1.24
8. Insects vector	20	26	25	71	0.92
9. Vibration	28	14	15	57	0.73
10. Others	253	180	210	643	8.27
Total	**2,663**	**2,543**	**2,565**	**7,771**	**100**

Source: the Department of Health, Bangkok Metropolis

The Pollution Control Department also reported noise complaint in the Bangkok Metropolis and Suburbs from 1992 to 1995. It indicated that factories were the main source of noise. Among this, furniture factory contributed 4-8 % of the complaints (Table C-1, Appendix C)(2).

In 1996, the record from the Department of Health, Bangkok Metropolis showed that there were 1,812 wood furniture factories in Bangkok (1). Most of these factories located in communities and had no noise control system. This led to noise annoyance in the communities. Generally, the effects of noise on human include communication and work interference, sleep disturbance, stress, hearing loss and other health effects.

The Eighth National Economic and Social Development Plan in effect 1997-2001 has been promoting the wood furniture industries (3). Accordingly, the number of wood furniture factory is increasing. Therefore, the tendency of annoyed noise is expected to increase if preventive and control measures are not attended.

The purpose of this study was to determine the relationship between noise levels from wood furniture factory and community subjective response. These results could be used as guideline for standard setting of annoyance noise from wood furniture factory.

1.2 Objectives

General objectives

1.To study the relationship between industrial noise levels and community subjective response.

2.To propose an appropriate annoyance noise guideline for wood furniture factory.

Specific objectives

1.To study the relationship between rating level (L_r) and community subjective response.

2.To study the relationship between difference of rating level and background noise (L_r-L_{90}) and community subjective response.

3.To study the relationship between noise pollution level (L_{np}) and community subjective response.

4.To study the relationship between the average maximum noise level (L_{10}) and community subjective response.

1.3 Variables

Independent variables:

Specific noise level ($L_{eq\text{-}Tr}$)

Rating level (L_r)

Background noise level (L_{90})

Noise pollution level (L_{np})

The average maximum noise level (L_{10})

Dependent variable:

Community subjective response

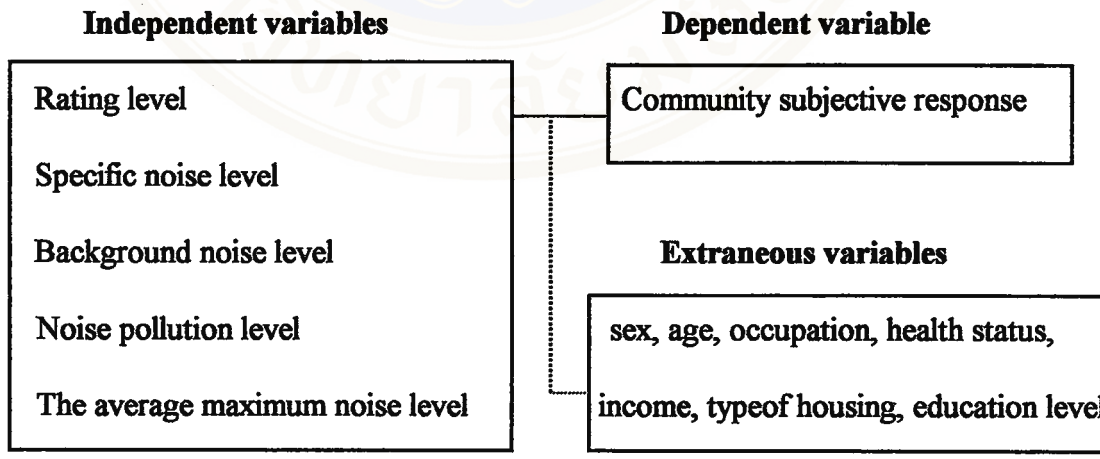
Extraneous variables:

sex, age, occupation, health status, income, type of housing, education level

1.4 Scope of study

The factories in this study were limited to wood furniture factories that located within community in Bangsue District, Bangkok Metropolis. The respondents included in this study were limited to dose whose lived or worked near the selected furniture factories.

1.5 Conceptual framework



1.6 Glossary and definition

Specific noise level, $L_{eq\text{-}Tr}$	The equivalent continuous A - weighted sound pressure level in decibels at the measurement position produced by the specific noise source over a given reference time interval. The specific noise level is quoted to the nearest whole number of decibels (4).
Reference time interval, T_r	The specified interval over which an equivalent continuous A-weighted sound pressure level is determined (4).
Measurement time interval, T_m	The total time over which measurements are taken (4).
Rating level, L_r	The specific noise level plus any adjustment for the character of the noise. If there are distinct impulses, add 5dB (A) to the specific noise level to obtain the rating level (4).
Background noise level, L_{90}	The A - weighted sound pressure level of the residual noise in decibels exceed for 90% of a given time interval. The background noise level is quoted to the nearest whole number of decibels (4).
L_r-L_{90}	A difference between rating level and background noise level.

Noise pollution level, L_{np}	L_{np} is L_{eq} + 2.56 σ, where L_{np} is the noise level over a specified period averaged on an energy basis, and σ is the standard deviation of the instantaneous noise level about that average value over the same period.
Community subjective response	The reactions of residents in community to industrial noise level.
Degree of annoyance	In this study, degree of annoyance is identified by using four-point annoyance scale : not annoyed, slightly annoyed, moderately annoyed and very annoyed.
Highly annoyed	The highly annoyed respondent obtained by combining the moderately annoyed and very annoyed responses from the four-point annoyance scale.
Equivalent continuous sound-pressure level, L_{eq}	The value of the A-weighted sound pressure level in decibels of continuous steady sound that is measured within a specific time interval
The average maximum noise level, L_{10}	The A - weighted sound pressure level of the noise in decibels exceed 10% of a given time interval.

Sound pressure level, L_p	The ratio of the pressure of a sound wave relative to a reference sound pressure. Sound pressure level in decibels is typically referenced to 20 microPascals.
Maximum noise level, L_{max}	Maximum noise level occurs in the measuring period.
Continuous noise or steady noise	Continuous noise or steady noise is normally defined as broadband noise of approximately constant level. In general, sound repeated more than once per second can be considered as steady.
Intermittent noise	Intermittent noise is impulsive noise or impact noise
Impulsive noise	Impulsive noise or impact noise is a sharp burst of sound, with an abrupt onset and rapid decay such as that made by hammer blows or explosions. Generally, impulsive noise is less than one-half second in duration and does not repeat more often than once per second.

CHAPTER II

LITERATURE REVIEW

Noise is considered as unwanted sound that may adversely affect the health and well being of individuals or populations. Physically, sound is a mechanical disturbance propagated as a wave motion in air and other elastic or mechanical media such as water or steel. Physiologically, sound is an auditory sensation evoked by this physical phenomenon. However, not all sound waves evoke an auditory sensation. The physical properties and perception of sound or noise are expressed and measured in different concepts and units.

2.1 Physical properties of sound

2.1.1 Frequency, wavelength, and speed of sound

Sound wave involve a succession of compression and rarefaction of an elastic medium such as air. These waves are characterized by the amplitude of pressure changes, their frequencies and the velocity of propagation. The speed of sound (c), the frequency (f), and the wavelength (λ), are related by the equation $\lambda = c / f$ (5).

In general, the components of sound in community are mixed complex waves. The sounds that reach human ears have a finite number of frequency components. The normal human ear is sensitive only to the components in the range from about 20 to 20,000 Hz. The ear does not " hear" frequencies that fall outside this range as shown in Figure 2-1 (6).

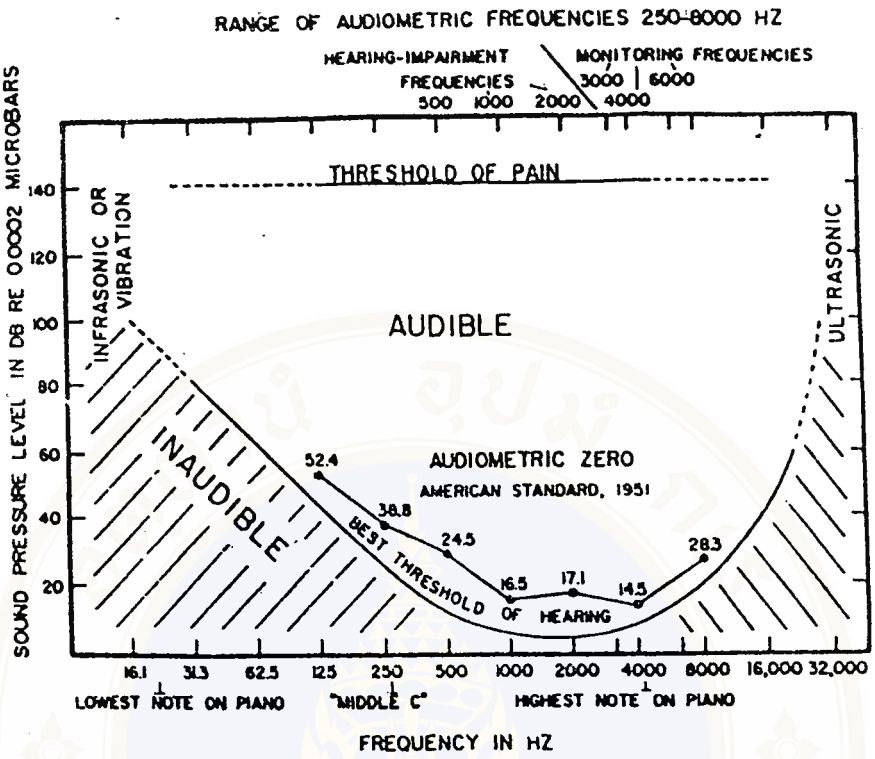


Figure 2-1 Range of audiometric frequency

Generally, sounds in community contain a mixture of frequencies generated from a variety of sources. A sound's frequency composition is called its spectrum. The frequency spectrum can be a determining factor in the level of annoyance caused by noise. High frequency noise is generally more annoying than low-frequency noise. Also, narrow frequency bands or pure tone (single frequencies) can be somewhat more harmful to hearing than broadband noise (7).

Sounds outside the normal hearing range of the human ear can also cause physical discomfort and annoyance. It has been suggested that ultrasonic frequencies (above 20,000 Hz) increasingly used in industry, can seriously damage the human ear even though the ear does not register their presence. Exposure to powerful ultrasonic can affect the nerve cell in the brain and spinal cord and can cause a feeling of nausea

or a burning sensation of the auditory canals. Similarly, infrasonic frequencies, i.e. below 20 Hz, if sufficiently intense, can affect the sense of balance, cause fatigue, irritation and nausea. The brain is particularly sensitive to infrasonic of 7 Hz which coincides with the brain alpha waves. Intense infrasonic can cause internal bleeding if exposure continues over a length of time (8).

2.1.2 Sound power and sound pressure level

The energy that causes the air particles to vibrate is called sound power. The sound power level describes the acoustical power radiated by a given source with respect to the international reference of 10^{12} watt. The equation that defines sound power level (L_w) is

$$L_w = 10 \log (W / W_{re}) \quad (dB)$$

where W_{re} is the reference power of 10^{12} watt and W is the sound power radiated by the source.

Even though sound power levels cannot be measured directly, as the acoustical power is emitted by a source, the air particles compress and expand around atmospheric pressure: thus, what are actually measured with a sound level meter are changes in sound pressure. Sound pressure level is defined as

$$L_p = 10 \log (P / P_{re})^2 \quad (dB)$$

where P_{re} is 20 x 10^{-6} Pascal, or 20 microPascal. This level was chosen as a reference because it has been found that the average young adult can perceive a 1,000 Hz tone at this reference. The magnitude of the sound pressure from a given sound depends on the distance from the source.

2.1.3 Propagation and transmission of sound

The sound intensity (I), at a distance (d), generated from a point source whose acoustic power (W), in free field is given by

$$I = W / 4\pi d^2$$

since the total energy which passes through a sphere of surface area $4\pi d^2$ is W.

The relationship between sound power level and source pressure. If a source is radiating sound equally in all directions, the energy will be spread over an increasing area as the distance from the source increases (8), as indicated in Figure 2-2.

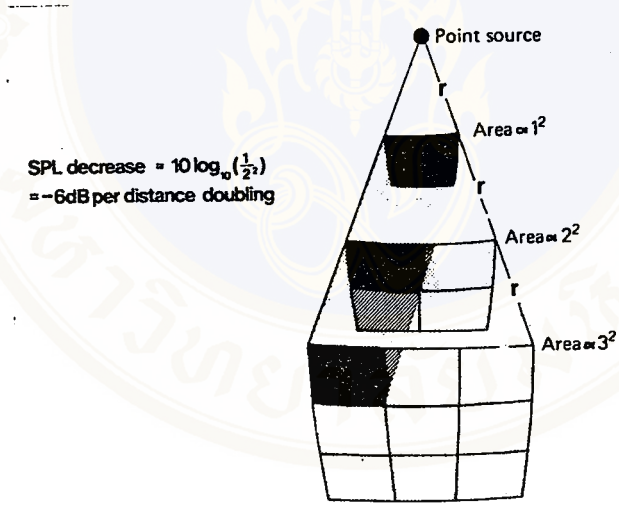


Figure 2-2 Inverse square law

The sound energy per unit area received at any point is inversely proportional to the square of the distance from the source, when the sound level at distance d_1 is L_1 dB, at distance d_2 (nd_1) is L_2 then it follow:

$$L_2 = L_1 - 20 \log (d_2 / d_1) = L_1 - 20 \log n$$

If the distance from the source is doubled the energy density is reduced to a quarter. This means, in terms of decibels, a decrease in level of 6 dB for every doubling of distance. The sound pressure will fall linearly with distance from the source, therefore each doubling of distance the pressure is halved, again leading to a 6 dB drop for each doubling distance. This law will only apply for external sound pressure level (or free field conditions) since in an enclosed space the level will be affected by reflections from floor and walls, etc.

2.2 Sound level meter

A sound level meter is an acoustical measuring instrument consisting of a microphone, an amplifier with a calibrated attenuator, a set of frequency-response network (weighting network) and an indicating meter.

2.2.1 Type of sound level meter

Sound level meters come in many different shapes and sizes, depending on the use and manufactures. There are four board classifications of meters and each classification has its stringent specification (16). The four classifications are general purpose, survey, precision and special purpose.

The two classifications that are normally used the survey sound level meter, classified as type2, and the precision sound level meter, classified as type1. The type2 meter has an accuracy of ± 2.0 dB at most frequencies and is designed a general–purpose sound level meter. The type1 is built to more stringent specifications and has a much higher accuracy of ± 0.5 dB at most frequencies and is designed a precision sound level meter (6).

2.2.2 A-weighted sound level

As acoustics has evolved, various techniques have been develop to describe noise environments, the subjective response, and how the human ear might be damaged with respect to exposure to noise. Weighting curves were devised for this purpose. They were placed within the sound level meter so that they could be electronically switched and used to weight the overall level being measured. Most precision sound level meters incorporate three selectable filters labeled A, B, and C. The A, B, and C filters are intended to the ear-response curves at low, moderate, and high loudness respectively.

However, the most notable of these curves is the " A-weight" curve. This has been found to describe the subjective or human response to noise and annoyance, and how the ear might be damaged by noise. The usual designation is dB A. The dB A combines the overall frequency content of noise source in a weighting network in a sound level meter that has a response much like the human ear (6,7).

As a result of its simplicity in rating the hazard to hearing, the A-weighting level has been adopted as the measurement for assessing noise exposure by the American Conference of Governmental Industrial Hygienists (ACGIH). The A-weighted sound level as the preferred unit of measurement was also adopted by the U.S. Department of Labor as part of its Occupational Safety and Health Standard. The A-weighted sound level have also been shown to provide reasonable good assessments of speech interference and community disturbance condition and adopted by EPA for these purposes (7).

2.2.3 Meter system of sound level meter

Two meter- needle ballistic modes of operation, fast and slow, are provided on every sound level meter. In fast mode , the needle responds relatively quickly to rapidly changing noise level, whereas in the slow mode, the needle responds rather slowly.

Generally, in a factory where an average noise level is often more useful, the slow mode would be selected to reduce rapid, hard-to-read needle excursions. OSHA requires the use of slow responds for measurements to check for compliance with its regulations (7).

2.2.4 Equivalent continuous sound pressure level, L_{eq}

To measure an average sound level, the meter averaging time is extended to equal the period of interest T, which may be an interval of seconds, minutes, or hours. This gives the equivalent continuous sound pressure level (L_{eq}) derived from the mathematical expression

$$L_{eq} = 10 \log [1/T \int^{t2}_{t1} (P_A^2(t)/P_o^2]dt$$

when P_o is the reference sound pressure (20 μPa). P_A is the instantaneous A-weighted sound pressure (5).

Equivalent continuous sound pressure level is widely accepted for the measurement of long term noise exposure. It has been adopted by the International Organization for Standardization for the measurement of both environmental noise exposure, ISO1996/1-1982(E), ISO1996/2-3-1987(E) and hearing damage risk, ISO1999-1997 (E).

2.2.5 Octave -band analyzer

The audible spectrum can be divided into various parts for analysis. This is accomplished with an appropriate spectrum analyzer. The analyzer will measure the sound pressure level (L_p) for the various parts of the spectrum. For example, the audible spectrum can be divided in to nine contiguous part called octave band.

The center frequencies (Hertz, Hz) of these octave bands are 31.5, 63, 125, 250, 500, 1000, 2000, 4000, and 8000. In the simplest from the analyzer will measure the sound pressure level (L_p) in each of these octave bands (6).

2.3 Effect of noise

Environment noise may interfere with a broad range of human activities in a way which degrades public health and welfare. Such activities include speech communication in conversation, telephone communication, listening to television and radio broadcasts, listening to music, relaxation and sleep.

2.3.1 Hearing loss

The hearing mechanism is divided anatomically in to three parts; the outer ear, middle ear and the inner ear. Functionally, the ear can be considered in two distinctly separate parts, the outer and middle ear joining together to collect the sound waves and transform the acoustic energy into mechanical energy. The inner ear transduces this mechanical energy into a series of nerve impulses which represent the acoustic events.

Hearing loss can be either temporary or permanent. Noise induced temporary threshold shift (NITTS) is a temporary loss of hearing acuity experienced after a relatively short exposure to excessive noise. Noise-induced permanent threshold shift

(NIPTS) is an irreversible (sensorineural) loss of hearing that is caused by prolonged noise exposure (5).

2.3.2 Interference with communication

Because of masking effect of noise, the comprehension of speech is affected due to decrease in intelligibility. Background noise occurring in telephone, radio and television communication causes poor information transfer, affecting daily social life and productivity.

It is known that noise interference with speech and hearing in occupational situation may lead to accidents due to misunderstanding, non understanding, inability to hear warning shout, approaching vehicles, falling objects, etc (12). For indoor good speech intelligibility, background noise levels, L_{eq} of less than 45 dB(A) are required (23).

2.3.3 Annoyance and comfort

Noise annoyance may be defined as a feeling of displeasure evoked by a noise. The effect of noise on annoyance and comfort depends upon many of its physical characteristics including its intensity, spectral characteristics, and variations of these with time. However, annoyance reactions are sensitive to many non-acoustic factors of social, psychological or economic circumstances, and there are considerable differences in individual reactions to the same noise (12).

2.3.4 Disturbance of sleep

Noise intrusion can cause difficulty in falling asleep and can awaken people who are asleep. Studies have indicated that the disturbance of sleep becomes increasingly apparent as ambient noise level exceed about 35 dB(A) L_{eq}. It has been found that the probability of subjects being awakened by a weak sound level of 40dB (A) is 5%, increasing to 30% at 70dB (A) (5).

2.3.5 Effect on performance

The effect of noise on task performance has been studied mainly in laboratory. It is evident that when a task involves auditory signals of any kind, noise at an intensity sufficient to mask or interfere with the perception of these signals will interfere with the performance of the task.

Noise can change the state of alertness of an individual and may increase or decrease efficiency. In industry, the most likely indicator of the effects of noise on performance would be an increase in accidents attributable to reduced vigilance, misunderstanding, inability to hear warning shout, etc.

The effect of noise on working efficiency are dependent not only upon the quality of the noise but also upon other variables such as task and individual. It is clear that when a task depends upon auditory cues, masking of these cues by noise will interfere with performance of the task.

2.3.6 Stress

The relationship between noise and stress is still unclear. In experimental studies, noise produces different reactions along the hypothalamo-hypo-physeal-adrenal axis including an increase in adenoeorticotropic hormone (ACTH) release and elevation

of corticosteroid levels. Some of these reactions have been elicited in an acute form in laboratory experiments at rather moderate levels of noise (5).

Effect on the systemic circulation such as constriction of blood vessels have been produced under laboratory conditions and a high incidence of circulatory disturbances including hypertension has been found in noise-exposed workers. A tendency of blood pressure to be higher in populations living in noisy areas around airport has been suggested but no conclusive evidence of this has been presented (5).

Panee Poonthewee (13) studied the relationship between duration-level of noise exposure and blood pressure among high noise exposed workers and found that the textile and metal stamping workers in age group of 35-49 years had mean systolic and diastolic blood pressures higher than the control group (p-value<0.001). Some significance factors related to blood pressure were percent noise dose, number of years exposed to noise, number of years using personal protection equipment (earplug), age and body mass index.

2.4 Evaluation of noise annoyance

2.4.1 Acceptability of noise in the community

Noise in community may or may not be acceptable to citizens in the area. Noise becomes unacceptable in any particular situation when it is distracting, especially during creative activity, sleep and speech communication.

Noise from factory can results in annoyance to the residents in community. However, industrial noise levels can probably be acceptable at relatively high levels, 50 dB(A) or more, when it meets certain criteria (15):

- It is continuous.

- It does not interfere with speech communication.

- It does not include pure tones or impacts.

- It does not vary rapidly and not interfere with sleeping.

The degree of annoyance is not necessarily related to the intensity of sound, although quite often it is. It may be influenced by subjective factors such as age occupation, health, and etc., and noise patterns containing distinct pure tones or particular characteristics. Annoyance is largely an individual response and varies with each person (8).

Generally, there are several parameters of noise that affect people and their response such as level of noise, frequency content, and the variation of these two with time.

2.4.2 Criteria for annoyance noise standard from factory

A factory located in community may be disruptive to neighbors depending upon the proximity and factory noise level. A city, county or country may have annoyance noise standard for control noise problem in community.

There are several methods of establishing noise criteria for evaluate noise level from factory as its effect to the community such as noise-pollution level, rating level, average maximum noise level, and etc.

(1) Noise-pollution level and the average maximum noise level

Noise-pollution level attempts to use the statistical properties of noise exposure to describe its noisiness. Noise-pollution level is defined as

$L_{np} = L_{eq} + 2.56\sigma$ where L_{eq} is the noise level over a specified period averaged on an energy basis, and σ is the standard deviation of the instantaneous noise level about that average value over the same period (16).

The noise level used in this expression can be the A- weighted sound level and the loudness level. In the calculation of noise-pollution level, the time period is to be one in which similar conditions prevail. Thus, night-time and daytime are treated separately. This noise-pollution level is another way of looking at a noise history and it yields results that are similar to the others such as L_{eq} 24 hr.

Unfortunately, L_{np} does not distinguish between the quiet residential background noise level on which are superimposed many children at play and passing neighbors' cars versus the rather steady but high noise level of a downtown commercial area. There is not enough information in the statistics alone to describe the noises that do or do not cause a large standard deviation. One common treatment of data is the use of the tenth percentile of the measured levels, the average maximum noise level (L_{10}), to indicate the nature of noise exposure in community (15).

(2) Community reaction to environmental noise

There are two methods of indirectly assessing the commulative effects of environmental noise on people. These are methods examining the reactions of individuals or groups of individuals to specific intruding noise, either (a) with respect to

actions taken (complaints, suits, etc.), or (b) in terms of response made to social survey questionnaires.

The results of social surveys are generally stated in terms of percentage of respondents expressing different degrees of disturbance or dissatisfaction due to the noisiness of their environments. Some surveys go into complex procedure to construct a scale of annoyance. Others report responses to the direct question of "How annoying is the noise?". Each social survey is related to some kind of measurement of the noise levels to which the survey respondents are exposed, enabling correlation between annoyance and outdoor noise levels in residential areas (23).

2.5 Selected community noise Standards

2.5.1 The United States Environmental Protection Agency (U.S.EPA)

The United States Environmental Protection Agency (U.S.EPA) (18) has stipulated the annoyance noise levels in terms of 24 hour equivalent continuous sound pressure level ($L_{eq}(24)$), and the day-night sound level (L_{dn}), of not more than 45 and 55 dB(A) for indoor and outdoor in residential areas, respectively. These would prevent and control the noise disturbance impact toward hearing, communication working, and relaxation or recreational activities. The details were shown in Table F-1 in Appendix F.

2.5.2 The World Health Organization (WHO)

The World Health Organization (WHO) (19) has designated community noise level in term of equivalent continuous sound pressure level (L_{eq}), for daytime and night-

time. Noise level shall not exceed more than 55 dB(A) in daytime and 45 dB(A) at night. The details of this standard were shown in Table F-2 in Appendix F.

2.5.3 The World Bank

Based on the characteristics of impact including activity interference and hearing loss, the World Bank (20) has designated noise level for residential area in term of L_{dn} not to exceed 45 dB(A) for indoor and 55 dB(A) for outdoor. In addition, L_{eq} 24 is set at 70 dB(A) for both indoor and outdoor. The details were shown in Table F-3 in Appendix F.

2.5.4 Japanese noise standard

Japanese noise standard (21) has designated noise level in term of L_{eq} for daytime, morning and evening, and night-time. The standard has classified community into three areas as AA, A, and B.

Area AA is area that required particular quietness such as areas where medical facilities are concentrated. The noise level for this area shall not exceed 45 dB(A) for daytime, 40 dB(A) for morning and evening, and 35dB(A) for night-time.

Area A is the primarily residential area. The noise level shall not exceed 50 dB (A) for daytime, 45 dB(A) for morning and evening, and 40 dB(A) for night-time.

Area B is the area where a substantial number of residences are located among shops and factories. The noise level shall not be higher than 60 dB(A) for daytime, 55 dB(A) for morning and evening, and 50 dB(A) night-time (Table F-4, Appendix F).

2.5.5Thai noise standard

Thai noise standard of noise level (22) has adopted L_{eq} 24 hr of 70 dB(A) for ambient noise level in community which maximum noise level (L_{max}) of not more than 115 dB(A).

Table2-1 detailed noise level criteria for residential area with industrial installations of some European and Asian countries (27).

Table 2-1 Noise criteria in dB(A) for residential area with industrial installations in European and Asian countries

Country	Noise Index	Day Time	Rest Periods	Night Time
Austria	L_r	50-55	-	40-45
Belgium	L_{95}	45-50	40-45	35-40
Denmark	L_r	45-50	40-45	35-40
France	L_r	50-55	40-45	40-45
Germany	L_r	50-55	-	35-40
Great Britain	L_r	L_{90}+10dB	-	L_{90}+10dB
Hong Kong	L_r	60-65	-	50-55
Italy	L_r	50-55	-	40-45
Japan	L_{50}	50-60	45-50	40-50
Netherlands	L_r	50	45	40
Norway	L_r	50	45	40
Sweden	L_r	50-55	45-50	40-45
Switzerland	L_r	55	-	45

L_r = Rating level

L_{50}, L_{90}, L_{95} = the fiftieth, ninetieth, and ninety-fifth percentile of noise level, respectively.

2.6 Literature cited

Trong-Neng Wu (32) explored the relationship between aircraft noise and annoyance in two schools that located near an international airport in Taiwan. Based on environmental noise measurements, 242 students of the sixth grade of both schools were recruited and classified into two groups of high and low noise exposure. Personal 24–hr noise exposure in both groups were also investigated. The result indicated that the proportion of annoyed students was higher in the high noise exposure group than other group, although the personal noise exposure was not a factor for annoyance.

Theodore J. Schultz (25) studied the relationship between traffic noise level and community annoyance. Traffic noise levels were measured in term of L_{dn}. Questionnaire was used to evaluate the degree of annoyance. The relationship between percentage of highly annoyed respondents and L_{dn} showed that the L_{dn} with 20 percent of highly annoyed respondents was 67 dB(A).

Dush T. and co-researchers (24) had studied noise annoyed in Brisbane from 1986 to 1988. Noise generation sources in communities were identified. They interviewed the residents of 27 communities which were selected as representative of six noise area categories base on Australian Standard (AS1055). Noise level were measured in terms of L_{eq}, L_{dn}, and the first, tenth, and ninetieth percentile of noise level (L_1, L_{10} and L_{90}) in those communities over a 24 hr period. The results of the study suggested a positive relationship between L_{dn} of various traffic noise sources and

percentage of highly annoyed respondents which were in accordance with the study of Schultz as shown in Figure 2-3.

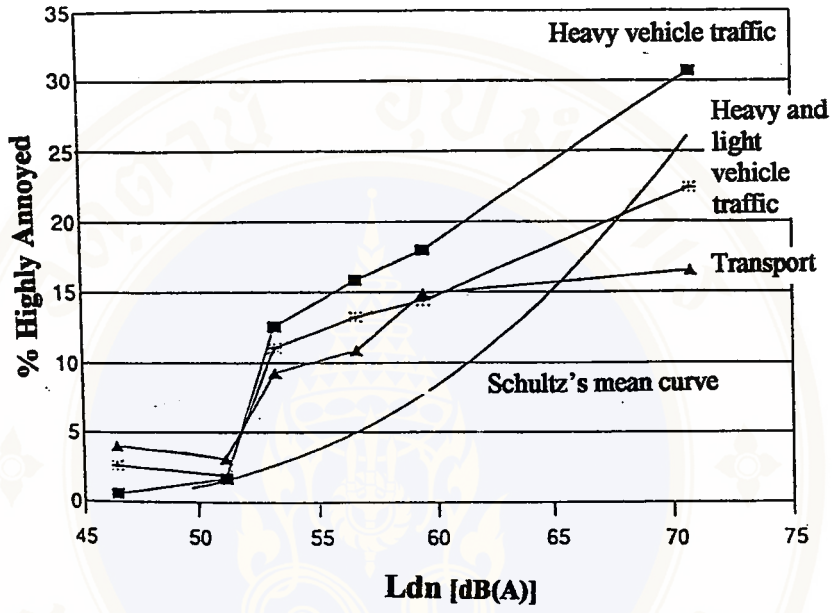


Figure 2-3 Relationship between percentage of highly annoyed respondents and traffic noise, (L_{dn})

Maria V. Bayo (26) reported the correlation of noise level in an urban hospital and health care workers' subjective responses. Noise levels at each 232 grid-points in the main building of the hospital were measured in term of L_{eq} 1 min. Most of the measured noise levels exceed 55 dB(A), and in some instances these noise levels were very high. Noise levels were perceived to be sufficiently high to interfere with their works, and affect patients' comfort and recovery.

The Pollution Control Department and S.T.S. Engineering Consultant Co., Ltd (2) studied the relationship between traffic noise in Bangkok and annoyance. The study was conducted by using a questionnaire assessed the annoyance respondents from the residents dwelling along a traffic corridor. Traffic noise levels were measured in terms of L_{eq}1 hr throughout a period of 24 hr. At the same time, noise levels were calculated in terms of traffic noise index (TNI), L_{dn}, and the tenth percentile of noise level, (L_{10}). The results indicated linear relationships between percentage of highly annoyed respondents and L_{eq} 24 hr, L_{dn} and L_{10} (correlation coefficient, r>0.5). At 20 percent of highly annoyed respondents the L_{eq} 24 hr, L_{dn} and L_{10} were 64.5, 70.9, and 68.7 dB(A), respectively. Therefore, this study proposed the L_{eq} 24 hr of 65 dB(A), L_{dn} of 71 dB(A) and L_{10} of 69 dB(A) as possible directive annoyance traffic noise standard manipulation.

British Standard Institution, BSI, (4) had issued a standard entitled Rating industrial noise affecting mixed residential and industrial areas, BS4142:1990, describing the procedure to investigate community noise annoyance by determination of the different value between rating level of specific noise and background noise. It establishes that a difference of around 10 dB or higher indicating the likelihood of noise complaints. A difference of around 5 dB is marginal significance. At a difference of below 5 dB indicates that complaints will occur. A difference of -10 dB is a positive indication that complaints are unlikely.

Bradley JS (29) reported the relationship between residential air conditioner noise and disturbance that noise level from neighbors' air conditioners and annoyance were significantly related. Responses were most strongly related to the noise levels that exceeded the ambient noise. Owners of air conditioners were less disturbed by their neighbors' air conditioner noise when the value of difference between noise level from air condition and ambient noise was 7 dB(A).

Numerous techniques have been devised to evaluate noise annoyance. Degree of annoyance can be verbally classified from not annoyed to very annoyed or with the aid of a number scale (e.g., 1-7 or 1-10) or by different scaling techniques based on several other questions relating to disturbance and activity interference (31).

The relationship of various noises including traffic, aircraft, air conditioner and community subjective response had been reported. However, noise from wood furniture factory has not been addressed despite of its annoying characteristic. Therefore, there is a need to investigate the relationship between noise from wood furniture factory and community subjective response in order to suggest guideline community noise level for this industry.

CHAPTER III

MATERIALS AND METHODS

3.1 Study design

This study was a cross-sectional survey study. It was designed to evaluate the relationship between community subjective response and noise level from wood furniture factory. Noise levels in communities and factories were measured in terms of sound pressure level (L_p), and equivalent continuous sound pressure level (L_{eq}). In addition, noise levels in communities were calculated in terms of rating level (L_r), noise pollution level (L_{np}), average maximum noise level (L_{10}), and difference between rating level and background noise level (L_r-L_{90}). Community subjective responses to existing community noise were evaluated by noise survey questionnaire.

3.2 Study method

3.2.1 Study sample

Factories: The factories in this study were wood furniture factories that located adjacent to community in Bangsue District, Bangkok. Statistical data of wood furniture factory in 1996 from the Department of Health, Bangkok Metropolis reported that approximately 17 % of furniture factory located in Bangsue District which the highest proportion of wood furniture factories situated in Bangkok Metropolis. Noise complaints from furniture factory in this district increased from about 4% in 1992-1995 to 8% in 1996–1998(2)(Tables C-1 and C-2). The update number of registered wood

furniture in Bangsue in 1999 was 355 plants, although the preliminary survey by the author indicated that many factories were shut down due to economic recession.

The inclusion criteria of factories for this study were:

(1) The factories were surrounded by communities.

(2) The factories were not located on main traffic roads.

(3) The factories must not located very close to other industrial factories such as auto repair shop.

With this the inclusion criteria, ten wood furniture factories were included in this study. Figure 3-1 showed the location of the selected factories.

Respondents: The respondents were purposely sampled from residents who lived adjacent to the wood furniture factories with the following inclusion criteria:

(1) Residents of either sex who lived or worked in a 100 m radius around the factories.

(2) Age not less than 15 years.

(3) No hearing problem.

(4) No relationship with the factories owner not being employed by the factories.

(5) No relative working in these the factories.

Figure 3-1 Location of ten selected wood furniture factories in Bangsue District, Bangkok.

3.2.2 Instrumentation

Instruments employed in this study were as follow:

3.2.2.1. Noise level measurement

(1) Integrating sound level meter (Type1) with octave band filter and Sound level calibration (pistonphone)

- RION, Model-NA 29E, Serial No.10851039
  (IEC 651-1979 Type1, JIS C 1505)
- LARSON DAVIS, Model-814, Serial No. 0110
  (ANSI S1.4-1983 Type1, IEC 651-1979 Type1)

(2) Measuring tape

(3) Tripod

3.2.2.2 Noise perception measurement

Noise perception of the residents was evaluated by noise survey questionnaire which was modified from the questionnaire used in the Brisbane Noise Survey (24) and that used in the study on Problem of Noise Pollution in the Community (Thailand)(28). The questionnaire consisted of 5 parts as follows:

Part 1 Demographic and socio-economics characteristics of respondents.

Part 2 Problems of community concern.

Part 3 Noise sources in community.

Part 4 Perception of respondents to annoying noise from wood furniture factory.

Part 5 Characteristics of respondents' house

The questionnaire was pre-tested for clarity of each question and then modified before implementation. The detail of the questionnaire was shown in Appendix D.

3.2.3 Measurement of noise levels

3.2.3.1 Community noise

Based on BS4142-1990 (4) and ISO 1996/1-1982 (11), the community noise in this study were measured as follow:

1. Background noise level, (L_{90})

(1) The background noise in communities was measured at the pre-determined stations in each community.

(2) The background noise was measured during an operation break or before or after the operation of the furniture factories.

(3) The background noise was measured in terms of 90 percentile of noise level (L_{90}), frequency weighting-A, at Fast mode.

(4) The noise measurement station was outside the building. The position of sound level meter was at 1.2 - 1.5 m above the ground, at least 3.5 m away from any reflecting structures.

(5) The measuring time interval was at least 5 min.

2. Specific noise level ($L_{eq\text{-}Tr}$), average maximum noise level (L_{10}), and 24 hr equivalent continuous sound pressure level (L_{eq} 24 hr)

The specific noise level was measured at the same stations as background noise measurement station.

(1) For a continuous noise of more than one hour, the specific noise level was measured in term of the equivalent continuous A-weighted sound pressure level one hour, (L_{eq}1hr). Frequency of the measured L_{eq} were analyzed simultaneous (31.5, 63, 125, 250, 500, 1K, 2K, 4K, and 8K Hz). Sound pressure level (L_p), was recorded at 5 minutes interval throughout a period of 1 hour as well as average maximum noise level, (L_{10}) during specific noise measurement.

(2) For a continuous noise of less than one hour, the measurement specific noise were done as follow:

(2.1) If the noise occurred only once of the hour, the noise level was measured as the equivalent continuous A-weighted sound pressure level, $L_{eq\text{-}Tm}$. The $L_{eq\text{-}Tm}$ was then used for the calculation of specific noise level by equation

$$L_{eq\text{-}Tr} = L_{eq\text{-}Tm} + 10 \log (T_m/T_r) \quad \text{---------(1)}$$

Where, T_m was the measuring time interval in minute.

(2.2) If the noise occurred more than once of the hour, the noise level was measured as the equivalent continuous A-weighted sound pressure level, $L_{eq\text{-}Ti}$. The $L_{eq\text{-}Ti}$ was then used for the calculation of of $L_{eq\text{-}Tm}$ by equation

$$L_{eq\text{-}Tm} = 10 \log [(1/T_m)\Sigma\, Ti\, 10^{0.1 Leq\text{-}Ti}] \quad \text{------(2)}$$

Where, Ti was the measuring time interval in minute

$$T_m = \Sigma Ti, \text{ min}$$

(3) Along with specific noise measurement, sound pressure level recorded at 5 minutes interval throughout a period of one hour whereas L_{10} was recorded hourly. In addition, L_{eq} 24 hr was also monitored.

(4) The noise measurement station was outside the building. The position of sound level meter was at 1.2 - 1.5 m above the ground, at least 3.5 m away from any reflecting structures.

(5) The sound level meter was operated at A-weighting and Slow mode. The reference time interval (T_r) was 1 hr.

3. Rating level, (L_r)

The rating level of noise source with impulse was obtained adding 5 dB, For noise without impulse, the rating level was the same as the specific noise level.

3.2.3.2 Factory noise

The noise level inside the factory was measured as 10 minutes the equivalent continuous A-weighted sound pressure level, (L_{eq}10min). The frequency of the measured L_{eq}10 min was analyzed at 31.5, 63, 125, 250, 500, 1K, 2K, 4K and 8K Hz. The L_{eq}30 min was also measured at boundary of the factories.

3.2.3.3 Noise pollution level, (L_{np})

Noise pollution level (L_{np}) in each community was calculated by equation

$L_{np} = L_{eq} + 2.56\ \sigma$, dB(A) -------- (3)

Where, σ is standard deviation of the sound pressure level obtained during the measurement of specific noise level.

3.2.4 Measurement of noise perception

The selected residents in the studies communities were interviewed by the author using the noise survey questionnaire at the same time of noise measurement.

3.3 Data collection

The noise levels and noise perception in this study was carried out from March 11 to May 28, 1999. A total of 160 noise measurements were performed and 198 were interviewed in this study. Among 160 noise measurements, 120 were of community noise, 30 were of inside factory noise, and 10 were measure at factory boundary.

3.4 Data analysis

3.4.1 Descriptive statistics

- Noise levels inside and at boundary of the factories, and noise levels in the communities were calculated by mean and standard deviation.

- Demographic and socio-economic characteristics of respondents were described by number and percentage.

3.4.2 Analytical statistics

Analytical statistics were carried out the SPSS/window version 6.13:

- The association between respondents characteristics and degree of annoyance and requirement of annoyance noise guideline were analyzed by statistics chi-square and measured index of association by phi.

- The relationship between percentage highly annoyed (independent variable) and the dependent variables: rating level, L_r-L_{90}, noise pollution level and average maximum noise level were analyzed by simple regression.

CHAPTER IV

RESULTS

With inclusion criteria of factory and respondent outlined in Chapter III, a total of ten factories and 198 respondents were included in this study.

4.1 General characteristics of selected wood furniture factories

In general, all of the factories had similar production process, machinery but horse-power and number of workers (Table 4-1). The horse-power in these factories ranged from 10 to 50 Hp although these which high horse-power did not operate in full capacity. Most of these factories (seven factories) had less than ten workers. The structures of most the factories were town house and commercial row house. These factories were 5 - 25 m. from the nearest house.

Table 4-1 General characteristics of factories classified by each factory

Factory	Characteristics of factory			
	Horse-power,Hp	Number of worker	Factory structure	Distance [1], m
I	22	7	Town house	10
II	50	15	Detached building	25
III	50	20	Commercial row building	8
IV	12	5	Commercial row building	5
V	20	8	Town house	10
VI	15	7	Town house	5
VII	10	5	Town house	15
VIII	10	5	Town house	8
IX	10	4	Commercial row house	5
X	50	12	Commercial row house	20

[1] distance between the factory and the nearest house

4.2 Respondents characteristics

A total number of 198 residents who lived or worked in building adjacent to wood furniture factories were interviewed. Among 198 respondents, 52.5% were women and 47.5% were men. The average age of respondents was 35 years. Most of the respondents (47%) were in age group of 21 – 40 years (Table 4-2). Approximately 29% of respondents had senior high school education. Approximately 23% of respondents worked private employee and equal proportions of the respondent were students, about 20% were self-employed. Over 50% of respondents lived in these areas more than 10 years. About 16% of respondents reported they had chronic illness such as allergy, hypertension.

The respondents housing included commercial row house, town house and detached house. The percentage of air condition room in these houses varied 25% in community XIII to 72% in community IX (Table 4-3). The distance between these houses and the factories varied from less than 10 m to 100 m.

Table 4-2 Characteristics of 198 respondents in ten communities of Bangsue District

Characteristic		number	percent
Sex			
	Male	94	47.5
	Female	104	52.5
Age			
	15 - 20	39	19.7
	21 - 30	49	24.7
	31 - 40	43	21.8
	41 - 50	37	18.6
	51 - 60	18	9.1
	>60	12	6.1
	Mean = 35.22, SD=14.73		
Education			
	Primary school	43	21.7
	Junior high school	33	16.7
	Senior high school	57	28.8
	Vocational school	24	12.1
	Bachelor's degree & Post-graduate	41	20.7
Occupation			
	Self-employed	39	19.7
	Employee	46	23.2
	Government employee	30	15.2
	House-wife	30	15.2
	Student	46	23.2
	Others	7	3.5

Table 4-2 Characteristics of 198 respondents in ten communities of Bangsue District (continued)

Characteristic		number	percent
Income (Baht /month)			
	<5000	38	19.2
	5001 to 10000	54	27.3
	10001 to 15000	29	14.6
	>15000	19	9.6
	No income	58	29.3
Status			
	Resident	130	65.7
	Working place	35	17.7
	Both resident & working place	33	16.7
Housing ownership			
	Owner	92	46.4
	Rent	39	19.7
	Share with others	38	19.2
	Not applicable (working place)	29	14.6
Residence	< 6 months	3	1.5
	6-12 months	8	4.0
	1-2 years	12	6.1
	2-5 years	24	12.1
	5-10 years	37	18.7
	> 10 years	114	57.6
Chronic illness	No	166	83.8
	Yes	32	16.2
Current infection	No	179	90.4
	Yes	19	9.6

Table 4-3 General characteristics of respondents' housing classified by community

Community	Characteristics of respondents' housing			
	Respondent (person)	Type of housing (%)	Air conditioning (AC) (%)	Distance [2] (m)
I	17	Commercial row house 52.9% Town house 47.1%	without AC. 70.6% with AC(some rooms)29.4%	10-20m 35.3% 21-30m 53%
II	23	Detached house 56.5% Town house 30.4%	without AC. 30.4% with AC(some rooms)56.5%	50-60m 26.1% 70-100m 39.1%
III	20	Commercial row house 50% Town house 25%	without AC. 70% with AC(some rooms)30%	<10m 55% 10-20m 53%
IV	18	Commercial row house 100%	without AC. 38.9% with AC(some rooms)61.1%	<10m 61.1% 10-20% 38.9%
V	21	Detached house 61.9% Town house 23.8%	without AC. 47.6% with AC(some rooms) 42.9%	20-30m 76.2%
VI	19	Detached house 84.2% Town house 15.8%	without AC. 68.4% with AC(some rooms) 31.6%	<10m 100%
VII	27	Detached building 88.9% (office)	with AC(all rooms) 48.1% with AC(some rooms) 29.6%	10-20m 37% 40-50m 40.7%
VIII	16	Detached house 100%	without AC. 62.5% with AC(some rooms) 25%	<10m 31.3% 10-20m 68.7%
IX	18	Commercial row house 100%	without AC. 27.8% with AC(some rooms) 72.2%	10-20m 22.2% 20-30m 27.8% 40-50m 27.8%
X	19	Detached house 52.6% Slum 47.4%	without AC. 100%	10-20m 26.3% 20-30m 47.4% 30-40m 26.3%

[2] distance between these houses and the factories

4.3 Noise level inside the factories and at factories boundary

Noise levels inside the factories were measured at least two times in terms of ten minutes equivalent continuous sound pressure level (L_{eq}10min), whereas these the factories boundary were measured once as L_{eq} 30 min. Table 4-4 showed the rages of L_{eq}10min and L_{eq}30min together with Lmax of the ten factories. The result of frequency analysis of these factories noise was displayed in Table 4-5.

Table 4-4 Noise level in terms of L_{eq} and L_{max} inside and at boundary's factories classified by each factory

Factory	Inside factory		Boundary's factory	
	L_{eq} 10 min dB(A)	L_{max} dB(A)	L_{eq} 30 min dB(A)	L_{max} dB(A)
I	88.5 - 90.5	96.3 – 99.0	85.7	99.0
II	89.0 – 92.6	95.2 – 101.9	82.1	98.1
III	81.8 – 87.5	97.6 – 106.4	75.9	98.8
IV	84.1 – 85.5	93.7 – 95.5	79.7	94.3
V	79.2 – 83.5	90.3 – 91.6	74.5	84.7
VI	82.7 – 85.6	93.4 – 95.7	72.1	89.5
VII	78.8 – 80.8	83.5 – 85.3	71.6	84.0
VIII	89.3 – 90.2	92.2 – 97.2	75.5	83.2
IX	81.5 – 83.1	93.3 – 94.4	80.5	90.2
X	80.8 – 84.3	86.8 – 90.9	70.7	81.5

Table 4-5 Frequency analysis of noise level inside wood furniture factory

Factory	Mean of noise level (L_{eq}) in dB								
	31.5 Hz	63 Hz	125 Hz	250 Hz	500 Hz	1KHz	2KHz	4KHz	8KHz
I	43.5	49.4	66.0	72.3	79.9	83.8	83.8	80.2	75.6
II	40.0	45.7	59.9	65.5	73.2	85.2	87.1	89.0	82.0
III	42.3	50.7	62.3	64.3	77.2	82.5	82.6	80.5	75.0
IV	35.6	49.2	60.4	65.6	73.0	78.2	80.1	81.4	72.5
V	50.0	52.0	55.6	62.7	69.2	72.0	73.0	75.1	66.3
VI	50.0	50.8	65.3	73.4	69.2	75.2	77.7	77.2	67.2
VII	34.5	53.1	61.2	64.5	70.1	72.9	73.2	71.1	63.3
VIII	44.5	50.3	67.2	73.3	80.5	84.8	84.3	81.2	75.5
XI	49.1	50.2	60.1	66.2	70.5	72.5	75.8	78.7	72.3
X	40.3	48.8	55.7	67.4	70.1	73.2	74.3	75.6	72.3

4.4 Noise level in the communities

4.4.1 Specific noise level ($L_{eq\ 1\ hr}$), the average maximum noise level (L_{10}), the maximum noise level (L_{max}), background noise level (L_{90}) and $L_{eq\ 24\ hr.}$

Specific noise levels ($L_{r\ 1\ hr.}$), were measured in the selected communities in term of equivalent continuous sound pressure level (L_{eq}), 1 hr throughout the factories operation time. In addition background noise level (L_{90}) and L_{eq}24 hr of these communities were assessed. The results illustrated in Table 4-6. The mean of specific noise levels ranged from 63.2 dB(A) in community X to 73.6 dB(A) in community III and IV which the means of L_{10} ranging from 65.9 to 77.3 dB(A).

The means of background noise levels (L_{90}), in these communities were 51.7 - 61.7 dB(A) while L_{eq} 24 hr measured seven communities were 63.4 - 71.5 dB(A).

Table 4-6 Mean and standard deviation of $L_{eq\ 1\ hr}$, L_{max}, L_{10}, L_{90}, and $L_{eq\ 24hr.}$ in communities classified by each community

Community	$L_{eq\ 1\ hr.}$ dB(A)		L_{max} dB(A)		L_{10} dB(A)		L_{90} dB(A)		$L_{eq\ 24\ hr.}$ dB(A)
	$\bar{x}$	(SD)	$\bar{x}$	(SD)	$\bar{x}$	(SD)	$\bar{x}$	(SD)	
I	72.1	(1.4)	87.3	(0.9)	76.0	(1.0)	55.6	(1.9)	68.6
II	65.1	(2.5)	88.6	(2.2)	67.3	(1.9)	51.9	(2.2)	64.6
III	73.6	(3.2)	92.4	(2.6)	77.3	(3.8)	54.8	(1.3)	68.8
IV	73.6	(0.8)	90.3	(2.5)	77.3	(0.7)	61.7	(1.3)	71.5
V	71.9	(0.2)	92.3	(1.9)	75.4	(0.7)	53.7	(1.7)	69.9
VI	67.7	(1.5)	83.0	(2.8)	70.2	(1.4)	57.4	(1.6)	66.2
VII	65.6	(0.3)	82.3	(0.8)	66.2	(0.3)	51.7	(0.2)	-
VIII	64.0	(0.8)	84.7	(2.6)	67.0	(1.7)	51.8	(0.2)	63.4
IX	72.8	(1.5)	83.2	(2.7)	76.2	(0.5)	56.7	(0.5)	-
X	63.2	(0.9)	76.5	(4.0)	65.9	(1.3)	54.6	(0.7)	-

4.4.2 Rating level (L_r), L_r-L_{90} and Noise pollution level (L_{np})

No impulse noise was observed during community noise measurement. Thus, the rating levels were equal to the measured specific noise levels as shown in Table 4-6. It was found that all communities but one (Community X) had L_r-L_{90} higher than 10 dB (A). Table 4-7 showed the calculated results difference between rating level and background noise level (L_r-L_{90}), and L_{np} in each community. Noise pollution level(L_{np}), in communities were 68.8 - 93.0 dB(A).

Table 4-7 The value of L_r-L_{90} and L_{np} classified by each community

Community	L_r-L_{90} dB(A)	L_{eq} dB(A)	SD dB(A)	L_{np}= L_{eq}+ 2.56SD dB(A)
I	16.6	72.1	3.23	80.4
II	13.3	65.1	6.06	81.6
III	18.8	73.6	7.58	93.0
IV	11.9	73.6	4.42	84.9
V	18.1	71.9	5.96	87.1
VI	10.3	67.7	3.50	76.6
VII	13.9	65.6	3.31	74.1
VIII	12.1	64.0	3.68	73.4
IX	16.2	72.8	3.13	80.8
X	8.6	63.2	2.18	68.8

4.4.3 Frequency analysis of community noise

Table 4-8 showed the frequency analysis of community noise. Figure 4-1 to 4-10 illustrated the comparison of communities and wood furniture factories noise level by each frequency.

Table 4-8 Frequency analysis of noise level in communities

Community	Mean of noise level (L_{eq}) in dB								
	31.5 Hz	63 Hz	125 Hz	250 Hz	500 Hz	1KHz	2KHz	4KHz	8KHz
I	50.0	51.2	52.9	57.2	63.7	66.2	67.2	64.7	57.5
II	40.2	43.6	49.7	53.5	57.1	57.2	57.6	55.4	48.6
III	42.3	46.5	53.3	58.2	63.7	66.0	65.0	62.9	56.7
IV	46.9	52.2	60.2	63.4	67.7	67.5	67.2	63.9	57.1
V	50.0	51.3	57.1	62.0	65.4	66.1	65.4	62.1	56.3
VI	42.0	49.2	54.2	57.7	61.5	60.9	60.1	59.1	53.0
VII	40.7	44.7	50.3	54.7	60.5	58.4	57.8	56.9	53.1
VIII	40.2	49.7	52.4	59.9	60.2	59.8	59.3	58.4	53.4
XI	50.1	52.3	53.4	58.9	65.1	67.5	67.8	68.6	66.4
X	40.1	45.4	50.8	57.2	59.3	57.4	55.5	54.3	48.7

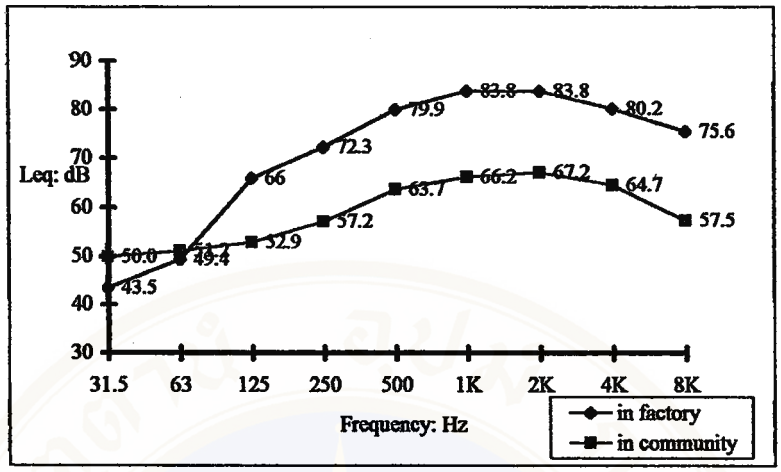


Figure 4-1 Frequency analysis of noise level, Leq, inside factory and in community I

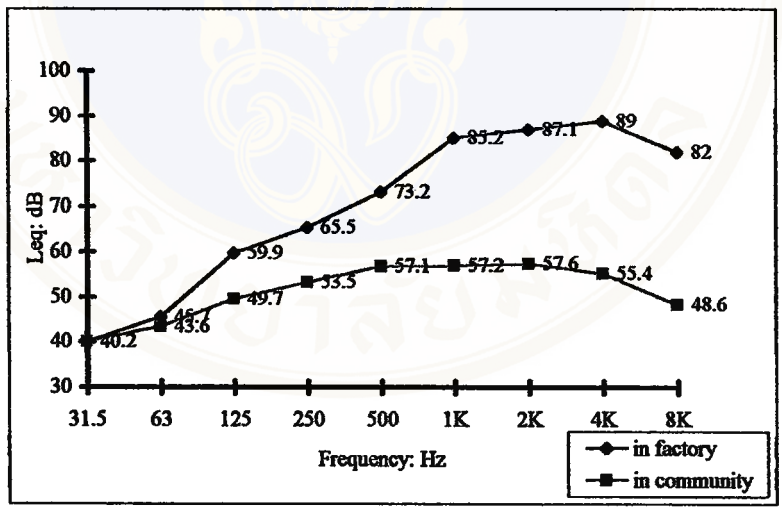


Figure 4-2 Frequency analysis of noise level,Leq, inside factory and in community II

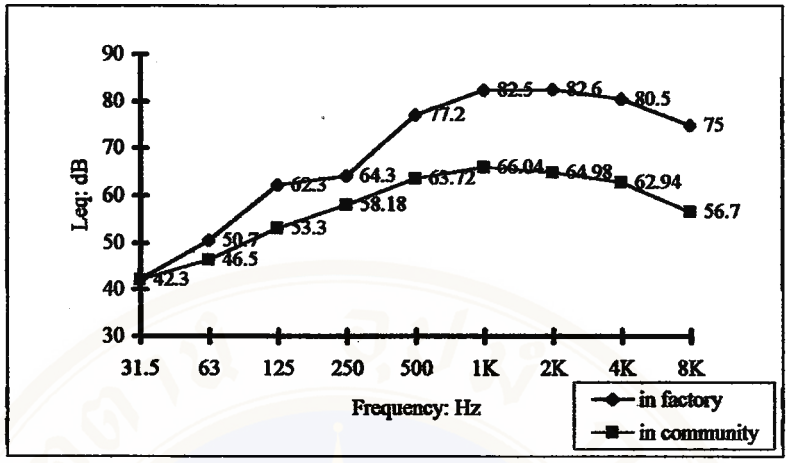


Figure 4-3 Frequency analysis of noise level, Leq, inside factory and in community III

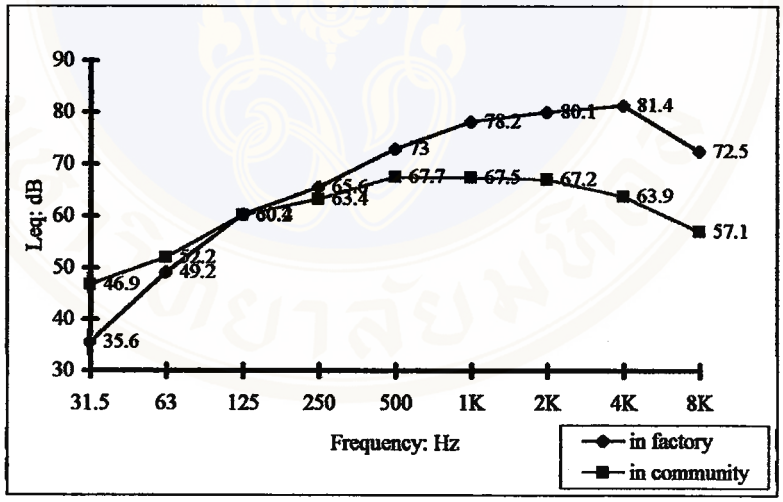


Figure 4-4 Frequency analysis of noise level,Leq, inside factory and in community IV

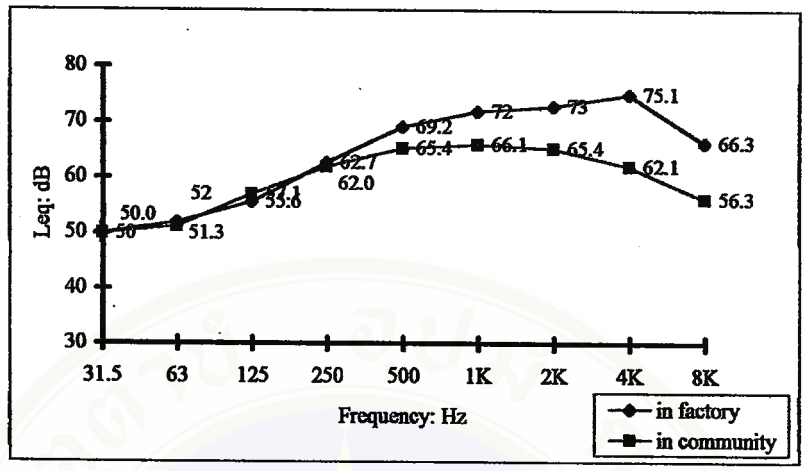


Figure 4-5 Frequency analysis of noise level, Leq, inside factory and in community V

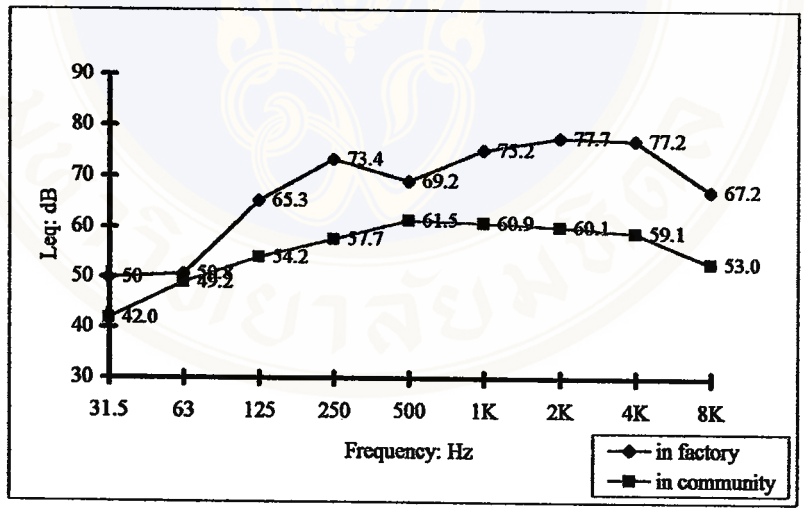


Figure 4-6 Frequency analysis of noise level, Leq, insde factory and in community VI

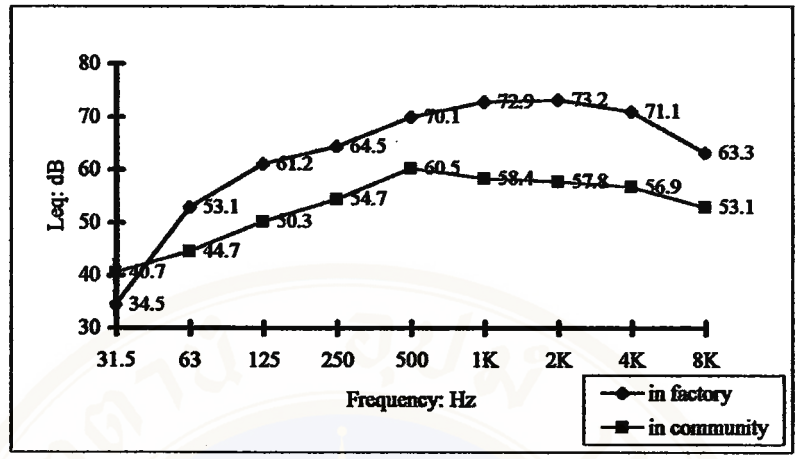


Figure 4-7 Frequency analysis of noise level, Leq,inside factory and in community VII

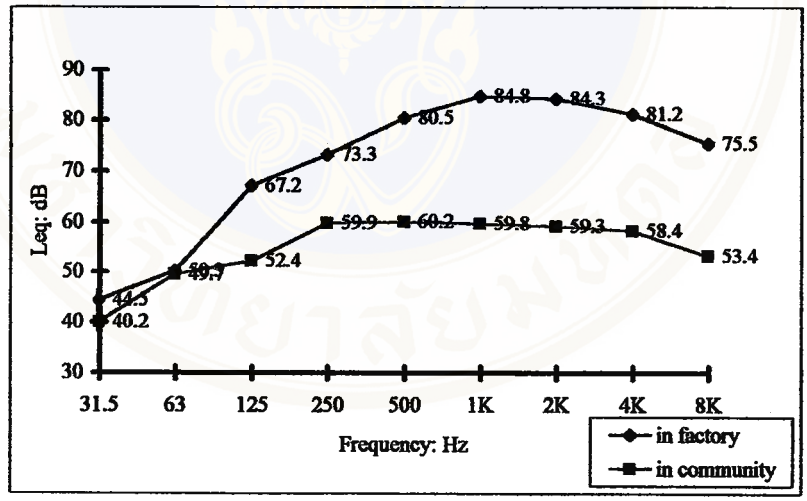


Figure 4-8 Frequency analysis of noise level,Leq,inside factory and in community VIII

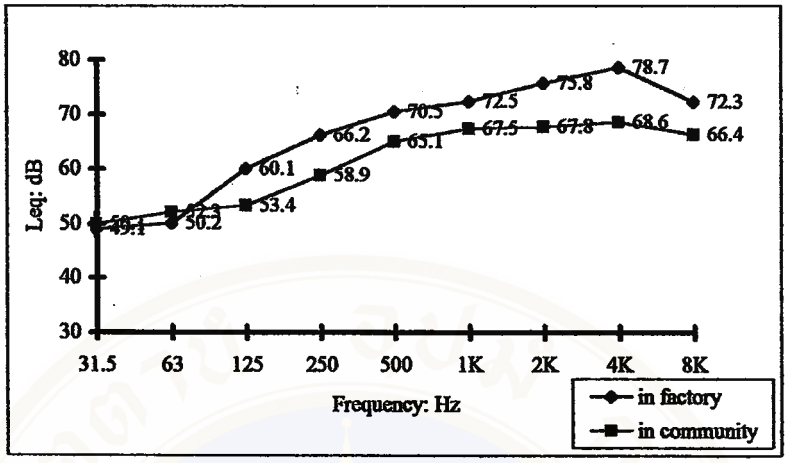


Figure 4-9 Frequency analysis of noise level, Leq, inside factory and in community IX

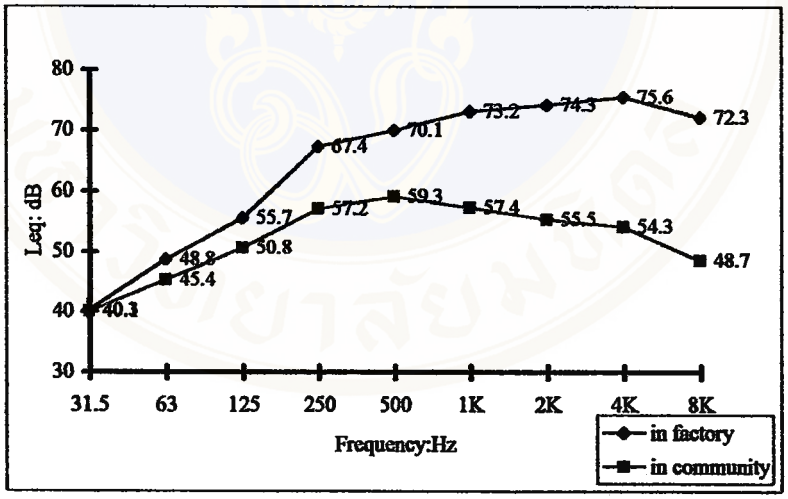


Figure 4-10 Frequency analysis of noise level, Leq, inside factory and in community X

4.5 Reactions of respondents to noise pollution

4.5.1 Extent of noise Problem

In order to determine the problem of community concern, respondents were asked to quantify a list of six environmental and related problems in each community. The results indicated 51% and 47.5% of respondents perceived the noise annoyance and air pollution as severe problems on Bangsue District (Table 4-9).

Table 4-9 Percentage of respondents concerned about certain problems in communities

Problems in community	% of respondents
1. Noise annoyance	51.0
2. Air pollution	47.5
3. Solid waste collection service	17.7
4. Flooding	16.7
5. Public Safety	16.7
6. Public utility and services	6.1

4.5.2 Annoyance noise source in community

In order to determine the main source of noise in the communities, respondents were asked to identify the sources in their communities. Table 4-10 indicated that wood furniture factory was the major annoying noise source in community (81.3%).

Table 4-10 Noise sources in communities as identified by respondents

Source of noise	Respondents	
	Number	Percent
Wood furniture factory	161	81.3
Traffic	86	43.4
Construction activity	13	6.6
Residential air conditioner	9	4.5

4.5.3 Noise annoyance from wood furniture factory

Most of the respondents (72.2%) suggested that wood furniture factories were the source of noise nuisance. About 70.7 % of respondents indicated that noise annoyance occurred sometime during the day (Table 4-11)

Table 4.11 Characteristics of nuisance from wood furniture factories

	Respondents	
	number	Percent
Type of nuisance		
Noise	143	72.2
Dust	110	55.6
Odor	46	23.2
Time of noise annoyance		
8 a.m. to 5 p.m.	140	70.7
5 p.m. to 10 p.m.	5	2.5
Frequency of noise annoyance		
Sometime	85	42.9
Always	14	7.1
During factory operation	46	23.2

4.5.4 Degree of annoyance due to noise from wood furniture factory

Degree of annoyance was classified into four-point scale ranging from "not at all annoyed" to "very annoyed". The respondents were then asked to scale their degree of noise annoyance. The results as shown in Table 4-12.

The scale of highly annoyed appeared in the last column of the Table 4-12 was obtained by combining the moderately annoyed and very annoyed scale. The percentage of highly annoyed scale was then used for the evaluation of relationship between noise level and noise annoyance in the later step.

Table 4-12 Degree of annoyance of respondents identified by each community

Community	Number	% annoyed of respondents				
		(1) not at all	(2) slightly	(3) moderately	(4) very	(3)+(4) Highly annoyed
I	17	11.8	35.3	41.2	11.8	53.0
II	23	52.9	23.5	5.9	17.6	23.5
III	20	5.0	30.0	15.0	50.0	65.0
IV	18	33.3	44.4	22.2	0	22.2
V	21	19.0	19.0	33.3	28.6	61.9
VI	19	42.1	42.1	15.8	0	15.8
VII	27	44.4	33.3	18.5	3.7	22.2
VIII	16	0	75.0	12.5	12.5	25.0
IX	18	0	55.5	27.8	16.7	44.5
X	19	47.4	42.1	5.3	5.3	10.6

4.5.5 Effect on lifestyle

The questionnaire required respondents to indicate the effect of noise from wood furniture factory on their lifestyles that were categorized as communication interference, disturbance of workplace, daily relaxation and sleeping.

The result indicated that noise from wood furniture factories affected 52% and 47.5% of respondents on their communication and relaxation, respectively (Table 4-13).

Table 4.13 Effects of noise from wood furniture factories on lifestyle.

Effect	Respondents	
	Number	Percent
Communication interference	79	52.0
Daily relaxation	69	47.5
Workplace interference	41	20.7
Sleep disturbance	37	18.7

4.5.6 Association between respondents characteristics and degree of annoyance

Chi-square (χ^2) statistic was employed to determine the effect of respondents characteristics on degree of annoyance. For the propose chi-square, the scale of "not at all annoyed" and "slightly annoyed" were combined together and considered as not annoyed.

The results of chi-square analysis, as shown in Table 4-14, reviewed that age, chronic illness, and distance from factory as significant association with degree of annoyance.

Table 4-14 Association of respondents characteristics and degree of annoyance**

Variables	p-value	Index of association (phi)
1. Sex	0.49387	
2. Age	0.01852*	0.26188
3. Occupation	0.85117	
4. Education level	0.47382	
5. Income	0.59551	
6. Chronic illness	0.00437*	0.20255
7. Housing ownership	0.23801	
8. Status in community	0.56561	
9. Time of residence	0.18215	
10. Distance from factory	0.00049*	0.33443
11. Type of housing	0.07800	
12. Air conditioning in the house	0.19097	
13. History of complaint	0.05297	

* Significant association

** Details for test of association by chi-square test statistic were shown in Appendix G.

4.5.7 Association between annoyance and requirement of annoyance noise guideline

The results of questionnaire survey of the respondents indicated that approximately 80 % of respondents in this study required annoyance noise guideline to control the noise from wood furniture factories (Table 4-15). Some of characteristics of respondents may affect their response the requirement of noise guideline. Then, characteristics of respondents were analyzed by chi-square (χ^2) test statistic. The result indicated that most of the characteristics, except the degree of noise annoyance, did not affect their response as shown in Table 4-16.

Table 4-15 Requirement of annoyance noise guideline of respondents classified by degree of annoyance

Degree of annoyance	Requirement of guideline		Total
	Required	Not required	
Not annoyed	97	33	130
Highly annoyed	61	7	68
Total	158 (79.8%)	40 (20.2%)	198 (100%)

Table 4-16 Association of respondents characteristics and the requirement of noise annoyance guideline**

Variables	p-value	Index of association (phi)
1. Sex	0.72568	
2. Age	0.84963	
3. Occupation	0.29339	
4. Education level	0.29723	
5. Income	0.91568	
6. Housing ownership	0.71235	
7. Status in community	0.57119	
8. Time of residence	0.30728	
9. History of complaint	0.46546	
10. Degree of annoyance	0.01203*	0.17847

* Significant association

** Details for test of association by chi-square test statistic were shown in Appendix G.

4.6 Relationship between factory noise levels and respondents subjective response

In the analysis of relationship between industrial noise levels and percentage of highly annoyed respondents, 20% of highly annoyed respondents were used as cut–of point as suggested U.S.EPA criteria.

4.6.1 Relationship between rating level (L_r) and percentage of highly annoyed respondents

Relationship between rating level (L_r) and percentage of highly annoyed respondents was linear with correlation coefficient (r), =0.7296, p-value = 0.017. The simple regression equation was y = 3.416x - 201.20, with R-square = 0.5296 as shown in Figure 4-11. This result indicated that the rating Level (L_r) at 20 percent of highly annoyed respondents was 65.0 dB(A).

4.6.2 Relationship between the average maximum noise level (L_{10}) and percentage of highly annoyed respondents

This study found that the relationship of between the average maximum noise level (L_{10}) and percentage of highly annoyed respondents was linear with correlation coefficient (r) = 0.7369, p-value = 0.015. The simple regression equation was y = 2.947x - 177.44, with R-square = 0.5413 as shown in Figure 4-12. The average maximum noise level at 20 percent of highly annoyed respondents was 67.0 dB(A).

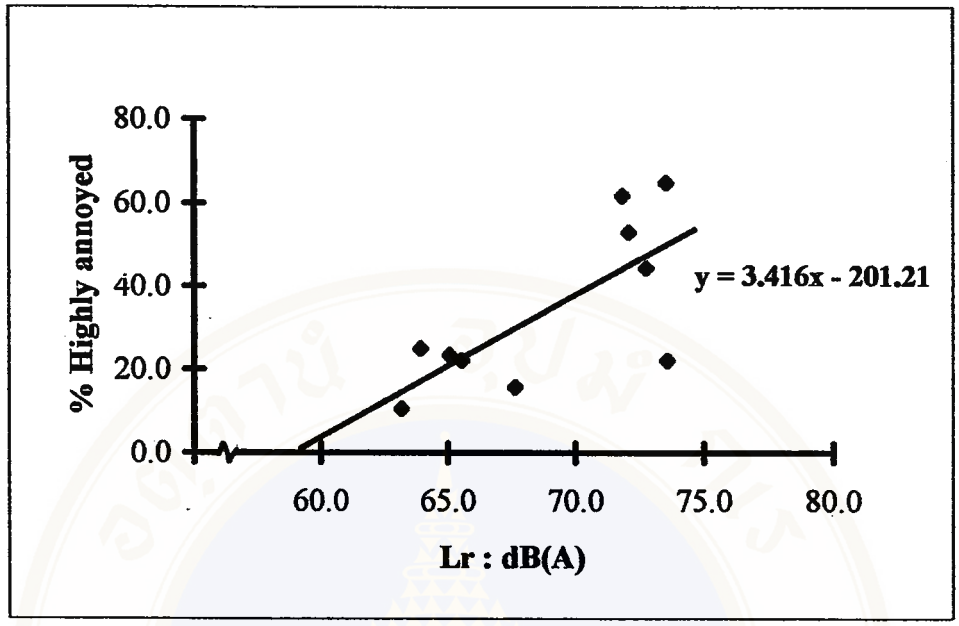


Figure 4-11 Relationship between Lr and percentage of highly annoyed respondents

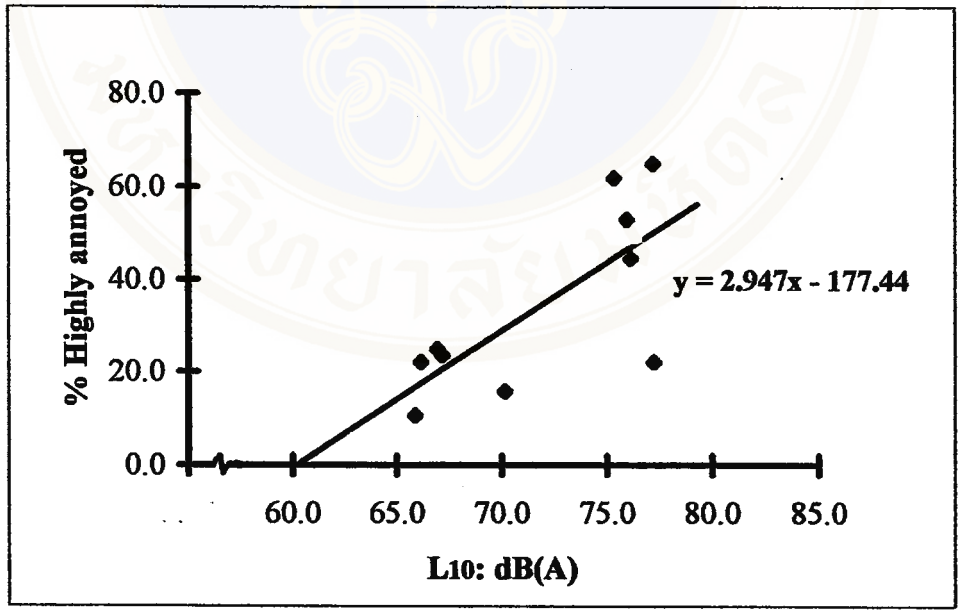


Figure 4-12 Relationship between L10 and percentage of highly annoyed respondents

4.6.3 Relationship between L_r-L_{90} and percentage of highly annoyed respondents

The relationship between L_r-L_{90} and percentage of highly annoyed respondents was linear with correlation coefficient (r), = 0.9594, p-value = 0.0001. The simple regression equation was y = 5.678x – 44.997, R-square = 0.9203 as shown in Figure 4-13. The result suggested that the value of L_r-L_{90} at 20 percent of highly annoyed respondents was +11.5 dB(A).

4.6.4 Relationship between noise pollution level (L_{np}) and percentage of highly annoyed respondents.

The relationship between noise pollution level (L_{np}) and percentage of highly annoyed respondents was linear with correlation coefficient (r), = 0.7867, p-value = 0.007. The simple regression equation was y = 2.184x - 140.34, R-square = 0.6167 as shown in Figure 4-14. The noise pollution level at 20 percent of highly annoyed respondents was 73.4 dB(A).

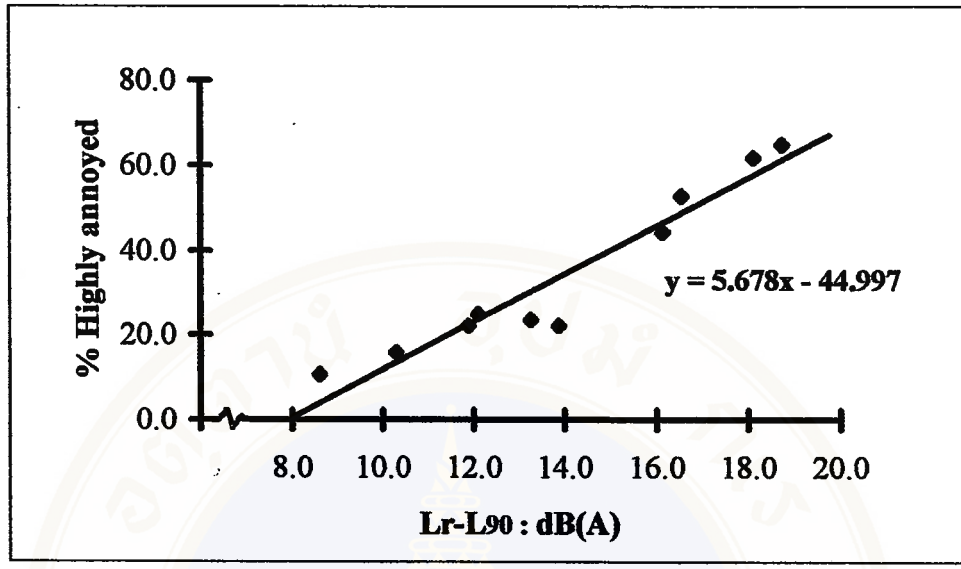


Figure 4-13 Relationship between Lr-L90 and percentage of highly annoyed respondents

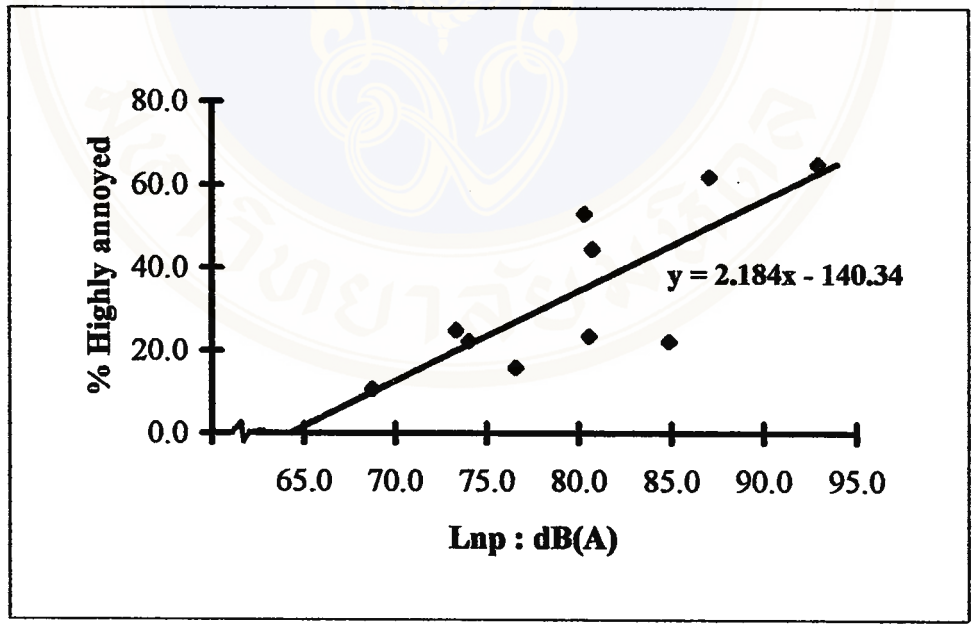


Figure 4-14 Relationship between Lnp and percentage of highly annoyed respondents

CHAPTER V

DISCUSSION CONCLUSION AND RECOMMENDATION

5.1 Discussion

This study was a cross-sectional survey study. It was designed to investigate the relationship between noise level from wood furniture factory and community subjective response. Noise measurement was carried out in ten factories and communities nearby the factories. A total of 198 residents of the communities were interviewed to determine the subjective response to noise. The field study was conducted from March 11 to May 28, 1999.

5.1.1 Study design

This study was both qualitatively and quantitatively studies. Data collection and analysis might commit some errors. However, this study was designed to the minimize errors at the planning stage.

(1) Random error

During conducting this study, due to fact that Thailand was facing low-economics crisis, many wood furniture factories were shut down. Following the selection criteria of factory, ten target were included factories in this study. In order to minimize the subject's selection bias and random error, the respondents in this study were selected by non-probability sampling sticky following the inclusion criteria of

respondent. 198 respondents were interviewed during measurement of noise level in communities.

Although the wood furniture factories operated continuously throughout the working hours, it was possible that the operation was interrupted from time to time. To take care the non-continuous noise due to the possible that interruption of the operation, noise level in term of L_{eq} 1 hr was hourly recorded throughout the working hours (8 a.m. to 5 p.m.) at each communities. The obtained values of L_{eq} 1 hr of each community were then analyzed average L_{eq} 1 hr and standard deviation (SD).

In order to ensure the quality of the data, The $\bar{x}$-control chart was as quality control for communities noise data including L_{eq} 1 hr, the average maximum noise level (L_{10}), and background noise level (L_{90}). The results from the thirty $\bar{x}$-control charts in Appendix B indicated the noise level in all communities were within the upper and lower warning limits ($\bar{x} \pm 2SD$).

(2) Systematic error

This study all the field measurement including noise measurement, interviewing of respondent, and data analysis were carried out by the author only in order to personal error. The noise measurement error was minimized following BS4142-1990 and ISO 1996/1-1982. To minimize the instrument error, the sound level meters were calibrated by electrically and acoustical before noise measurement.

(3) Confounding

It is possible that noise level in communities may be interfere from noise source other than wood furniture factories such as traffic and other noise generating industries. To minimize possible error from these factors, the selection of communities and factories in this study were limited to those which were away from main road and other industries according to the inclusion criteria of factory.

5.1.2 Study results

(1) Extent of noise problem in communities

This study indicated that noise is the most concern problem of the respondents (51%) in the Bangsue District. It was agree with the report of the Department of Health, Bangkok Metropolis which indicated that noise was the most significant environmental problem in Bangkok (1).

When noise source was investigated, this study reviewed that noise from wood furniture factories should be the top priorities of control because the largest proportions of the respondents (81.3%) were affected by the noise. The frequency analysis of noise levels inside the factories and in the communities showed that these noise levels had the same frequencies range. It suggests that wood furniture factories were the source of community noise in the study areas.

The mean of L_{eq} 1 hr in ten communities ranged from 63.2 to 73.6 dB(A) which exceeded the WHO and World Bank noise guideline 55 dB(A) (Table F-2 and F-3, Appendix F). All of L_{eq} 24 hr in seven communities [63.4 – 71.5 dB(A)] also exceed the U.S.EPA annoyance noise standard for outdoor of 55 dB(A) (Table F-1, Appendix

F). When the rating level of communities [63.2 - 73.6 dB(A)] were consider, they also exceeded rating level standard of Austria, France, Germany, Italy, Sweden, and Switzerland (Table 2-1). If community noise is evaluated against the BS4142-1990, the value of Lr-L_{90} in nine communities exceeded 10 dB(A). This indicates that the tendency of complaints are likely as suggested by the standard.

Because of the high noise level compared to various noise standard as discussed above, It is not surprising to find out that 52% of respondents had communication interference. In addition, frequency analysis of community noise indicated that the high noise levels covered the important intelligible frequency range from 500 to 4000 Hz.

(2) Degree of annoyance of respondents

Degree of annoyance was evaluated by a four-point categorical scale ranking from not annoyed to very annoyed. The percentage of highly annoyed was obtained by combining percent of response in moderate and very annoyed scale (2,24,25,32).

This study found that the relationship between percentage of highly annoyed respondents and noise levels from wood furniture factory were linear having correlation coefficient(r) of 0.73 - 0.96 (p-values < 0.05) as shown in Figure 4-11 to 4-14. The result was in accordance with the studies of Dush T. and Schutz who also reported a positive relationship between noise level and percentage of highly annoyed respondents.

(3) Factors that affect degree of annoyance

This study found a significant association between degree of annoyance and certain characteristics of respondents. These characteristics included age (phi = 0.2619,

p-value = 0.0185), chronic illness (phi = 0.2026, p-value = 0.0044), and distance from factory (phi = 0.3344, p-value = 0.0005). It can be concluded that the older respondents or unhealthy persons are less tolerant to noise compared to the healthy ones. The significant association between degree of annoyance and distance from factory is expected due to the reduction of noise level with the increase of distance from noise source.

(4) Annoyance noise standard

This study found that most of respondents (80%) required annoyance noise standard for wood furniture factory that located in community.

In setting annoyance noise guideline, noise survey questionnaire is generally used to assess residents response to noise in the community together with noise measurement (23,24,25). Because, at present Thailand has no annoyance standard for mixed residential and industrial areas. The four relationships of community noise and percentage of highly annoyed respondents found in this study were evaluated for an appropriate annoyance noise guideline.

Scenario1: Rating level, (L_r)

A significant linear relationship between rating level and percentage of highly annoyed respondents (r = 0.73, p-value < 0.017) was indicated by the equation y = 3.416x – 201.2, R^2 = 0.5296. Using the U.S.EPA of 20% highly annoyed respondents, this study suggests a rating level of 65.0 dB(A) as annoyance noise guideline.

This guideline value is the same as that of Hong Kong, although, the guideline in some European countries and Japan ranged from 50.0 to 55.0 dB(A) (27). The 10

dB(A) higher rating level found in this study compared to the European countries and Japan may be due to differences in tolerant to noise, standard of living, education, land use, environmental awareness, and population characteristics. Another explanation for the difference in rating level is that noise source and noise characteristics in this study may be different from those countries. The noise source in this study was from wood furniture factory only whereas the noise source those countries were from different industries.

Scenario2: Average maximum noise level, (L_{10})

A significant linear relationship between the average maximum noise level (L_{10}), and percentage of highly annoyed respondents ($r = 0.74$, p-value = 0.015) was indicated by the equation $y = 2.947x - 177.44$, $R^2 = 0.5413$. Using the U.S.EPA of 20% highly annoyed respondents, this study suggests the average maximum noise level of 67.0 dB (A) as annoyance noise guideline. The L_{10} in this study was less than the study of the Pollution Control Department 1.8 dB(A) due to differences in tolerant to noise, environmental awareness, and population characteristics. Another explanation for the difference in L_{10} is that noise source and noise characteristics in this study may be different from the study of the Pollution Control Department. The noise source in this study was from wood furniture factory only whereas the noise source those study was from traffic in Bangkok.

Scenario3: Difference between rating level and background noise, (L_r-L_{90})

A significant linear relationship of a difference between rating level and background noise level (L_r-L_{90}), and percentage of highly annoyed respondents (r =0.96, p-value = 0.0001) was indicated by the equation y = 5.678x – 44.997, R^2 = 0.9203. Using the U.S.EPA of 20% highly annoyed respondents, this study suggests a L_r-L_{90} of 11.5 dB(A) as annoyance noise guideline.

This guideline value is higher than the British Standard, BS4141-1990 1.5 dB (A) may be due to differences in tolerant to noise, standard of living, education, land use, environmental awareness, and population characteristics. Another explanation for the difference in L_r-L_{90} is that noise source and noise characteristics in this study may be different from British Standard. The noise source in this study was from wood furniture factory only whereas the noise source those standard were from various industries.

Scenario4: Noise pollution level, (L_{np})

A significant linear relationship between noise pollution level (L_{np}), and percentage of highly annoyed respondents (r =0.79, p-value = 0.007) was indicated by the equation y = 2.184x – 140.34, R^2 = 0.6167. Using the U.S.EPA of 20% highly annoyed respondents, this study suggests the noise pollution level of 73.4 dB(A) as annoyance noise guideline.

From four noise index discussed above, it was found in this study that the relationship of the value of difference between rating level and background noise level (L_r-L_{90}), and percentage of highly annoyed respondents was highly significant (p-value = 0.0001) with correlation coefficient of 0.96.

Therefore, based on British Standard, BS4142:1990, the value of difference between rating level and background noise level (L_r-L_{90}) of 11.5 dB(A) is proposed as a guideline value of annoyance noise in mixed residential and wood furniture industrial areas.

5.2 Conclusion

This study reviewed a significant linear relationship of L_r, L_{10}, L_r-L_{90}, and L_{np}, and percentage of highly annoyed respondents (r = 0.73 – 0.96, p-value = 0.017-0.0001). The guideline value of annoyance noise levels, base on 20 percent of highly annoyed respondents were:

- Rating level (L_r) 65.0 dB(A),

  (y = 3.416x–201.2, R-square = 0.5296)

- Average maximum noise level (L_{10}) 67.0 dB(A),

  (y = 2.947x-177.44, R-square = 0.5413)

- Difference between rating level and background noise level,(L_r-L_{90}) 11.5dB(A), (y = 5.678x – 44.997, R-square = 0.9203)

- Noise pollution level (L_{np}) 73.4 dB(A)

  (y = 2.184x – 140.34, R-square = 0.6167)

The most appropriate guideline for annoyance noise for mixed residential and wood furniture industrial areas was the difference between rating level and background noise level (L_r-L_{90}) 11.5 dB(A).

5.3 Recommendation for further study

Further investigation on community noise annoyance from industry should consider:

1. If possible study of further study of annoyance noise from wood furniture factory should cover other areas.

2. Investigation should extent to other noise generating industries such as auto repair shops, machinery, metal product industry, and etc.

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APPENDIX A

Noise levels in the factories and the communities

Table A-1 Noise levels in factory and community No I

No.	Area	Leq 1 hr.	Leq 24 hrs.	Lmax	L10	L90	Octave Band Analysis: dB									
		dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	31.5	63	125	250	500	1K	2K	4K	8K	AP
1	in factory	88.7-90.5		99.0			43.5	49.4	66.0	72.3	79.9	83.8	83.8	80.2	75.6	90.5
2	bounary factory	85.7		99.0			35.2	46.6	62.0	66.3	75.1	80.2	80.2	80.0	73.2	85.7
3	in community	73.3		87.4	76.4		50.0	51.1	54.2	57.7	64.6	68.0	68.8	64.8	56.7	73.3
		72.2		87.4	77.3		50.0	51.1	53.8	57.3	63.5	66.9	67.4	64.2	56.5	72.2
		72.0		88.2	75.1		50.0	51.1	52.9	57.1	64.0	65.9	67.1	64.6	57.8	72.0
		72.0		88.2	75.5		50.0	51.1	52.7	57.2	64.2	65.8	67.1	64.7	58.1	72.0
		69.6		85.8	74.9		50.0	51.5	51.7	56.6	61.6	63.5	64.6	61.7	56.6	69.6
		73.7		86.6	76.8		50.0	51.2	52.0	57.3	64.2	67.3	68.2	68.4	60.4	73.7
			68.6	101.7			50.0	50.1	51.8	55.8	62.8	64.1	61.9	59.1	53.5	68.6
	background noise					55.1										
						52.3										
						55.7										
						55.9										
						58.0										
						55.4										

Table A-2 Noise levels in factory and community No II

No.	Area	Leq 1 hr.	Leq 24 hrs.	Lmax	L10	L90	Octave Band Analysis: dB									
		dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	31.5	63	125	250	500	1K	2K	4K	8K	AP
1	in factoy	89.0 - 92.6		10.1.9			40.0	45.7	59.9	65.5	73.2	85.2	87.1	89,0	82,0	92.6
2	boundary factory	82,1		98.1			40.2	47.7	54.3	66.7	69.3	74.6	75,9	77,1	74,7	82.1
3	in community	64,3		89.6	65.9		40.2	44.1	50.9	55.0	57.7	58.8	57,2	54,1	47.7	64.3
		68,0		88.7	70.2		40.1	44.1	52.4	57.6	63.4	62.8	60,1	55,8	49.8	68.0
		67,5		86.1	68.5		40.5	43.2	53.1	55.7	58.0	58.6	56,3	55,1	48.8	67.5
		65.5		89.6	66.3		40.1	45.3	51.7	55.6	60.4	58.1	57,7	56,4	52.6	65.5
		64,3		86.1	67.4		40.1	44.4	49.7	56.1	59.3	57.2	56,3	53,2	47.9	64.3
		61.2		91.6	65.2		40.0	40.2	40.2	40.8	43.6	47.7	57,8	58,0	44.7	61.2
			64.6	96.9			40.1	43.3	51.3	55.3	59.9	56.9	57,9	53,6	48.0	64.6
	background noise					51.6										
						51.6										
						52.8										
						48.4										
						51.6										
						55.1										

Table A-3 Noise levels in factory and community No III

No.	Area	Leq 1 hr.	Leq 24 hrs.	Lmax	L_{10}	L_{90}	Octave Band Analysis: dB									
		dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	31.5	63	125	250	500	1K	2K	4K	8K	AP
1	in factory	81.8-87.5		106.4			42.3	50.7	62.3	64.3	77.2	82.5	82.6	80.5	75.0	87.5
2	boundary factory	75.9		98.8			41.2	49.0	54.8	58.5	65.9	70.4	71.5	67.9	60.7	75.9
3	in community	71.5		90.9	74.5		40.4	46.7	52.8	58.2	64.0	66.5	65.6	62.6	57.5	71.5
		70.2		90.1	73.2		40.2	43.5	51.6	56.7	63.4	65.2	64.1	61.2	53.7	70.2
		73.4		95.5	76.9		50.0	50.5	55.2	60.0	65.3	67.5	66.0	67.0	59.7	73.4
		77.0		95.2	81.3											77.0
		71.3		89.7	82.5		40.5	45.8	51.7	57.6	63.1	66.4	65.1	63.4	59.0	71.3
		70.0		93.1	75.1		40.4	46.0	55.2	58.4	62.8	64.6	64.1	60.5	53.6	70.0
			68.8	97.8			40.1	44.3	52.7	57.5	63.4	63.7	61.7	58.1	52.1	68.8
	background noise					54.7										
						55.9										
						55.1										
						55.1										
						55.8										
						52.3										

Table A-4 Noise levels in factory and community No IV

No.	Area	Leq 1 hr.	Leq 24 hrs.	Lmax	L10	L90	Octave Band Analysis; dB									
		dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	31.5	63	125	250	500	1K	2K	4K	8K	AP
1	in factory	84.1-85.5		93.7			35.6	49.2	60.4	65.6	73	78.2	80.1	81.4	72.5	85.5
2	boundary factory	79.7		94.3			39.1	49.3	59.3	64.2	69.8	73.2	74.7	73.8	67.6	79.7
3	in community	72.7		91.6	76.5		40.1	50.3	59.0	62.9	66.8	66.5	66.2	62.4	56.8	72.7
		73.4		92.6	77.6		40.7	50.9	59.6	62.9	68.1	67.3	66.4	62.9	56.9	73.4
		74.0		90.2	77.3		50.1	52.9	61.2	63.1	68.0	68.2	67.4	64.1	56.7	74.0
		74.8		85.5	78.4		50.1	53.4	60.8	64.8	68.9	68.3	68.3	65.3	59.4	74.8
		73.0		91.4	76.7		50.1	52.6	60.1	62.9	66.9	67.1	67.2	64.1	56.1	73.0
		73.8		90.3	77.3		50.1	52.8	60.7	63.5	67.4	67.4	67.6	64.6	56.6	73.8
			71.5	101.5			50.5	52.7	59.0	61.8	66.2	65.9	64.0	60.3	55.8	71.5
	background noise					61.2										
						60.5										
						63.6										
						60.5										
						61.3										
						63.1										

Table A-5 Noise levels in factory and community No V

No.	Area	Leq 1 hr.	Leq 24 hrs.	Lmax	L10	L90	Octave Band Analysis: dB									
		dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	31.5	63	125	250	500	1K	2K	4K	8K	AP
1	in factory	79.2-85.5		90.3			50.0	52.0	55.6	62.7	69.2	72.0	73.0	75.1	66.3	85.5
2	boundary factory	74.5		84.7			50.0	50.5	54.8	60.3	66.9	68.3	67.5	69.1	60.7	74.5
3	in community	71.8		92.7	75.6		50.0	51.5	57.8	62.8	65.3	65.5	65.0	62.4	56.7	71.8
		71.9		92.7	75.9		50.0	51.4	57.1	62.4	65.7	66.1	65.2	62.0	56.0	71.9
		72.1		93.3	75.1		50.0	51.3	56.9	62.0	65.6	66.6	65.8	62.0	55.8	72.1
		71.5		88.4	76.4		50.1	51.0	57.1	61.7	64.1	65.1	65.5	63.1	57.7	71.5
		71.9		93.3	74.9		50.0	51.2	56.8	61.7	65.6	66.4	65.4	61.6	55.7	71.9
		72.0		93.3	74.5		50.0	51.3	57.0	61.6	65.8	66.6	65.2	61.5	55.8	72.0
			69.9	93.6			50.0	50.5	53.6	57.3	63.1	65.4	63.5	60.1	54.7	69.9
	background noise					55.9										
						52.3										
						55.1										
						55.1										
						52.3										
						51.7										

Table A-6 Noise levels in factory and community No VI

No.	Area	Leq 1 hr.	Leq 24 hrs.	Lmax	L10	L90	Octave Band Analysis: dB									
		dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	31.5	63	125	250	500	1K	2K	4K	8K	AP
1	in factory	82.7-85.6		93.4			50.0	50.8	65.3	73.4	69.2	75.2	77.7	77.2	67.2	85.6
2	boundary factory	72.1		89.5			50.0	52.7	61.8	64.0	66.5	65.4	63.6	61.3	54.3	72.1
3	in community	66.5		80.7	68.7		40.4	49.2	54.1	57.6	59.7	59.6	59.2	58.1	50.8	66.5
		69.7		85.5	72.1		50.0	51.0	56.1	57.6	62.0	63.1	63.1	63.3	56.3	69.7
		68.8		85.5	71.0		40.3	45.7	55.1	58.6	64.3	61.7	60.2	58.8	57.1	68.8
		66.2		79.9	69.6		40.3	48.9	51.9	57.6	59.4	59.1	58.8	58.9	51.6	66.2
		66.4		80.7	68.7		40.3	50.0	53.2	57.4	59.6	59.4	59.3	58.4	51.0	66.4
		68.5		85.5	71.1		40.4	50.3	54.9	57.6	64.0	62.7	60.2	57.1	51.1	68.5
			66.2	85.5			40.0	45.9	52.2	56.5	68.9	59.5	58.6	59.1	54.0	66.2
	background noise					58.5										
						58.4										
						57.7										
						55.9										
						58.9										
						54.8										

Table A-7 Noise levels in factory and community No VII

No.	Area	Leq 1 hr.	Leq 24 hrs.	Lmax	L10	L90	Octave Band Analysis: dB									
		dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	31.5	63	125	250	500	1K	2K	4K	8K	AP
1	in factory	78.8-80.8		85.3			34.5	53.1	61.2	64.5	70.1	72.9	73.2	71.1	63.3	80.8
2	boundary factory	71.6		84.0			39.7	49.2	58.4	64.6	68.3	69.4	69.5	68.7	63.5	71.6
3	in community	66.0		82.2	65.8		40.3	45.1	50.7	54.6	60.7	58.9	58.1	57.2	53.4	66.0
		65.3		81.9	65.9		41.1	44.3	49.9	54.7	60.2	57.9	57.5	56.5	52.8	65.3
		65.4		81.9	66.2											
		65.5		82.0	66.4											
		65.5		81.9	66.5											
		65.8		84.0	66.5											
	background noise					51.4										
						51.5										
						51.7										
						51.8										
						51.9										
						51.9										

Table A-8 Noise levels in factory and community No VIII

No.	Area	Leq 1 hr.	Leq 24 hrs.	Lmax	L10	L90	Octave Band Analysis: dB									
		dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	31.5	63	125	250	500	1K	2K	4K	8K	AP
1	in factory	89.3-90.2		97.2			44.5	50.3	67.2	73.3	80.5	84.8	84.3	81.2	75.5	90.2
2	boundary factory	75.5		84.3			39.8	49.2	56.5	63.6	65.6	69.4	68.7	68.1	63.6	75.5
3	in community	65.6		87.2	67.1		40.2	49.7	52.4	59.9	60.2	59.8	59.3	58.4	53.4	65.6
		64.1		87.2	66.1											
		63.6		81.5	65.7											
		63.5		81.5	69.1											
		63.6		85.9	68.9											
		63.4		85.0	65.1											
	background noise					51.8										
						52.0										
						51.9										
						52.0										
						51.7										
						51.6										

Table A-9 Noise levels in factory and community No IX

No.	Area	Leq 1 hr.	Leq 24 hrs.	Lmax	L10	L90	Octave Band Analysis: dB									
		dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	31.5	63	125	250	500	1K	2K	4K	8K	AP
1	in factory	81.5-83.1		93.3			49.1	50.2	60.1	66.2	70.5	72.5	75.8	78.7	72.3	83.1
2	boundary factory	80.5		90.2			40.5	50.9	54.2	63.9	66.5	70.3	73.1	74.5	68.4	80.5
3	in community	72.1		86.1	76.4											
		73.5		81.7	76.8											
		73.3		80.6	76.4		50.1	52.3	53.4	58.9	65.1	67.5	67.8	68.6	66.4	73.3
		73.1		84.4	76.4											
		74.6		80.1	75.8											
		70.2		86.1	75.4											
	background noise					56.0										
						56.2										
						56.6										
						56.8										
						57.0										
						57.3										

Table A-10 Noise levels in factory and community No X

No.	Area	Leq 1 hr.	Leq 24 hrs.	Lmax	L10	L90	Octave Band Analysis: dB									
		dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	31.5	63	125	250	500	1K	2K	4K	8K	AP
1	in factory	84.3		90.7			40.3	48.8	55.7	67.4	70.1	73.2	74.3	75.6	72.3	81.1
2	boundary factory	70.7		81.5			40.4	50.3	53.8	57.6	64.0	65.8	66.7	60.9	56.8	70.7
3	in community	62.5		78.1	65.3											
		61.8		69.1	64.3											
		63.3		77.8	65.1											
		63.6		75.4	66.3		40.1	45.4	50.8	57.2	59.3	57.4	55.5	54.3	48.7	63.6
		64.1		77.9	66.9											
		64.1		80.6	67.7											
	background noise					55.4										
						55.4										
						54.9										
						53.7										
						54.2										
						54.0										

APPENDIX B

Quality control of communities noise data

Table B-1 Specific noise Level in communities

Com.No.	Morning			Afternoon			Xave	SD	UCL	LCL	UWL	LWL
I	73.3	72.2	72.0	72.0	69.6	73.7	72.1	1.4	76.3	67.9	74.9	69.3
II	64.3	67.5	68.0	65.5	64.3	61.2	65.1	2.5	72.6	57.6	70.1	60.1
III	71.5	70.2	73.4	77.0	78.0	71.3	73.6	3.2	83.2	64.0	80.0	67.2
IV	72.7	73.4	74	74.8	73	73.8	73.6	0.8	76.0	71.2	75.2	72.0
V	71.9	71.8	72.1	71.5	71.9	72	71.9	0.2	72.5	71.3	72.3	71.5
VI	66.5	69.7	68.8	66.2	66.4	68.5	67.7	1.5	72.2	63.2	70.7	64.7
VII	66	65.3	65.4	65.5	65.8	65.6	65.6	0.3	66.5	64.7	66.2	65.0
VIII	65.6	64.1	63.6	63.5	63.6	63.4	64.0	0.8	66.4	61.6	65.6	62.4
IX	72.1	73.5	73.3	73.1	74.6	70.2	72.8	1.5	77.3	68.3	75.8	69.8
X	62.5	61.8	63.3	63.6	64.1	64.1	63.2	0.9	65.9	60.5	65.0	61.4

Table B-2 Background noise Level in communities

Com.No.	Morning			Afternoon			Xave	SD	UCL	LCL	UWL	LWL
I	55.1	52.3	55.7	55.9	58.0	56.4	55.6	1.9	61.3	49.9	59.4	51.8
II	51.6	51.6	52.8	48.4	51.6	55.1	51.9	2.2	58.5	45.3	56.3	47.5
III	54.7	55.9	55.1	55.1	55.8	52.3	54.8	1.3	58.7	50.9	57.4	52.2
IV	61.2	60.5	63.6	60.5	61.3	63.1	61.7	1.3	65.6	57.8	64.3	59.1
V	55.9	52.3	55.1	55.1	52.3	51.7	53.7	1.7	58.8	48.6	57.1	50.3
VI	58.5	58.4	57.7	55.9	58.9	54.8	57.4	1.6	62.2	52.6	60.6	54.2
VII	51.4	51.5	51.7	51.8	51.9	51.9	51.7	0.2	52.3	51.1	52.1	51.3
VIII	51.8	52.0	51.9	52.0	51.7	51.6	51.8	0.2	52.4	51.2	52.2	51.4
IX	56.0	56.2	56.6	56.8	57.0	57.3	56.7	0.5	58.2	55.2	57.7	55.7
X	55.4	55.4	54.9	53.7	54.2	54.0	54.6	0.7	56.7	52.5	56.0	53.2

Table B-3 The Average Maximum Noise Level (L10) in communities

Com.No.	Morning			Afternoon			Xave	SD	UCL	LCL	UWL	LWL
I	76.4	77.3	75.1	75.5	74.9	76.8	76.0	0.98	78.9	73.1	78.0	74.0
II	65.9	70.2	68.5	66.3	67.4	65.2	67.3	1.86	72.8	61.7	71.0	63.5
III	74.5	73.2	76.9	81.3	82.5	75.1	77.3	3.77	88.6	65.9	84.8	69.7
IV	76.5	77.6	77.3	78.4	76.7	77.3	77.3	0.68	79.3	75.3	78.7	75.9
V	75.6	75.9	75.1	76.4	74.9	74.5	75.4	0.7	77.5	73.3	76.8	74.0
VI	68.7	72.1	71	69.6	68.7	71.1	70.2	1.41	74.4	66.0	73.0	67.4
VII	65.8	65.9	66.2	66.4	66.5	66.5	66.2	0.31	67.1	65.3	66.8	65.6
VIII	67.1	66.1	65.7	69.1	68.9	65.1	67.0	1.68	72.0	62.0	70.4	63.6
IX	76.4	76.8	76.4	76.4	75.8	75.4	76.2	0.51	77.7	74.7	77.2	75.2
X	65.3	64.3	65.1	66.3	66.9	67.7	65.9	1.26	69.7	62.2	68.5	63.4

Table B-4 The Maximum Noise Level (Lmax) in communities

Com.No.	Morning			Afternoon			Xave	SD
I	87.4	87.4	88.2	88.2	85.8	86.8	87.3	0.91
II	89.6	88.7	86.1	89.6	86.1	91.6	88.6	2.17
III	90.9	90.1	95.5	95.2	89.7	93.1	92.4	2.56
IV	91.6	92.6	90.2	85.5	91.4	90.3	90.3	2.5
V	92.7	92.7	93.3	88.4	93.3	93.3	92.3	1.93
VI	80.7	85.5	85.5	79.9	80.7	85.5	83.0	2.79
VII	82.2	81.9	81.9	82	81.9	84	82.3	0.83
VIII	87.2	87	81.5	81.5	85.9	85	84.7	2.63
IX	86.1	81.7	80.6	84.4	80.1	86.1	83.2	2.72
X	78.1	69.1	77.8	75.4	77.9	80.6	76.5	3.97

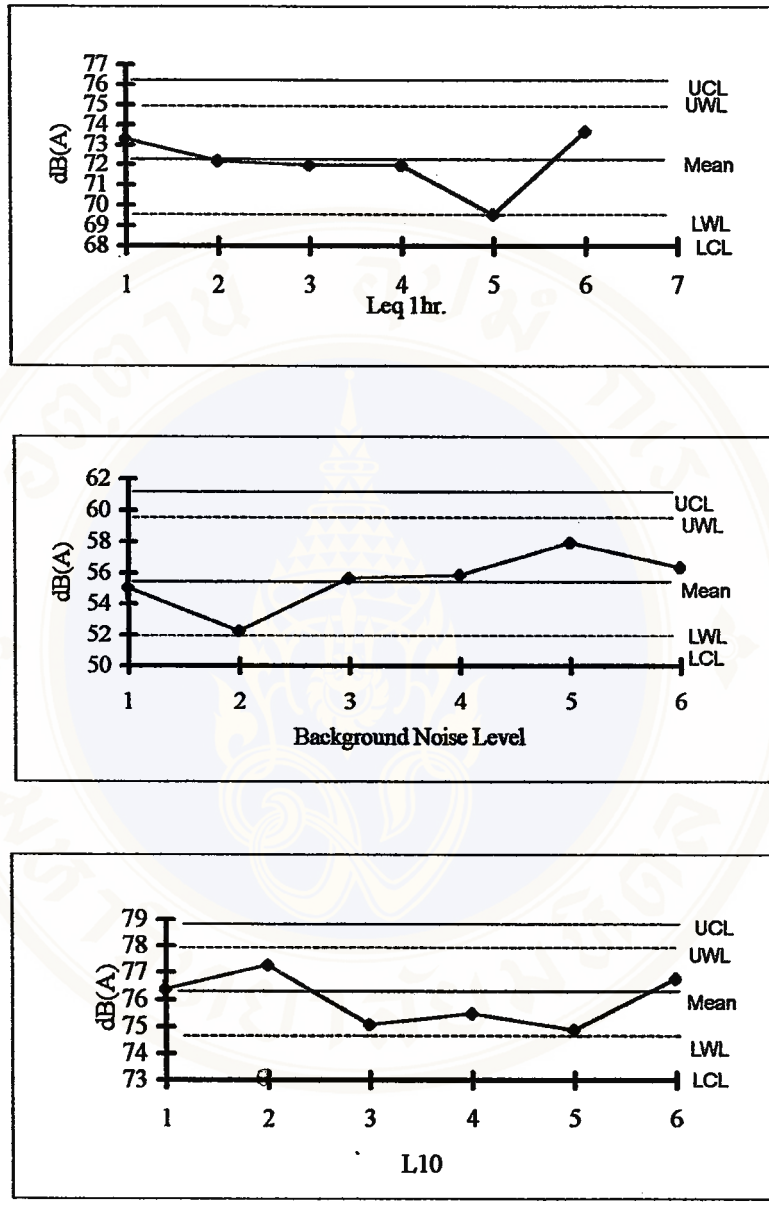


Figure B-1 Quality control chart of noise level in community No.I

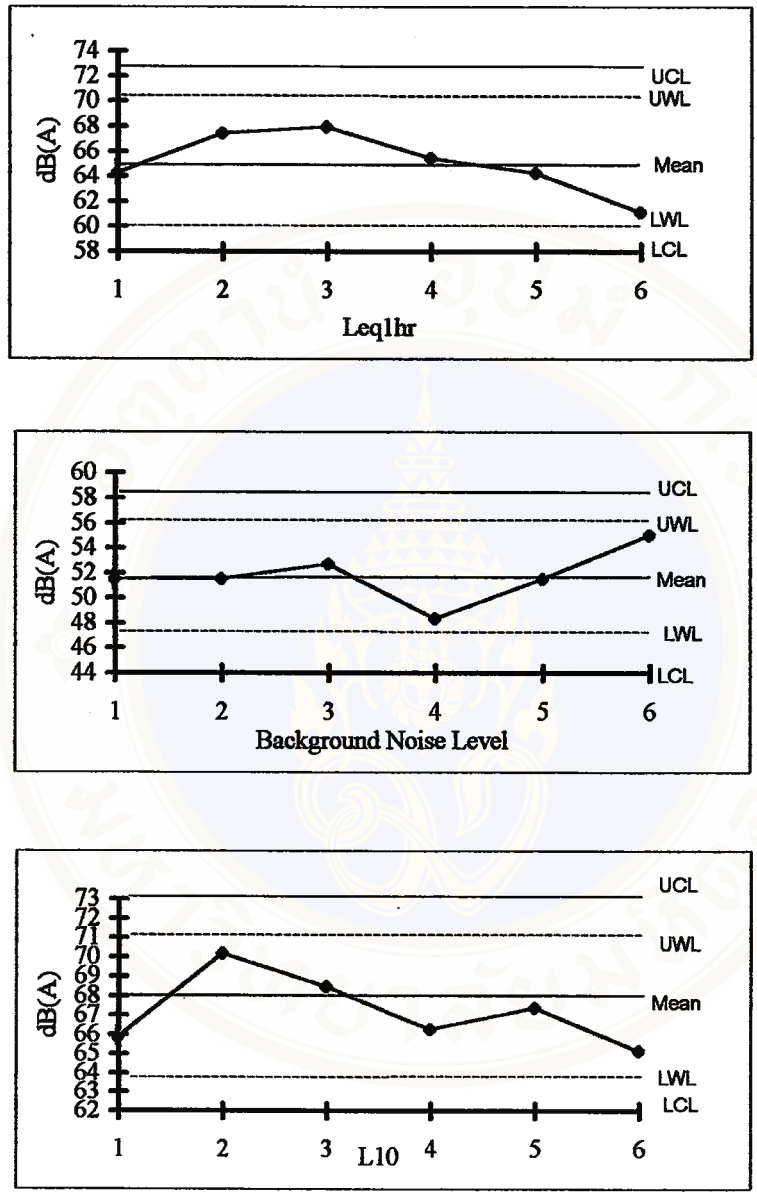


Figure B-2 Quality control chart of noise level in community No.II

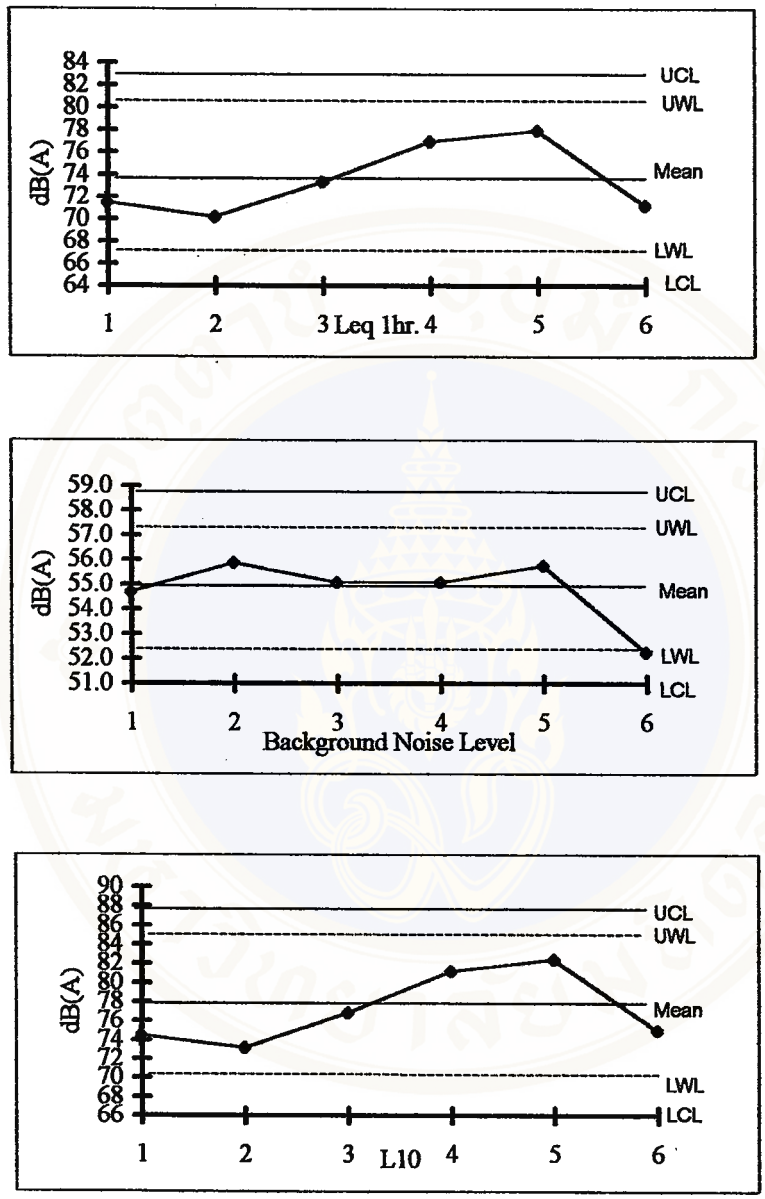


Figure B-3 Quality control chart of noise level in community No.III

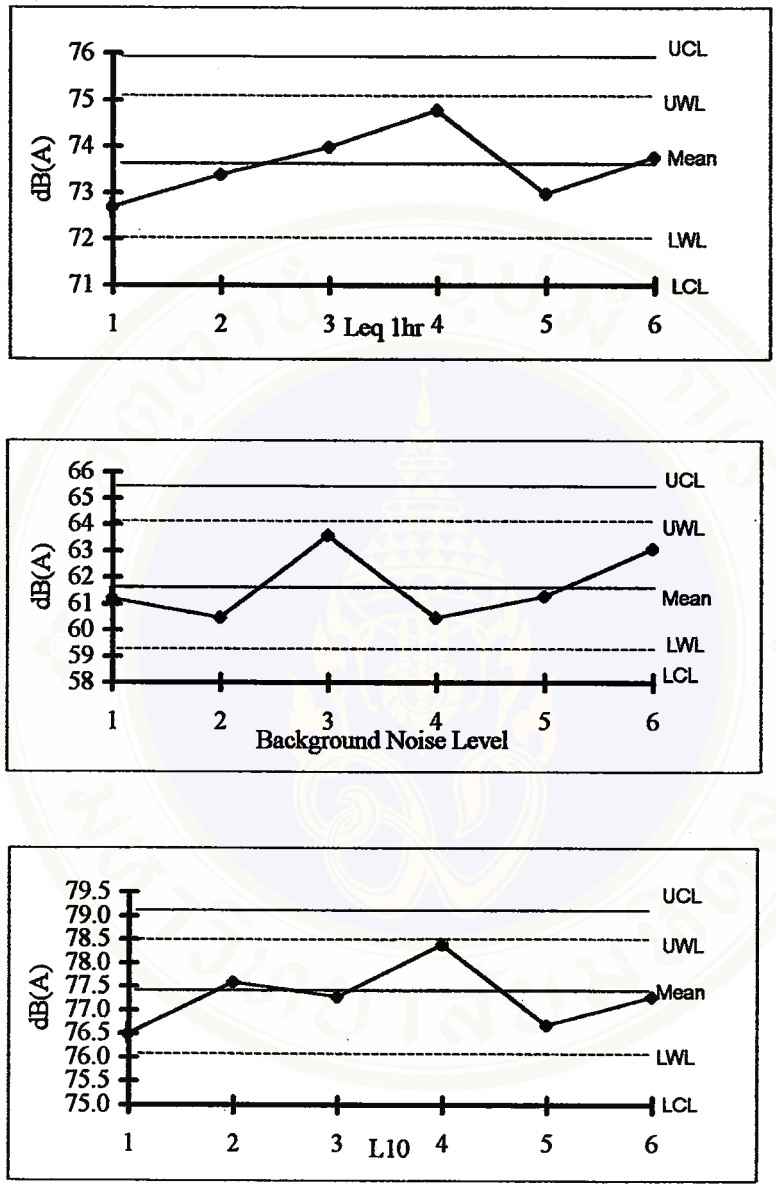
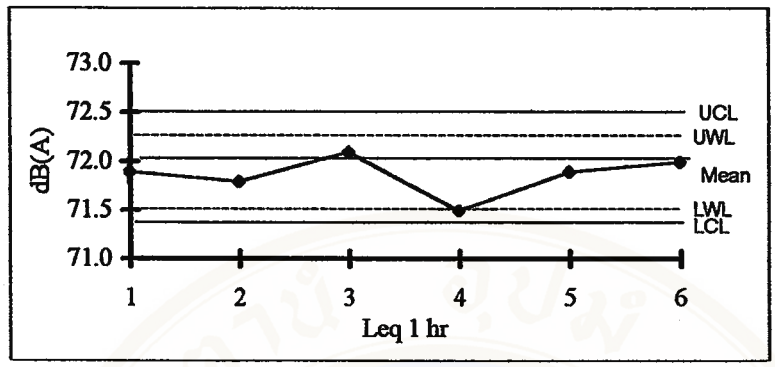
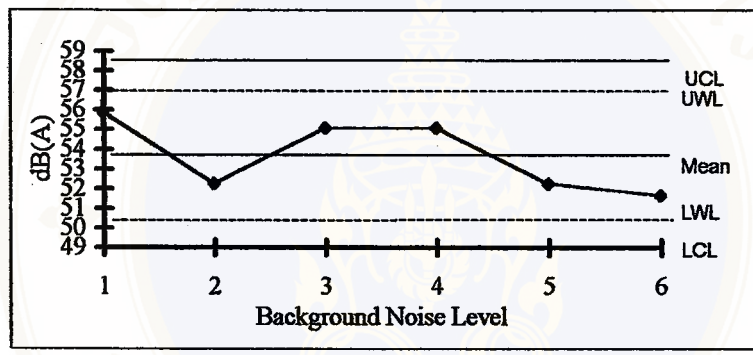


Figure B-4 Quality control chart of noise level in community No.IV





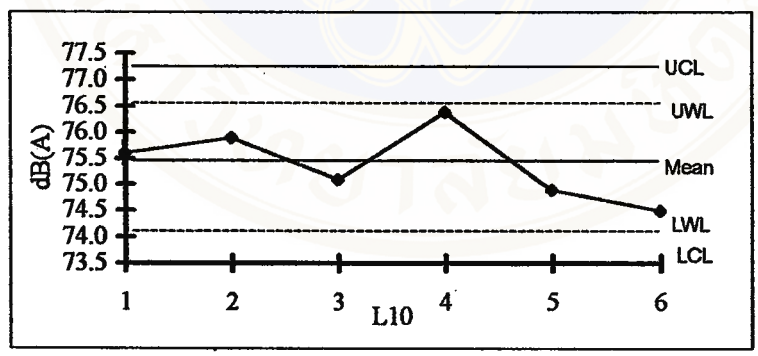


Figure B-5 Quality control chart of noise level in community No.V

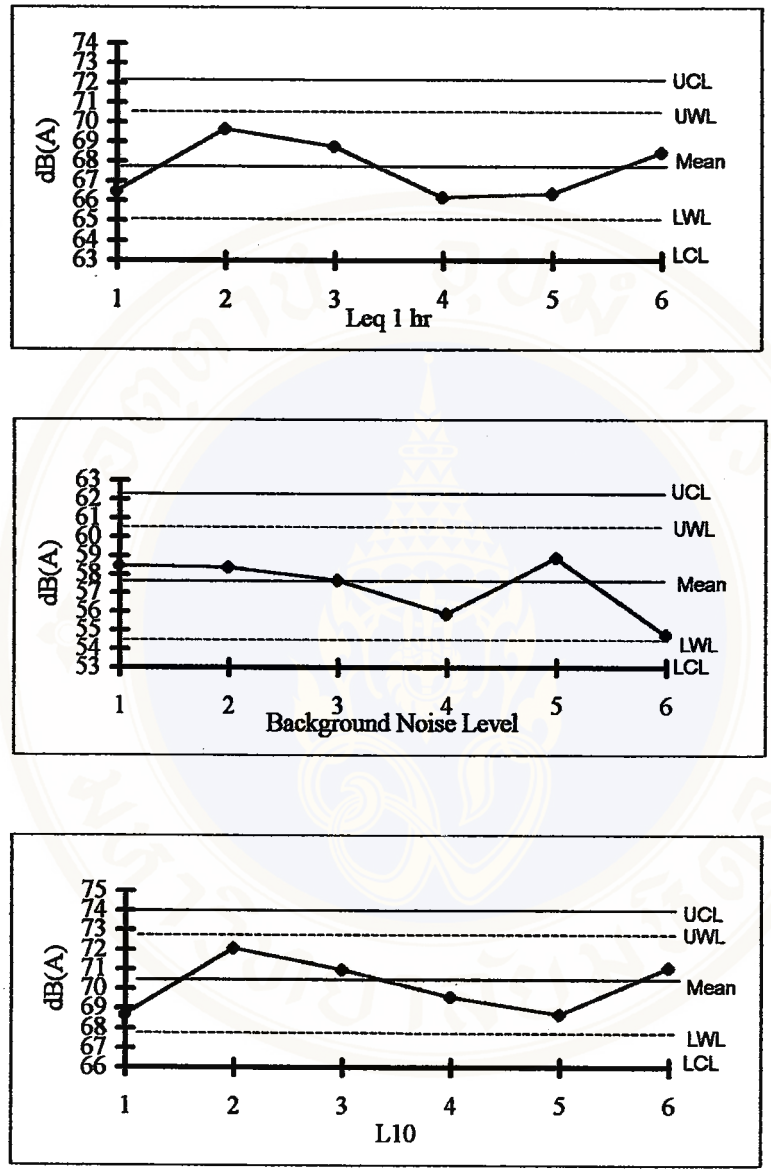


Figure B- 6 Quality control chart of noise level in community No. VI

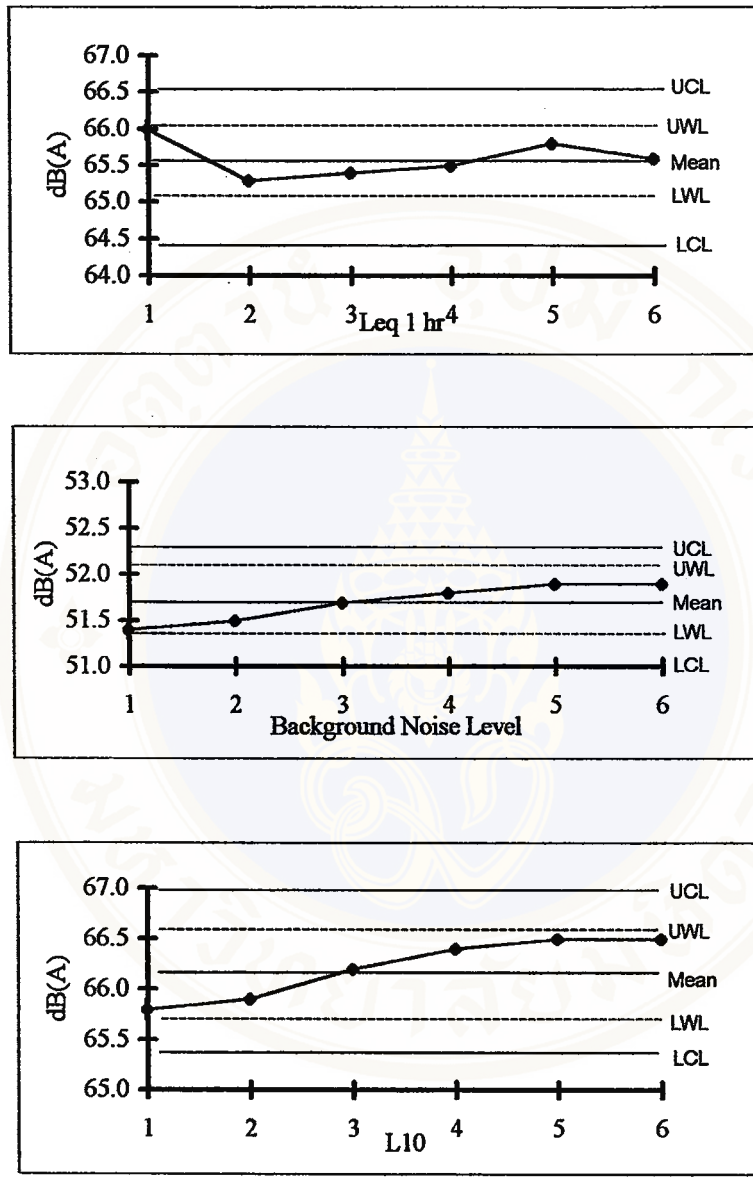


Figure B-7 Quality control chart of noise level in community No.VII

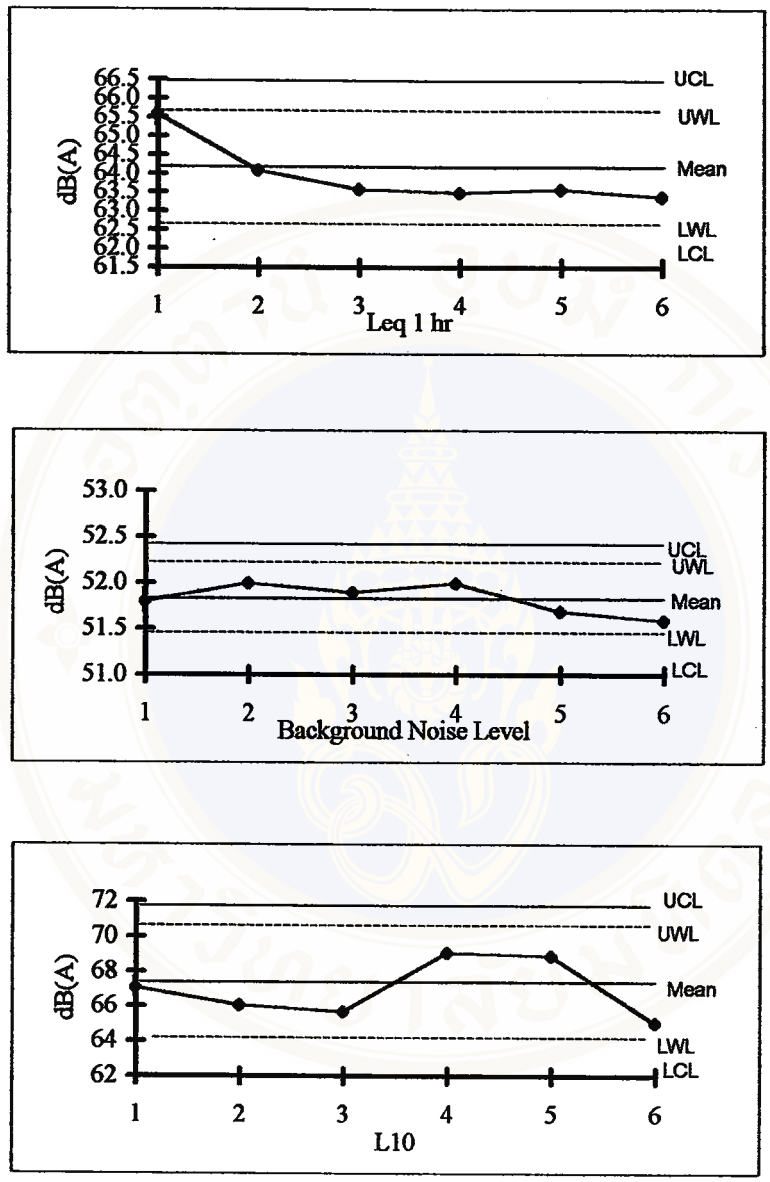


Figure B-8 Quality control chart of noise level in community No.VIII

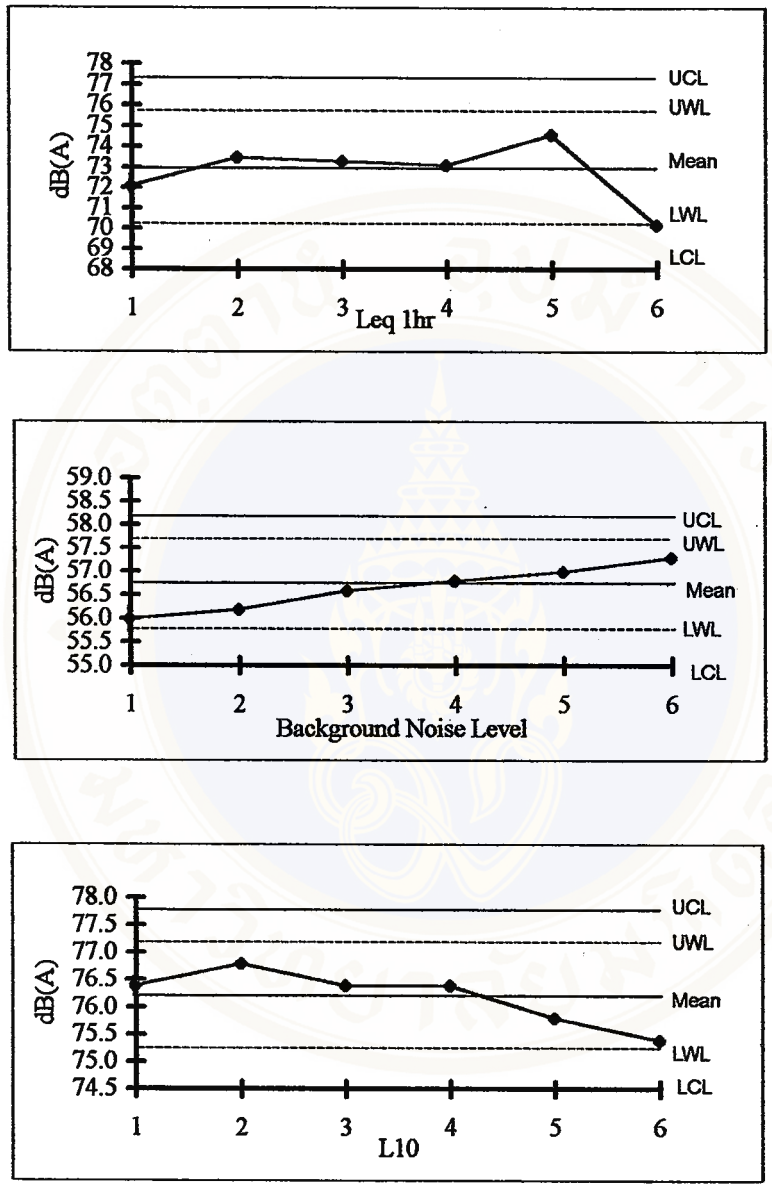


Figure B-9 Quality control chart of noise level in community No.IX

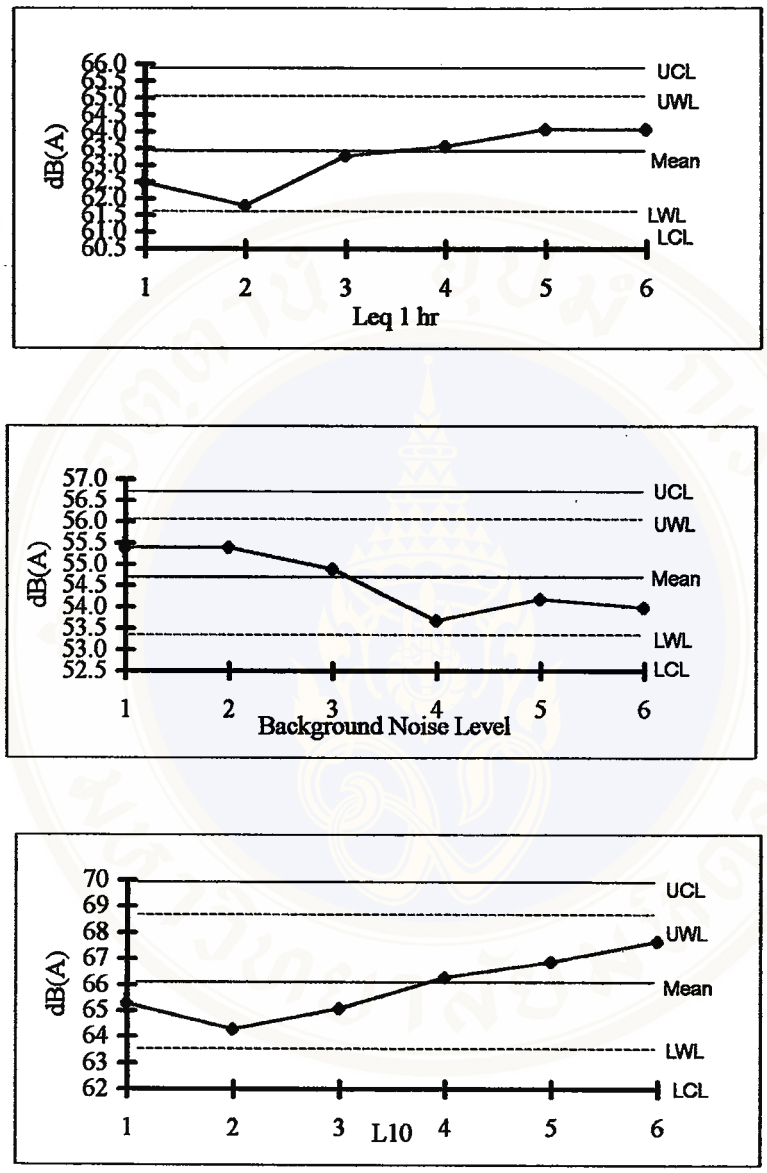


Figure B-10 Quality control chart of noise level in community No.X

APPENDIX C

Statistic of noise complaint

TableC- 1 Statistical Data of compliant due to Loud Noise in Bangkok Metropolis and Suburbs 1992 - 1995 from Pollution Control Department

Activities	Percent			
	1992	1993	1994	1995
1. Automobile repair, forging and color spray shop	4	25	20	20
2. Factory				
- Automobile Assembly Factory	12	16.7	24	16
- Packaging	8	-	8	-
- Fabric Weaving- Thread Winding	12	-	-	4
- Furniture Making	4	-	8	4
- Others	32	20.8	12	20
3. Hotels and Restaurants	-	16.7	4	20
4. Others	28	20.8	24	16
Total	**100**	**100**	**100**	**100**

Source : Pollution Control Department.

Table C-2 Statistical data on Annoyance Causes from Wood furniture Factory* in Bangsue district 1996 -1998

Year	Number of complaint	Source of complaint*	Percentage
1996	32	3	9.38
1997	50	5	10.0
1998	48	3	6.25
Total	**130**	**11**	**8.46**

Source: Department of Environment and Sanitation, Bangsue District

APPENDIX D

Noise survey questionnaire

Noise Questionnaire

Site.....
Respondent No..... Interviewer.....

This survey is to gather statistical information on noise and its effect on people in the community adjacent furniture factory. All information given is treat as strictly confidential. No names are recorded.

1. You living status in this community
[ ] 1.Resident [ ] 2. Working place [ ] 3.Both resident and working place

2. How long have you lived (worked) at your present address?.....years..... months.

3.If you lived in this community, what is your ownership status the house?
[ ] 1.House owner [ ] 2.Under installment [ ] 3.Share with others
[ ] 4. Rent [ ] 5.Other .....

4.Please indicate the degree of environmental problem in your community.

Problem	degree of problem			
	1 no problem	2 little	3 moderate	4 severe
1.Air Pollution 2.Noise Annoyance 3.Solid Waste Collection 4.Flooding 5.Public Safety 6.Public Utility and Services 7.Other				

5.Predominant noise source ?
[ ] 1. Indoor
[ ] 2. Outdoor
[ ] 3. Both indoor and outdoor
[ ] 4. Others.....

6. Source of noise annoyance in your neighborhood.
[ ] 1.Construction activities
[ ] 2. Building or house air condition
[ ] 3. Small industrial factory ; i.e., Wood furniture factory
[ ] 4. Traffic
[ ] 5. Others.....

7. Please indicate the degree of disturbance or nuisance from wood furniture factory in your neighborhood.

[ ] 1. No problem
[ ] 2. Little
[ ] 3. Moderate
[ ] 4. Severe

8. What type of nuisance from the wood furniture factory affecting on your daily life ?

[ ] 1. Noise [ ] 2. Odor [ ] 3.Dust [ ] 4. Others.....

9. If there is noise nuisance, what time during the does it disturbed you? .....

10. How frequent was the noise from furniture factory?

[ ] 1.Sometime [ ] 2.always [ ] 3. All time on running process

11. Your feeling on noise from the wood furniture factory?

[ ] 1. Not annoyed
[ ] 2. Slightly annoyed
[ ] 3. Moderately annoyed
[ ] 4. Very annoyed

12. Please indicate the effect on your daily life from the wood furniture factory. (Disturbed with)

[ ] 1. Communication
[ ] 2. Daytime working
[ ] 3. Daily relax
[ ] 4. Sleeping

13.Do you try to solve the noise annoyance?

[ ] 1.Yes. (how) ..... [ ] 2.No.

14. Have you ever complained to authority about the noise annoyance from the wood furniture factory?

[ ] 1.Yes. [ ] 2.No.

15. Have your neighbor ever complained to authority about the noise annoyance from the wood furniture factory?

[ ] 1.Yes. [ ] 2.No. [ ] 3. Don't known

16.Does any of your cousins work in the furniture factory located in this community?

[ ] 1.Yes. [ ] 2.No.

17. The expectation of noise level in your community

[ ] 1. Stay at this level [ ] 2. Lesser [ ] 3.Other.....

18. Do you think your community requires annoyance noise standard?

[ ] 1. Require [ ] 2. Not require [ ] 3.Other.....

Personal data of respondents

19. Age ..... years.
20. Sex
    [ ] 1.Male [ ] 2.Female
21. Education
    [ ] 1.Primary school [ ] 2.Junior high school [ ] 3.Senior high school
    [ ] 4.Vocational school [ ] 5.Bachlor's degree [ ] 6.Post-graduate
22. Occupation
    [ ] 1. Self employed [ ] 2. Employee [ ] 3. Government employee
    [ ] 4. House-wife [ ] 5. Student [ ] 6. Other .....
23. Income (Baht per month)
    [ ] 1.No income [ ] 2. <5,000 [ ] 3. 5,000-10,000
    [ ] 4.10,001 – 15,000 [ ] 5.15,001-20,000 [ ] 6. Over 20,000
24.Do you have chronic illness?
    [ ] 1.No [ ] 2. Yes.....
25.At the present time, do you have any infections?
    [ ] 1. No. [ ] 2.Yes.....
26. Do you have hearing problem?
    [ ] 1.No [ ] 2. Yes.....

27. Distance from the wood furniture factory to your home (office).....meters.

28. House type
    [ ] 1.Commercial row house
    [ ] 2.Town House
    [ ] 3.Condominium, Apartment
    [ ] 4.Detached House
    [ ] 5.Other.....
29. Building material
    [ ] 1.Cement [ ] 2.Wood [ ] 3.Cement and wood [ ] 4.Other
30. Is your home (office) air conditioning?
    [ ] 1.Without AC [ ] 2.With AC (all rooms)
    [ ] 3.With AC (some rooms) [ ] 4.Other.....
31. How satisfied were you live in your home (office)?
    [ ] 1. Unsatisfied
    [ ] 2. Moderately satisfied
    [ ] 3. Very satisfied
32. How satisfied were you live or work in this community?
    [ ] 1. Unsatisfied
    [ ] 2. Moderately satisfied
    [ ] 3. Very satisfied

APPENDIX E

Questionnaire survey result

Table E-1 Result of the Noise Annoyance Survey in the Community (Adjacent to the furniture factory) Questionnaire.

Descriptive	I		II		III		IV		V		VI		VII		VIII		IX		X	
	No	%	No	%	No	%	No	%	No	%	No	%	No	%	No	%	No	%	No	%
1 Status in community																				
1.Resident	14	82.4	17	73.9	14	70	7	38.9	19	90.5	14	73.7	0	0	16	100	11	61.1	18	94.7
2.Working place	0	0	1	4.3	3	15	2	11.1	0	0	0	0	27	100	0	0	2	11.1	0	0
3.Both	3	17.6	5	21.7	3	15	9	50	2	9.5	5	26.3	0	0	0	0	5	27.8	1	5.3
Total	17	100	23	100	20	100	18	100	21	100	19	100	27	100	16	100	18	100	19	100
2. Time of residence																				
1.up to 6 months	0	0	1	4.3	1	5	0	0	1	4.8	0	0	0	0	0	0	0	0	0	0
2.>6 months to 1 yr	0	0	5	21.7	1	5	0	0	0	0	0	0	0	0	2	12.5	0	0	0	0
3.>1 yr to 2 yrs	0	0	1	4.3	1	5	3	16.7	3	14.3	3	15.8	0	0	0	0	1	5.6	0	0
4.>2yr to 5 yrs	0	0	1	4.3	5	25	2	11.1	2	9.5	1	5.3	6	22.2	2	12.5	5	27.8	0	0
5.>5 yrs to 10 yrs	0	0	1	4.3	4	20	4	22.2	2	9.5	2	10.5	13	48.1	0	0	2	11.1	8	42.1
6.over 10 yr	17	100	14	60.9	8	40	9	50	13	61.9	13	68.4	8	29.6	12	75	10	55.6	11	57.9
Total	17	100	23	100	20	100	18	100	21	100	19	100	27	100	16	100	18	100	19	100
3 Housing ownership																				
1.House owner	5	29.4	17	73.9	8	40	12	66.7	13	61.9	9	47.4	1	3.7	9	56.3	9	50	5	26.3
2.under installment	2	11.8	0	0	0	0	1	5.6	0	0	0	0	1	3.7	0	0	0	0	0	0
3.Share with others	1	5.9	3	13	6	30	1	5.6	8	38.1	9	47.4	0	0	7	43.8	3	16.7	0	0
4.Rent	9	52.9	3	13	5	25	1	5.6	0	0	1	5.3	0	0	0	0	6	33.3	14	73.7
5.Other	0	0	0	0	1	5	3	16.7	0	0	0	0	25	92.6	0	0	0	0	0	0
Total	17	100	23	100	20	100	18	100	21	100	19	100	27	100	16	100	18	100	19	100
4.Social - Environment problem																				
4.1 Air pollution																				
1.No problem	1	5.9	8	34.8	2	10	2	11.1	3	14.3	8	42.1	3	11.1	1	6.3	2	11.1	3	15.8
2.Little	6	35.3	9	39.1	7	35	6	33.3	13	61.9	5	26.3	5	18.5	7	43.8	2	11.1	11	57.9
3.Moderate	4	23.5	3	13	3	15	6	33.3	4	19	4	21.1	16	59.3	4	25	8	44.4	2	10.5
4.Severe	6	35.5	3	13	8	40	4	22.2	1	4.8	2	10.5	3	11.1	4	25	6	33.3	3	15.8
Total	17	100	23	100	20	100	18	100	21	100	19	100	27	100	16	100	18	100	19	100

Table E-1 Result of the Noise Annoyance Survey in the Community (Adjacent to the furniture factory) Questionnaire. (continued)

Descriptive	I		II		III		IV		V		VI		VII		VIII		IX		X	
	No	%	No	%	No	%	No	%	No	%	No	%	No	%	No	%	No	%	No	%
4.2 Noise annoyance																				
1.No problem	0	0	3	13	0	0	1	5.6	1	4.8	2	10.5	1	3.7	1	6.3	0	0	1	5.3
2.Little	6	35.3	10	43.5	4	20	8	44.4	10	47.6	11	57.9	7	25.9	11	68.8	7	38.9	13	68.4
3.Moderate	10	58.8	7	30.4	6	30	8	44.4	7	33.3	5	26.3	16	59.3	1	6.3	4	22.2	3	15.8
4.Severe	1	5.9	3	13	10	50	1	5.6	3	14.3	1	5.3	3	11.1	3	18.8	7	38.9	2	10.5
Tatal	17	100	23	100	20	100	18	100	21	100	19	100	27	100	16	100	18	100	19	100
4.3 Solid waste collection																				
1.No problem	7	41.2	10	43.5	11	55	12	66.7	13	61.9	17	89.5	5	18.5	12	75	7	38.9	13	68.4
2.Little	6	35.3	8	34.8	5	25	3	16.7	5	23.8	2	10.5	16	59.3	3	18.8	5	27.8	3	15.8
3.Moderate	2	11.8	1	4.3	2	10	3	16.7	3	14.3	0	0	4	14.8	1	6.3	4	22.2	1	5.3
4.Severe	2	11.8	4	17.4	2	10	0	0	0	0	0	0	2	7.4	0	0	2	11.1	2	10.5
Tatal	17	100	23	100	20	100	18	100	21	100	19	100	27	100	16	100	18	100	19	100
4.4 Flooding																				
1.No problem	7	41.2	15	65.2	9	45	12	66.7	14	66.7	18	94.7	8	29.6	11	68.8	16	88.9	4	21.1
2.Little	6	35.3	2	8.7	5	25	3	16.7	4	19	1	5.3	15	55.6	2	12.5	1	5.6	12	63.2
3.Moderate	2	11.8	2	8.7	2	10	2	11.1	2	9.5	0	0	3	11.1	2	12.5	0	0	0	0
4.Severe	2	11.8	4	17.4	4	20	1	5.6	1	4.8	0	0	1	3.7	1	6.3	1	5.6	3	15.8
Tatal	17	100	23	100	20	100	18	100	21	100	19	100	27	100	16	100	18	100	19	100
4.5 Public safety																				
1.No problem	6	35.3	9	39.1	9	45	11	61.1	10	47.6	12	63.2	15	55.6	10	62.5	12	66.7	8	42.1
2.Little	6	35.3	9	39.1	5	25	6	33.3	3	14.3	7	36.8	9	33.3	6	37.5	3	16.7	9	47.4
3.Moderate	2	11.8	2	8.7	2	10	1	5.6	6	28.6	0	0	0	0	0	0	3	11.1	1	5.3
4.Severe	3	17.6	3	13	4	20	0	0	2	9.5	0	0	3	11.1	0	0	1	5.6	1	5.3
Tatal	17	100	23	100	20	100	18	100	21	100	19	100	27	100	16	100	19	100	19	100
4.6 Public utility and service																				
1.No problem	12	70.6	20	87	15	75	13	72.2	17	81	13	68.4	20	74.1	13	81.3	17	94.4	18	94.7
2.Little	3	17.6	1	4.3	0	0	5	27.8	4	19	6	31.6	5	18.5	3	18.8	0	0	1	5.3
3.Moderate	2	11.8	2	8.7	4	20	0	0	0	0	0	0	2	7.4	0	0	0	0	0	0
4.Severe	0	0	0	0	1	5	0	0	0	0	0	0	0	0	0	0	0	5.6	0	0
Tatal	17	100	23	100	20	100	18	100	21	100	19	100	27	100	16	100	17	100	19	100

Table E-1 Result of the Noise Annoyance Survey in the Community (Adjacent to the furniture factory) Questionnaire. (continued)

Descriptive	I		II		III		IV		V		VI		VII		VIII		IX		X	
	No	%	No	%	No	%	No	%	No	%	No	%	No	%	No	%	No	%	No	%
5 Predominant noise source																				
1.Indoor >Outdoor	1	5.9	1	4.3	0	0	0	0	1	4.8	0	0	0	0	0	0	0	0	0	0
2.Outdoor > Indoor	14	82.4	21	91.3	19	95	17	94.4	14	66.7	18	94.7	23	85.2	15	93.8	18	100	8	42.1
3.Both	2	11.8	1	4.3	1	5	0	0	6	28.6	1	5.3	3	11.1	1	6.3	0	0	5	26.3
4.Others	0	0	0	0	0	0	1	5.6	0	0	0	0	1	3.7	0	0	0	0	6	31.6
Tatal	17	100	23	100	20	100	18	100	21	100	19	100	27	100	16	100	18	100	19	100
6. Source of noise annoyance																				
1.Construction activities	0	0	2	8.7	3	15	0	0	5	23.8	0	0	1	3.7	0	0	1	5.6	1	5.3
2.House air conditioning	3	17.6	0	0	0	0	0	0	2	9.5	1	5.3	2	7.4	0	0	1	5.6	0	0
3.Wood furniture industr	15	88.2	9	39.1	20	100	14	77.8	17	81	14	73.7	25	92.6	16	100	17	94.4	11	57.9
4.Traffics	4	23.5	13	56.5	10	50	14	77.8	11	52.4	14	73.7	6	22.2	6	37.5	3	16.7	3	15.8
7 Degree of nuisance from wood furniture factory																				
1. No problem	2	11.8	12	52.2	1	5	6	33.3	5	23.8	8	42.1	11	40.7	0	0	0	0	9	47.4
2. Little	6	35.3	5	21.7	5	25	7	38.9	5	23.8	8	42.1	8	29.6	8	50	10	55.6	8	42.1
3. Moderate	4	23.5	1	4.3	5	25	4	22.2	7	33.3	3	15.8	6	22.2	5	31.3	5	27.8	1	5.3
4. Severe	5	29.4	5	21.7	9	45	1	5.6	4	19	0	0	2	7.4	3	18.8	3	16.7	1	5.3
Tatal	17	100	23	100	20	100	18	100	21	100	19	100	27	100	16	100	18	100	19	100
8. Type of nuisance from wood furniture factory																				
1. Noise	14	82.4	11	47.8	19	95	12	66.7	17	81	11	57.9	15	55.6	16	100	18	100	10	52.6
2.Odor	6	35.3	5	21.7	2	10	3	16.7	7	33.3	0	0	8	29.6	9	56.3	4	22.2	2	10.5
3.Dust	15	88.2	8	34.8	17	85	11	61.1	13	61.9	8	42.1	10	37	11	68.8	12	66.7	5	26.3
9.Duration time with noise disturb																				
1. 8.00 am - 1.00 pm	15	88.2	8	34.8	17	85	11	61.1	15	71.4	11	57.9	16	59.3	16	100	17	94.4	10	52.6
2.1.00 pm - 5.00 pm	0	0	0	0	1	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3. 8.00 am - 5.00 pm	0	0	0	0	1	5	1	5.6	1	4.8	0	0	0	0	0	0	0	0	0	0
4. 5.00 pm - 10 Pm	0	0	3	13	0	0	0	0	1	4.8	0	0	0	0	0	0	1	5.6	0	0

Table E-1 Result of the Noise Annoyance Survey in the Community (Adjacent to the furniture factory) Questionnaire. (continued)

Descriptive	I		II		III		IV		V		VI		VII		VIII		IX		X	
	No	%	No	%	No	%	No	%	No	%	No	%	No	%	No	%	No	%	No	%
10 Frequency of noise with annoyance																				
1.Sometimes	14	82.4	4	17.4	5	25	11	61.1	8	38.1	9	47.4	10	37	8	50	14	77.8	9	47.4
2. Always	0	0	2	8.7	3	15	0	0	2	9.5	0	0	2	7.4	1	6.3	3	16.7	0	0
3. All time	3	17.6	5	21.7	11	55	1	5.6	7	33.3	2	10.5	4	14.8	7	43.8	1	5.6	1	5.3
11. Feeling on noise from wood furniture factory																				
1. Not annoying	2	11.8	12	52.2	1	5	6	33.3	4	19	8	42.1	12	44.4	0	0	0	0	9	47.4
2. Slightly annoying	6	35.3	5	21.7	6	30	8	44.4	4	19	8	42.1	9	33.3	12	75	10	55.6	8	42.1
3. Moderately annoying	7	41.2	2	8.7	3	15	4	22.2	7	33.3	3	15.8	5	18.5	2	12.5	5	27.8	1	5.3
4. Very annoying	2	11.8	4	17.4	10	50	0	0	6	28.6	0	0	1	3.7	2	12.5	3	16.7	1	5.3
Total	17	100	23	100	20	100	18	100	21	100	19	100	27	100	16	100	18	100	19	100
12. Effect of noise (disturbed)																				
1. Communication	17	100	3	13	13	65.0	13	72.2	11	52.4	6	31.6	6	22.2	11	68.8	17	94.4	6	31.6
2. Daytime working	3	17.6	2	8.7	3	15.0	4	22.2	8	38.1	0	0.0	12	44.4	2	12.5	5	27.8	2	10.5
3. Daily relaxation	9	52.9	10	43.5	14	70.0	3	16.7	13	61.9	6	31.6	2	7.4	14	87.5	13	72.2	9	47.4
4. Sleeping	5	29.4	4	17.4	8	40.0	2	11.1	7	33.3	4	21.1	1	3.7	4	25.0	2	11.1	0	0.0
13. Noise prevention																				
1.No	14	82.6	6	26.1	17	85	12	66.7	16	76.2	11	57.9	16	59.3	10	62.5	18	100	10	52.6
2.Yes	1	5.9	5	21.7	2	10	0	0	1	4.8	0	0	0	0	6	37.5	0	0	0	0
14. Complaint to authority of respondents																				
1. Ever	0	0	4	17.4	2	1	0	0	1	4.8	0	0	0	0	3	18.8	4	22.2	0	0
2. Never	15	88.2	7	30.4	17	85	12	66.7	16	76.2	11	57.9	16	59.3	13	81.3	14	77.8	10	52.6
15. Complaint to authority of neighbor																				
1. Ever	0	0	1	4.3	0	0	0	0	2	9.5	0	0	1	3.7	1	6.3	5	27.8	0	0
2. Never	5	29.4	7	30.4	5	25	4	22.2	12	57.1	12	63.2	5	18.5	7	43.8	3	16.7	19	100
3. Don't know	12	70.6	15	65.2	15	75	14	77.8	7	33.3	7	36.8	21	77.8	8	50	10	55.6	0	0
Total	17	100	22	95.6	20	100	18	100	19	90.4	19	100	26	96.3	15	93.8	13	72.3	19	100

Table E-1 Result of the Noise Annoyance Survey in the Community (Adjacent to the furniture factory) Questionnaire. (continued)

Descriptive	I		II		III		IV		V		VI		VII		VIII		IX		X	
	No	%	No	%	No	%	No	%	No	%	No	%	No	%	No	%	No	%	No	%
16 Have cousin work in the wood furniture factory																				
1. Yes	2	11.8	0	0	0	0	6	33.3	5	23.8	1	5.3	0	0	2	12.5	0	0	1	5.3
2. No	15	88.2	23	100	20	100	12	66.7	16	76.2	18	94.7	27	100	14	87.5	18	100	18	94.7
Total	17	100	23	100	20	100	18	100	21	100	19	100	27	100	16	100	18	100	19	100
17. Expectation to Community noise level																				
1. Stay at this level	2	11.8	4	17.4	2	10	2	11.1	5	23.8	5	26.3	1	3.7	1	6.3	0	0	2	10.5
2. Less	13	76.5	16	69.6	13	65	9	50	14	66.7	6	31.6	26	96.3	12	75	13	72.2	7	36.8
3. Others	2	11.8	3	13	5	25	7	38.9	2	9.5	8	42.1	0	0	3	18.8	5	27.8	10	52.6
Total	17	100	23	100	20	100	18	100	21	100	19	100	27	100	16	100	18	100	19	100
18.Requirement of annoyance noise standard																				
1. required	16	94.1	21	91.3	19	95	12	66.7	11	52.4	15	78.9	23	85.2	15	93.8	14	77.8	12	63.2
2. Not required	1	5.9	2	8.7	1	5	6	33.3	10	47.6	4	21	4	14.8	1	6.3	4	22.2	7	36.8
Total	17	100	23	100	20	100	18	100	21	100	19	100	27	100	16	100	18	100	19	100
19. Age																				
15 -20 yrs	3	17.6	7	30.4	2	10	3	16.7	7	33.3	3	15.8	0	0	3	18.8	6	33.3	5	26.3
21 -30 yrs	4	23.5	4	17.4	8	40	6	33.3	7	33.3	4	21.1	5	18.5	4	25	2	11.1	5	26.3
31 -40 yrs	5	29.4	5	21.7	3	15	3	16.7	2	9.5	7	36.8	11	40.7	2	12.5	2	11.1	3	15.8
41 - 50 yrs	4	23.5	4	17.4	3	15	4	22.2	3	14.3	0	0	11	40.7	2	12.5	4	22.2	2	10.5
51 - 60 yrs	1	5.9	0	0	1	5	2	11.1	2	9.5	4	21.1	0	0	3	18.8	4	22.2	1	5.3
>60 yrs	0	0	3	13	3	15	0	0	0	0	1	5.3	0	0	2	12.5	0	0	3	15.8
Total	17	100	23	100	20	100	18	100	21	100	19	100	27	100	16	100	18	100	19	100
20.Sex																				
1. Male	9	52.9	9	36.1	9	45	8	44.4	8	38.1	8	42.1	24	88.9	7	43.8	7	38.9	5	26.3
2. Female	8	47.1	14	60.9	11	55	10	55.6	13	61.9	11	57.9	3	11.1	9	56.3	11	61.1	14	73.7
Total	17	100	23	97	20	100	18	100	21	100	19	100	27	100	16	100	18	100	19	100

Table E-1 Result of the Noise Annoyance Survey in the Community (Adjacent to the furniture factory) Questionnaire. (continued)

Descriptive	I		II		III		IV		V		VI		VII		VIII		IX		X	
	No	%	No	%	No	%	No	%	No	%	No	%	No	%	No	%	No	%	No	%
21. Education																				
1. Primary school	5	29.4	4	17.4	9	45	4	22.2	2	9.5	6	31.6	1	3.7	4	25	4	22.2	4	21.1
2. Junior high school	2	11.8	2	8.7	2	10	1	5.6	7	33.3	3	15.8	0	0	5	31.3	4	22.2	7	36.8
3. Senior high school	5	29.4	9	39.1	4	20	6	33.3	4	19	4	21.1	10	37	3	18.8	6	33.3	6	31.6
4. Vocational School	2	11.8	0	0.0	2	10	3	16.7	4	19	0	0	12	44.4	1	6.3	0	0	1	5.3
5. Bachelor's degree	3	17.6	5	21.7	3	15	4	22.2	4	19	6	31.6	4	14.8	3	18.8	4	22.2	1	5.3
6. Graduate	0	0	3	13.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	17	100	23	100	20	100	18	100	21	100	19	100	27	100	16	100	18	100	19	100
22. Occupation																				
1. Self employed	2	11.8	4	17.4	6	30	8	44.4	3	14.3	5	26.3	0	0	4	25	5	27.8	2	10.5
2. Employee	7	41.2	3	13	4	20	5	27.8	4	19	8	42.1	2	7.4	3	18.8	6	33.3	4	21.1
3. Government officer	3	17.6	1	4.3	0	0	0	0	2	9.5	1	5.3	25	92.6	1	6.3	0	0	0	0
4. House wife	4	23.5	5	21.7	3	15	0	0	3	14.3	2	10.5	0	0	4	25	3	16.7	7	36.8
5. Student	1	5.9	7	30.4	6	30	5	27.8	9	42.9	3	15.8	0	0	3	18.8	4	22.2	5	26.3
6. Others	0	0	3	13	1	5	0	0	0	0	0	0	0	0	1	6.3	0	0	1	5.3
Total	17	100	23	100	20	100	18	100	21	100	19	100	27	100	16	100	18	100	19	100
23. Income (Baht per month)																				
1. No income	4	23.5	9	39.1	5	25	3	16.7	8	38.1	5	26.3	0	0	5	31.3	7	38.9	12	63.2
2. <5,000	2	11.8	4	17.4	11	55	3	16.7	5	23.8	4	21.1	0	0	3	18.8	3	16.7	3	15.8
2. 5,000 - 10,000	7	41.2	3	13	3	15	10	55.6	5	23.8	4	21.1	13	48.1	3	18.8	3	16.7	3	15.8
3. 10,001 - 15,000	4	23.5	5	21.7	1	5	2	11.1	2	9.5	2	10.5	5	18.5	4	25	3	16.7	1	5.3
4. 15,001 - 20,000	0	0	0	0	0	0	0	0	1	4.8	3	15.8	7	25.9	0	0	1	5.6	0	0
5. >20,000	0	0	2	8.7	0	0	0	0	0	0	1	5.3	2	7.4	1	6.3	1	5.6	0	0
Total	17	100	23	100	20	100	18	100	21	100	19	100	27	100	16	100	18	100	19	100
24. Chronic disease																				
1.No	13	76.5	21	91.3	15	75	16	88.9	18	85.7	15	78.9	19	70.4	13	81.3	17	94.4	19	100
2.Yes	4	23.5	2	8.7	5	25	2	11.1	3	14.3	4	21.1	8	29.6	3	18.8	1	5.6	0	0
Total	17	100	23	100	20	100	18	100	21	100	19	100	27	100	16	100	18	100	19	100
25 Current infection																				
1.No	14	82.4	22	95.7	18	90	15	83.3	18	85.7	17	89.5	24	88.9	15	93.8	18	100	18	94.7
2.Yes	3	17.6	1	4.3	2	10	3	16.7	3	14.3	2	10.5	3	11.1	1	6.3	0	0	1	5.3
Total	17	100	23	100	20	100	18	100	21	100	19	100	27	100	16	100	18	100	19	100

Table E-1 Result of the Noise Annoyance Survey in the Community (Adjacent to the furniture factory) Questionnaire. (continued)

Descriptive	I		II		III		IV		V		VI		VII		VIII		IX		X	
	No	%	No	%	No	%	No	%	No	%	No	%	No	%	No	%	No	%	No	%
27. Distance from factory																				
<10 m.					11	55	11	61.1			19	100			5	31.3				
10 - 20 m.	6	35.3			7	35	7	38.9	1	4.8			10	37	11	68.7	4	22.2	5	26.3
21 - 30 m.	9	53	4	17.4	2	10			16	76.2			4	14.8			5	27.8	9	47.4
31 - 40 m.	2	11.8							1	4.8			2	7.4					5	26.3
41 - 50 m.			2	8.7					3	14.3			11	40.7			5	27.8		
51 - 60 m.			6	26.1													1	5.6		
61 - 70 m.			2	8.7													3	16.7		
> 70m.			9	39.1																
Total	17	100	23	100	20	100	18	100	21	100	19	100	27	100	16	100	18	100	19	100
28. Type of housing																				
1. Commercial Building	9	52.9	3	13	10	50	18	100	3	14.3	0	0	1	3.7	0	0	18	100	0	0
2. Town house	8	47.1	7	30.4	5	25	0	0	5	23.8	3	15.8	0	0	0	0	0	0	0	0
3. Condominium,A/P	0	0	0	0	2	10	0	0	0	0	0	0	1	3.7	0	0	0	0	0	0
4. Detached house	0	0	13	56.5	1	5	0	0	13	61.9	16	84.2	1	3.7	16	100	0	0	10	52.6
5. Others	0	0	0	0	2	10	0	0	0	0	0	0	24	88.9	0	0	0	0	9	47.4
Total	17	100	23	100	20	100	18	100	21	100	19	100	27	100	16	100	18	100	19	100
29. Building material in dwelling																				
1. Cement	8	47.1	7	30.4	7	35	17	94.4	8	38.1	0	0	24	88.9	4	25	18	100	0	0
2. Wood	0	0	0	0	2	10	0	0	4	19	13	68.4	0	0	5	31.3	0	0	15	78.9
3. Cement & wood	9	52.9	16	69.6	11	55	1	5.6	9	42.9	6	31.6	3	11.1	7	43.8	0	0	4	21.1
Total	17	100	23	100	20	100	18	100	21	100	19	100	27	100	16	100	18	100	19	100
30.Air Conditioning in house or office																				
1. Without A.C.	12	70.6	7	30.4	14	70	7	38.9	10	47.6	13	68.4	8	29.6	10	62.5	5	27.8	19	100
2. With A.C. (all rooms)	0	0	3	13	0	0	0	0	2	9.5	0	0	13	48.1	2	12.5	0	0	0	0
3.With A.C.(some rooms)	5	29.4	13	56.5	6	30	11	61.1	9	42.9	6	31.6	6	22.2	4	25	13	72.2	0	0
Total	17	100	23	100	20	100	18	100	21	100	19	100	27	100	16	100	18	100	19	100

Table E-1 Result of the Noise Annoyance Survey in the Community (Adjacent to the furniture factory) Questionnaire. (continued)

Descriptive	I		II		III		IV		V		VI		VII		VIII		IX		X	
	No	%	No	%	No	%	No	%	No	%	No	%	No	%	No	%	No	%	No	%
31. Satisfaction to House																				
1. Unsatisfied	2	11.8	0	0	1	5	0	0	0	0	0	0	4	14.8	0	0	1	5.6	1	5.3
2. Moderately satisfied	13	76.5	22	95.7	17	85	18	100	18	85.7	18	94.7	21	77.8	14	87.5	16	88.9	18	94.7
3. Very satisfied	2	11.8	1	4.3	2	10	0	0	3	14.3	1	5.3	2	7.4	2	12.5	1	5.6	0	0
Total	17	100	23	100	20	100	18	100	21	100	19	100	27	100	16	100	18	100	19	100
32. Satisfaction to community																				
1. Unsatisfied	6	35.3	5	21.7	7	35	0	0	5	23.8	1	5.3	8	29.6	4	25	6	33.3	5	26.3
2. Moderately satisfied	11	64.7	17	73.9	13	65	18	100	14	66.7	17	89.5	19	70.4	12	75	12	66.7	14	73.7
3. Very satisfied	0	0	1	4.3	0	0	0	0	2	9.5	1	5.3	0	0	0	0	0	0	0	0
Total	17	100	23	100	20	100	18	100	21	100	19	100	27	100	16	100	18	100	19	100

APPENDIX F

Community noise standards

Table F-1 UNITED STATES ENVIRONMENTAL PROTECTION AGENCY PROTECTIVE NOISE LEVELS

Yearly L_{dn} Values That Protect Public Health and Welfare with a Margin of Safety

Effect	Level	Area
Hearing	$L_{eq(24)}$ <=70 dB	All areas (at the ear)
Outdoor activity interference and annoyance	L_{dn} <= 55 dB	Outdoor in residential areas and farms and other outdoor areas where people spend widely varying amounts of time and other places in which quiet is a basis for use
	$L_{eq(24)}$ <=55dB	Outdoor areas where people spend limited amounts of time, such as school yards, playgrounds, etc.
Indoor activity interference and annoyance	L_{dn} <=45 dB	Indoor residential areas
	L_{eq} <=45dB	Other indoor areas with human activities such as school, etc.

Table F-2 RECOMMENDED NOISE EXPOSURE LIMITS BY WORLD HEALTH ORGANIZATION

Summary of Recommended Noise Exposure Limits

Environment	Recommended Maximum Leq Level(a)	Effects
Industrial/ Occupational	75 dB(A) $L_{eq(8\text{-}h)}$	Predictable risk of hearing impairment at higher levels
Community/urban :		
Daytime	55 dB(A) L_{eq}	Annoyance increases at higher levels
Night-time	45 dB(A) L_{eq}	Difficulties in falling asleep at higher levels
Indoor/domestic :		
Daytime	45 dB(A) L_{eq}	Speech communication deteriorates at higher levels
Night-time	35 dB(A) L_{eq}	Increased awakening at higher levels

Note : a:" The equivalent continuous A-weighted sound present level ", L_{eq} is recommended for use with a time relate to the problem under study, e.g., $Leq_{(8\text{-}h)}$ for, the occupational noise measured during an 8-h shift

Table F-3 WORLD BANK ENVIRONMENTAL NOISE GUIDELINES
Yearly Average Equivalent Sound Levels Required for Protection of Public Health and Welfare

		INDOOR			OUTDOOR		
	measure (e,f)	Activity Interference	Hearing loss Consideration	To protect Against both effect (b)	Activity Interference	Hearing loss Consideration	To protect Against both effect (b)
Residential with Outside Space and Farm Residences	Ldn	45		45	55		55
	Leq(24)		70			70	
Residential with no Outside space	Ldn	45		45			
	Leq(24)		70				
Commercial	Leq(24)	(a)	70	70(c)	(a)	70	70(c)
Inside Transportation	Leq(24)	(a)	70	(a)			
Industrial	Leq(24)	(a)	70	70(c)	(a)	70	70(c)
	(d)						
Hospitals	Ldn	45		45	55		55
	Leq(24)					70	
Education	Leq(24)	45		45	55		55
	Leq(24)		70			70	
	(d)						
Recreational Areas	Leq(24)	(a)	70	70(c)	(a)	70	70(c)
Farm Land and General Unpopulated Land	Leq(24)				(a)	70	70(c)

Notes : a.. Since different types of activities appear to be associated with offerrent levels, identification of a maximum level for activity interference may be difficult except in those circumstances where speech communication is a critical activity.

b. Based on lowest level. c. Based only on hearing loss.

d. A Leq(8) of 75 dB may be identified in these situations so long as the exposure over the remaining 16 hous per day is low enough to result in a negligible contribution to the 24-hour average, i.e., no greater than an Leq of 60 dB

e. Ldn=Day-night average A-weighted equivalent sound level, with a 10 decibel weighting applied to night time levels.

f. Leq(24) = Equivalent A-weighted sound level over 24 hours.

Table F-4 JAPANESE REGULATORY NOISE STANDARD

Category of area	Division of hours		
	Daytime	Morning & evening	Nigh-time
	Not more than	Not more than	Not more than
AA	45	40	35
A	50	45	40
B	60	55	50

Note: Standard values vary depending on the area type. Therefore, classification of areas is left to the discretion of prefectural governors.

AA – Areas which require particular quite. For instance, areas where medical facilities are concentrated.

A – Primarily residential areas.

B – Areas where a substantial number of residences are located among shops and factories.

APPENDIX G
Chi- square tests

Association between respondents characteristics and degree of annoyance

Table G-1 Association between respondents characteristics and degree of annoyance classified by sex

	Degree of annoyance		Total
	Not annoyed	Highly annoyed	
Male	64	30	94
Female	66	38	104
Total	130	68	198

Pearson chi-square = 0.47, df = 1, p-value = 0.46387

Table G-2 Association between respondents characteristics and degree of annoyance classified by age

year	Degree of annoyance		Total
	Not annoyed	Highly annoyed	
15-20	27	12	39
21-30	28	21	49
31-40	32	11	43
41-50	26	11	37
51-60	14	4	18
>60	3	9	12
Total	130	68	198

Pearson chi-square = 13.58, df = 5, p-value = 0.01852

Table G-3 Association between respondents characteristics and degree of annoyance classified by occupation

	Degree of annoyance		Total
	Not annoyed	Highly annoyed	
Self employed	25	14	39
Employee	30	16	46
Government employee	21	9	30
House wife	20	10	30
Student	31	15	46
Others	3	4	7
Total	130	68	198

Pearson chi-square = 1.99, df = 5, p-value = 0.85117

Table G-4 Association between respondents characteristics and degree of annoyance classified by education

	Degree of annoyance		Total
	Not annoyed	Highly annoyed	
Primary school	29	14	43
Junior high school	23	10	33
Senior high school	41	16	57
Vocational school	14	10	24
Bachelor's degree & post graduate	23	18	41
Total	130	68	198

Pearson chi-square = 3.53, df = 4, p-value = 0.47382

Table G-5 Association between respondents characteristics and degree of annoyance classified by income

Baht / month	Degree of annoyance		Total
	Not annoyed	Highly annoyed	
No income	41	17	58
<5,000	22	16	38
5,001-10,000	35	19	54
10,000-15,000	21	8	29
>15,000	11	8	19
Total	130	68	198

Pearson chi-square = 2.78, df = 4, p-value = 0.59551

Table G-6 Association between respondents characteristics and degree of annoyance classified by chronic illness

	Degree of annoyance		Total
	Not annoyed	Highly annoyed	
No	116	50	166
Yes	14	18	32
Total	130	68	198

Pearson chi-square = 8.12, df = 1, p-value = 0.00437

Table G-7 Association between respondents characteristics and degree of annoyance classified by Housing ownership

	Degree of annoyance		Total
	Not annoyed	Highly annoyed	
House owner	51	37	88
Under installment	3	1	4
Share with others	25	13	38
Rent	28	11	39
Others	23	6	29
Total	130	68	198

Pearson chi-square = 5.52, df = 4, p-value = 0.23801

Table G-8 Association between respondents characteristics and degree of annoyance classified by status in community

	Degree of annoyance		Total
	Not annoyed	Highly annoyed	
Resident	82	48	130
Working place	25	10	35
Both	23	10	33
Total	130	68	198

Pearson chi-square = 1.14, df = 2, p-value = 0.56561

Table G-9 Association between respondents characteristics and degree of annoyance classified by time of residence

year	Degree of annoyance		Total
	Not annoyed	Highly annoyed	
1-2	17	6	23
2-5	12	12	24
>5	101	50	151
Total	130	68	198

Pearson chi-square = 3.41, df = 2, p-value = 0.18215

Table G-10 Association between respondents characteristics and degree of annoyance classified by distance from factory

Meter (m.)	Degree of annoyance		Total
	Not annoyed	Highly annoyed	
1-10	29	25	54
11-20	40	28	68
21-30	16	11	27
31-40	7	0	7
41-50	17	4	21
51-100	21	0	21
Total	130	68	198

Pearson chi-square = 22.14, df = 5, p-value = 0.00049

Table G-11 Association between respondents characteristics and degree of annoyance classified by type of housing

	Degree of annoyance		Total
	Not annoyed	Highly annoyed	
Commercial row building	38	24	62
Town house	14	14	28
Condominium, A/P	3	0	3
Detached house	47	23	70
Others	38	7	35
Total	130	68	198

Pearson chi-square = 8.40, df = 4, p-value = 0.07800

Table G-12 Association between respondents characteristics and degree of annoyance classified by air condition (A.C.) in the house

	Degree of annoyance		Total
	Not annoyed	Highly annoyed	
Without A.C.	75	30	105
With A.C.(all rooms)	12	8	20
With A.C. (some rooms)	43	30	73
Total	130	68	198

Pearson chi-square = 3.31, df = 2, p-value = 0.19097

Table G-13 Association between respondents characteristics and degree of annoyance classified by history of complaint

	Degree of annoyance		Total
	Not annoyed	Highly annoyed	
Ever	4	10	14
Never	73	58	131
Total	77	68	145

Pearson chi-square = 3.74, df = 1, p-value = 0.05297

Association between respondents characteristics and requirement of annoyance noise guideline

Table G-14 Association between respondents characteristics and requirement of annoyance noise guideline classified by sex

	Requirement of standard		Total
	Required	Not required	
Male	76	18	94
Female	82	22	104
Total	158	40	198

Pearson chi-square = 0.12, df = 1, p-value = 0.72568

Table G-15 Association between respondents characteristics and requirement of annoyance noise guideline classified by age

year	Requirement of standard		Total
	Required	Not required	
15-20	30	9	39
21-30	39	10	49
31-40	35	8	43
41-50	30	7	37
51-60	13	5	18
>60	11	1	12
Total	158	40	198

Pearson chi-square = 2.0, df = 5, p-value = 0.84963

Table G-16 Association between respondents characteristics and requirement of annoyance noise guideline classified by occupation

	Requirement of standard		Total
	Required	Not required	
Self employed	30	9	39
Employee	37	9	46
Government employee	25	5	30
House wife	20	10	30
Student	39	7	46
Others	7	0	7
Total	158	40	198

Pearson chi-square = 6.13, df = 5, p-value = 0.29339

Table G-17 Association between respondents characteristics and requirement of annoyance noise guideline classified by education

	Requirement of standard		Total
	Required	Not required	
Primary school	31	12	43
Junior high school	25	8	33
Senior high school	45	12	57
Vocational school	20	4	24
Bachelor's degree & post graduate	37	4	41
Total	158	40	198

Pearson chi-square = 4.90, df = 4, p-value = 0.29723

Table G-18 Association between respondents characteristics and requirement of annoyance noise guideline classified by income

Baht / month	Requirement of standard		Total
	Required	Not required	
No income	44	14	58
<5,000	31	7	38
5,001-10,000	44	10	54
10,000-15,000	23	6	29
>15,000	16	3	19
Total	158	40	198

Pearson chi-square = 0.96, df = 4, p-value = 0.91568

Table G-19 Association between respondents characteristics and requirement of annoyance noise guideline classified by ownership house status

	Requirement of standard		Total
	Required	Not required	
House owner	69	19	88
Under installment	3	1	4
Share with others	30	8	38
Rent	30	9	39
Others	26	3	29
Total	158	40	198

Pearson chi-square = 2.13, df = 4, p-value = 0.71235

Table G-20 Association between respondents characteristics and requirement of annoyance noise guideline classified by status in community

	Requirement of standard		Total
	Required	Not required	
Resident	103	27	130
Working place	30	5	35
Both	25	8	33
Total	158	40	198

Pearson chi-square = 1.12, df = 2, p-value = 0.57119

Table G-21 Association between respondents characteristics and requirement of annoyance noise guideline classified by time of resident

year	Requirement of standard		Total
	Required	Not required	
< 5	35	12	47
>5	123	28	151
Total	158	40	198

Pearson chi-square = 1.04, df = 1, p-value = 0.30728

Table G-22 Association between respondents characteristics and requirement of annoyance noise guideline classified by history of complaint

	Requirement of standard		Total
	Required	Not required	
Ever	13	1	14
Never	106	25	131
Total	119	26	145

Fisher's Exact Test, p-value = 0.46546

Table G-23 Association between respondents characteristics and requirement of annoyance noise guideline classified by degree of annoyance

	Requirement of standard		Total
	Required	Not required	
Not annoyed	97	33	130
Highly annoyed	61	7	68
Total	158	40	198

Pearson chi-square = 6.31, df = 1, p-value = 0.01203

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