Social surveys on community response to road traffic noise in Hanoi and Ho Chi Minh City

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INTRODUCTION

Though a number of social surveys on community response to noise have been conducted in European and in American countries as well as in Japan (Fields 2001; Miedema & Vos 1998; Schultz 1978), only few surveys in other Asian countries especially the developing countries have been published (Sato et al. 2000). Vietnam is one of the developing countries in Asia that suffers excessive noise emission from road traffic. The problem is that there has not been any proper measure to cope with the situation, and that Vietnam does not have a national policy on noise. Data on community response to road traffic noise have, therefore, been collected, which is hoped to be a major source for the establishment of a practical noise policy for Vietnam. Serving this purpose, social surveys on community response to road traffic noise and noise measurements have been conducted in major cities in Vietnam, i.e. Hanoi and Ho Chi Minh city, in order to investigate the characteristics of road traffic noise here and to establish dose-response relationships for road traffic noise in Vietnam.

Hanoi is the capital city of Vietnam, serving as the political, the cultural and the largest educational center. Hanoi attracts a large number of not only world-wide tourists, but also inhabitants from other provinces coming here for work. While Hanoi is reflected as a major metropolitan area of Northern area, Ho Chi Minh city is considered the largest city in Southern area and the biggest urban agglomeration of Vietnam. While Hanoi's population is 4.2 million people (2006), Ho Chi Minh's population now exceeds 6 million people (2006), excluding over 2 million migrants who live here as temporary residents or commuters. Together with many positive sides both cities have to offer, Hanoi and Ho Chi Minh are now facing worsening situations of road traffic noise, increasing volumes and chaotic flows of road traffic.

In September 2005 and September 2007, two large-scaled social surveys on community response to road traffic noise and noise measurements were conducted in Hanoi and Ho Chi Minh city, respectively. The sample sizes were 1503 in Hanoi, and 1471 in Ho Chi Minh city, including both row house and apartment residents.

SOCIAL SURVEY AND NOISE MEASUREMENT

Social surveys and noise measurements were conducted in Hanoi and Ho Chi Minh city under the same method. Based on preliminary investigation, eight sites (coded as "site" with number accordingly from 1 to 8) were selected based on overall criteria: (1) having high traffic volume; (2) having high density of residential population; and (3) being a combined dwelling area of row houses and apartments. All row houses

and apartments of the study sites were exposed directly to the main roads, and the apartments were mainly four-storied buildings.

Social surveys

Hanoi survey was conducted over 4 periods in September 2005. The surveys were principally conducted at weekends when family members were at home. The questionnaires used in the social surveys included 41 questions concerning: (1) respondents' living environment and housing; (2) noise annoyance and indoor activity interferences; (3) self-reported sensitivity and attitudes to noise source; and (4) socio–demographic variables. Since it is impossible to select respondents with, for example, the nearest birthday method on a one-person per family basis from voters' lists in Vietnam, fathers, mothers and others were selected in order. The survey was carried out in form of face-to-face interviews. In the questionnaires, annoyance caused by road traffic noise was evaluated using two scales constructed according to ICBEN methods (Yano & Ma 2004): a 5-point verbal scale ("extremely annoyed" = 5, "very annoyed" = 4, "moderately annoyed" = 3, "slightly annoyed" = 2 and "not at all annoyed" = 1) and an 11-point numeric scale (endpoint markings "not at all annoyed" and "extremely annoyed"). The verbal annoyance question was phrased, "Thinking about the last 12 months or so, when you are at home, how much does noise from road traffic noise bother, disturb or annoy you?." The numerical annoyance question was phrased, "Thinking about the last 12 months or so, which number from 0 to 10 best shows how much you are bothered, disturbed or annoyed by road traffic noise?." Listening disturbance (indoor conversation, listening to telephone, listening to radio/TV), and sleep disturbance (difficulty falling asleep and being awakened) were also evaluated using the 5-point verbal scale. The question was phrased, "How much does noise from road traffic disturb you in the following cases? For example, when you are having indoor conversation." The response rates were 50 % in Hanoi, and 61 % in Ho Chi Minh city. The outline of the social surveys in both cities is summarized in Table 1.

Table 1: Outline of the social surveys in Hanoi and Ho Chi Minh city

Street ID		Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Total
Hanoi										
Street name		Truong Chinh	Ton That Tung	Lang	Nguyen Trai	Lang Ha	Tran Hung Dao	Tran Quang Khai	Hong Ha	
Survey date		10th-11th Sept.	3rd-4th Sept.	3rd-4th Sept.	13th-14th Sept.	13th-14th Sept.	3rd-4th Sept.	3rd-4th Sept.	25th Sept.	
Sample size	Row house	322	25	324	315	48	18	1	82	1135
	Apartment	0	0	0	150	92	111	0	15	368
	Total	322	25	324	465	140	129	1	97	1503
Response rate										50 %
Ho Chi Minh										
Street name		Doan Van Bo	Ton Dan	Nguyen Trai	Ly Thuong Kiet	Lac Long Quan	Pham Phu Thu	Cach Mang T8	Bach Dang	
Survey date		1st, 2nd, 4th Aug.	1st, 2nd, 4th Aug.	1st, 2nd, 4th Aug.	5th, 8th, 9th Aug.	5th, 8th, 9th Aug.	5th, 8th, 9th Aug.	11th, 12th, 18th Aug.	11th, 12th, 18th Aug.	
Sample size	Row house	130	179	189	106	184	169	194	186	1337
	Apartment	40	0	0	94	0	0	0	0	134
	Total	170	179	189	200	184	169	194	186	1471
Response rate										61 %

Noise measurements

In Hanoi, noise measurement for row houses was conducted at eight sites in September 2005 from the 19th to 22nd, including 24-hour noise measurement and short-term noise measurement. The 24-hour measurement was performed at reference points, 1.2 m high and from 2 m to 12 m away from the road shoulders. Short-term noise measurement was carried out at the reference points and other several points simultaneously. Distance reduction equations were formulated based on the short-term measurement. Noise exposure to each house was estimated by the 24-hour noise measurement values and the distance reduction equations. All noise data was analyzed without any special sound identified in 24 hours such as ambulance and/or trains' horn sounds, etc. Day-evening-night noise level (L_{den}) in Hanoi ranged from 69 to 83 dB.

An additional vertical noise reduction measurement for apartments was conducted at four sites (sites 4, 5, 6 and 8) in September 2006. Short-term vertical noise reduction measurement was performed at every floor of the apartment block simultaneously. At each floor, a microphone was placed at an assigned spot on the balcony facing to the road, and all was operated at the same time.

In Ho Chi Minh city, the same noise measurement method was conducted at the eight sites from the 17th to 18th of September 2007, including the 24-hour noise measurement, short-term horizontal noise reduction measurement and short-term vertical reduction measurement for apartment. The representative noise exposure values were estimated as the exposure at the average distant points. The vertical noise reduction measurement for apartments were performed at two sites (sites 1 and 4). The noise exposure to apartments was calculated as the average noise level by weighting the number of respondents living on each floor. Day-evening-night noise level (L_{den}) in Ho Chi Minh city ranged highly from 75 to 83 dB.

In both cities, traffic volume counting was performed by reproducing a video camera recording. Figures 1 and 2 show the traffic volume at all sites in Hanoi and Ho Chi Minh city, respectively.

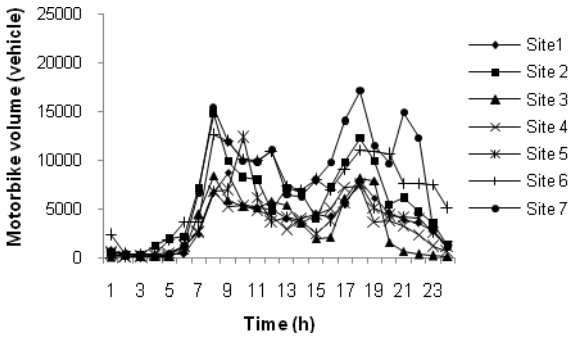

Figure 1: Motorbike volume in Hanoi

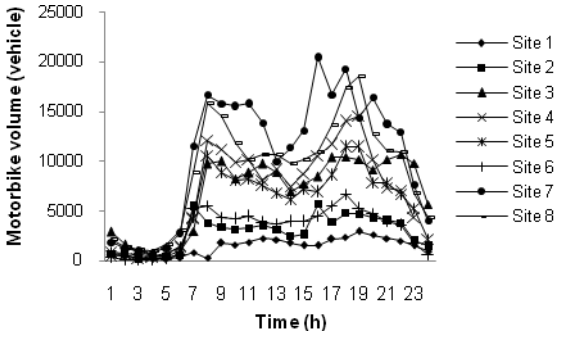

Figure 2: Motorbike volume in HCMC

RESULTS

Characteristic of road traffic noise

Road traffic noise in both cities is characterized by a large amount of motorbikes emitting frequent horn sounds.

As it can be seen in Figures 1 and 2, a large number of motorbikes in use during 24 hours in both cities can be observed. Though Ho Chi Minh city seemed to have slightly more motorbikes than Hanoi, the time pattern of traffic volume is almost the

same, in which motorbikes were seen fewer early in the morning, but sharply increased at 7 A.M. The motorbike volume stayed consistently high during the day in both cities, and highest around the time interval from 5 P.M. to 7 P.M. in Hanoi (peak at 18,000 pass-bys in one hour), and from 4 P.M. to 6 P.M. in Ho Chi Minh city (peak at 21,000 pass-bys in one hour).

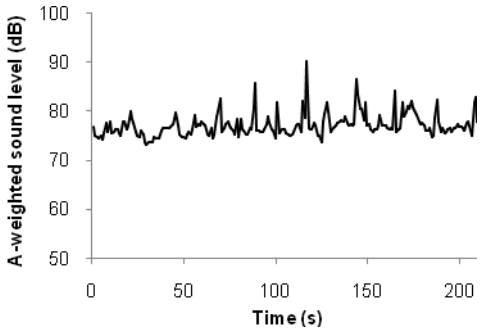

Figure 3: Sound level fluctuation at 17:00 in Hanoi

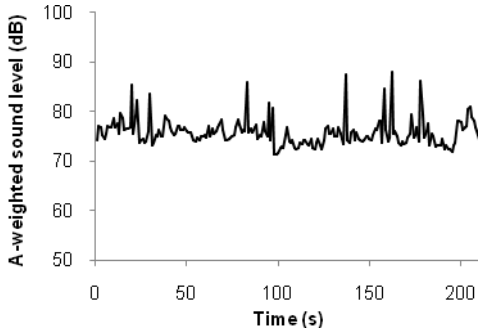

Figure 4: Sound level fluctuation at 17:00 in HCMC

Figures 3 and 4 show sound level fluctuation at 17:00 in Hanoi and Ho Chi Minh city, respectively. Sharp peaks in the figures are identified as horn sounds.

Dose-response relationships

General annoyance was evaluated using a 5-point verbal scale and an 11-point numeric scale. The % highly annoyed is defined by top 1 of the 5-point verbal scale and top 3 of the 11-point numeric scale. The dose-response curves for general annoyance were drawn onto Miedema and Vos' curve in Figures 5 and 6.

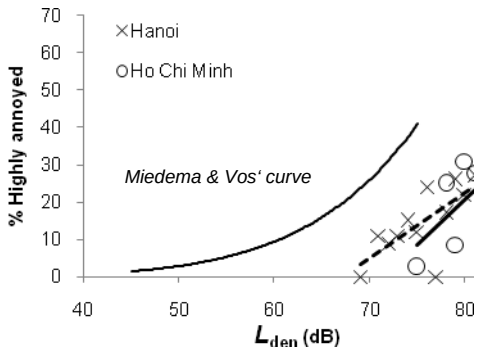

Figure 5: Dose-response curve for general annoyance evaluated by top 1 of the 5-point verbal scale

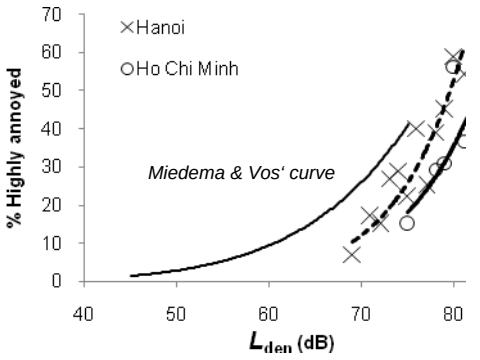

Figure 6: Dose-response curve for general annoyance evaluated by top 3 of the 11-point numeric scale

Figure 5 compares the dose-response curves between Hanoi and Ho Chi Minh city with % highly annoyed defined by top 1 of the 5-point verbal scale. It can be seen that the dose-response curve of Hanoi is slightly higher than that of Ho Chi Minh city, yet, both curves are lower than Miedema's curve. The reason may be due to the fact % highly annoyed range obtained for Hanoi (top 20 %) is lower than that for Miedema's (top 28 %).

Figure 6 compares the dose-response curves obtained from top 3 of the 11-point numeric scale between Hanoi and Ho Chi Minh city. Both dose-response curves for Hanoi and Ho Chi Minh city seem to fit better onto Miedema's curve, but still slightly lower.

Linear regression analysis was made with general annoyance as the criterion and noise level as the predictor. There was a siginificant main effect of noise exposure on annoyance among Hanoi respondents. However, for Ho Chi Minh city, no significant main effect was found for noise exposure on annoyance. This may due to the fact that noise exposure range in Ho Chi Minh city was smaller compared to Hanoi.

Listening disturbance was investigated among respondents of both cities based on the direction of living room window: one group had living room window facing the road, the other group did not. Sleep disturbance was also investigated based on the direction of bedroom window: the first group had bedroom window facing the road, the second group did not. Listening disturbance is defined in the case of respondents affected by road traffic noise while having indoor conversations, and sleep disturbance is defined in the case of respondents having difficulty falling asleep due to road traffic noise. Percent listening disturbed and % sleep disturbed are defined by top 2 of the 5-point verbal scale.

Figures 7 and 8 display the results for listening disturbance of Hanoi and Ho Chi Minh city's respondents, respectively. In Figure 7, it can be seen that there was a small effect of living room window direction on listening disturbance, in which in Hanoi people having living room window facing the road tended to be more disturbed in their indoor conversations by road traffic noise than people of the other group. However, no significant difference was found between these two groups. In Ho Chi Minh city, as shown in Figure 8, there was no effect of window direction on listening disturbance.

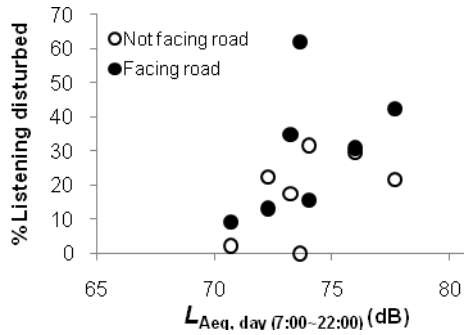

Figure 7: Listening disturbance in Hanoi

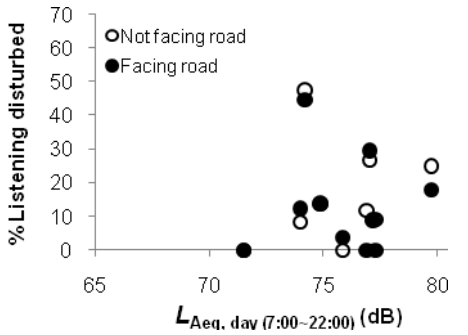

Figure 8: Listening disturbance in HCMC

Investigating sleep disturbances, Figures 9 and 10 show the results of Hanoi and Ho Chi Minh city, respectively. In Hanoi (see Figure 9), there was no effect of bedroom window direction on sleep disturbance. However, in Ho Chi Minh city (see Figure 10), a significant small effect of bedroom window direction was found (p<0.01) in which the group having bedroom window facing the road was more annoyed by road traffic noise than the other group.

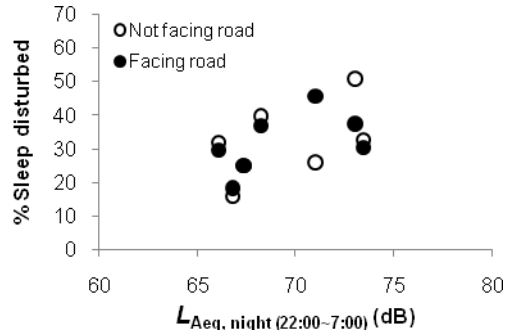

Figure 9: Sleep disturbance in Hanoi

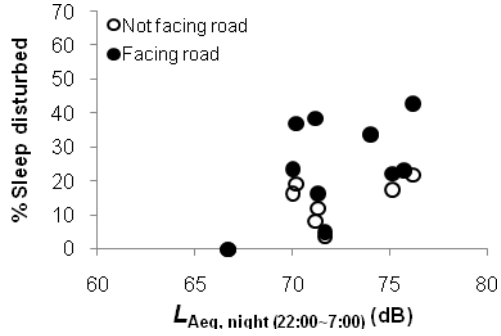

Figure 10: Sleep disturbance in HCMC

Effects of moderators on road traffic noise annoyance

Several non-acoustical factors subjecting to moderate variations in road traffic noise annoyance were assessed in the questionnaires. The factors investigated were noise sensitivity and attitudes to noise source.

Noise sensitivity was evaluated using the 5-point verbal scale. The respondents of both cities were divided into two groups, the insensitive group (first 2 categories–*slightly* and *not at all*–of the verbal scale) and the sensitive group (last 2 categories–*very* and *extremely*). Annoyance taken by top 1 of the 5-point verbal scale was compared between these two groups of respondents in both cities.

Figure 11 indicates that in Hanoi the noise sensitive group had higher annoyance than the insensitive group. Significant difference (p<0.01) was found in annoyance response between these two groups. As Figure 12 illustrates, Ho Chi Minh city's respondents also developed the same tendency with Hanoi's, in which the noise sensitive group was significantly more annoyed by road traffic noise than the insensitive group (p<0.01).

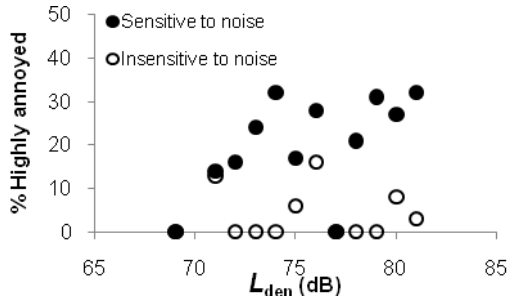

Figure 11: Compare % highly annoyed based on noise sensitivity in Hanoi

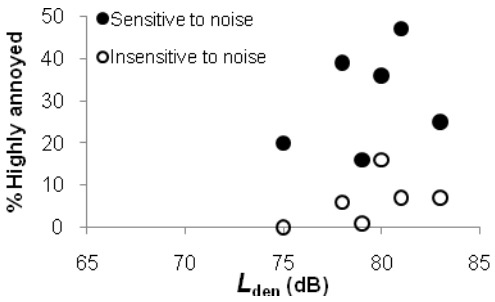

Figure 12: Compare % highly annoyed based on noise sensitivity in HCMC

Investigating the effect on annoyance of the moderator as attitude to noise source, the question was phrased, "How safe do you think the following transportation is? For example, motorbikes." Attitude to noise source was evaluated by the 5-point verbal scale, from which two groups of respondents were divided: one group considered motorbikes safe (taken by first two categories of the verbal scale) and the other group considered motorbikes not safe (taken by last two categories).

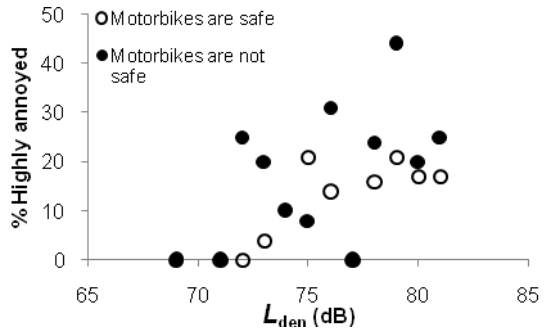

Figure 13: Compare % highly annoyed based on attitudes to noise source in Hanoi

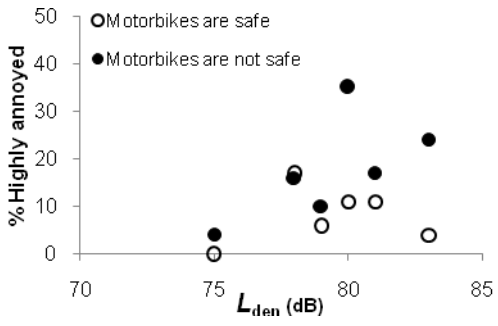

Figure 14: Compare % highly annoyed based on attitudes to noise source in HCMC

Figures 13 and 14 compare % highly annoyed between these two groups in Hanoi and Ho Chi Minh city, respectively. In Figure 13, it is indicated that in Hanoi noise annoyance of the group considering motorbikes not safe seemed to be greater than that of the other group. A significant difference (p<0.01) in annoyance response be-

tween the two groups was found. In Ho Chi Minh city (see Figure 14), there was a clearer difference in annoyance response between the two groups in which the group considering motorbikes not safe was significantly more annoyed by road traffic noise than the group considering motorbikes safe (p<0.01).

Multiple regression analysis was made with annoyance assessed on the 5-point verbal scale as the criterion and noise exposure together with noise sensitivity and attitudes to noise source in terms of safety evaluation as the predictors. The results are shown in Table 2(a) and (b).

The result in Table 2(a) indicates that in Hanoi, the factors noise sensitivity, attitudes to noise source and noise level are associated with noise annoyance. In sum noise sensitivity contributes more to the prediction of noise annoyance in Hanoi. There were significant correlations between noise exposure and noise sensitivity (r=0.21, p<0.01), and between noise sensitivity and attitudes to noise source (r=0.18, p<0.01). However, no significant correlation was found between noise exposure and attitudes to noise source.

Table 2(a): Results of multiple regression analysis with noise annoyance (assessed on 5-point verbal) as the criterion and noise level and some moderators as the predictors in Hanoi

Parameters	B	SE	Beta	T	p
Intercept	-2.19	0.54		-4.05	0.00
Noise level (L_{den})	0.05	0.01	0.17	7.55	0.00
Noise sensitivity	0.47	0.02	0.50	22.04	0.00
Attitudes to noise source (Safety evaluation)	0.06	0.03	0.05	2.19	0.03

R^2 = .325

Table 2(b): Results of multiple regression analysis with noise annoyance (assessed on 5-point verbal) as the criterion and noise level and some moderators as the predictors in Ho Chi Minh

Parameters	B	SE	Beta	T	p
Intercept	1.88	0.88		2.15	0.03
Noise level (Lden)	0.00	0.01	-0.01	-0.41	0.68
Sensitivity to noise	0.55	0.02	0.59	27.63	0.00
Attitudes to noise source (Safety evaluation)	0.10	0.03	0.07	3.45	0.00

R^2 = .363

The result from Table 2(b) demonstrates that in Ho Chi Minh city, only two factors noise sensitivity and attitudes to noise source were associated with noise annoyance, among which in sum noise sensitivity also contributes more to noise annoyance prediction. There were significant correlations between noise exposure and noise sensitivity (r=0.05, p<0.05), and between noise sensitivity and attitudes to noise source (r=0.14, p<0.01). However, no significant correlation was found between noise exposure and attitudes to noise source.

CONCLUSIONS

It was obtained that road traffic noise in Hanoi and Ho Chi Minh city was characterized by a large number of motorbikes emitting frequent horn sounds. Dose-response relationships between noise exposure and % highly annoyed (evaluated by top 1 of the 5-point verbal scale and top 3 of the 11-point numeric scale) were established, in which dose-response curves were drawn onto Miedema and Vos' curve. Dose response curves of Hanoi and Ho Chi Minh city are slightly lower compared to Miedema and Vos' curve.

Listening disturbance was compared between two groups of respondents based on living room window direction. A small effect of window direction was found in Hanoi; however, this was not statistically significant. Sleep disturbance was also compared between two groups of respondents based on bedroom window direction. A significant small effect of window direction was found in Ho Chi Minh city, i.e. people with houses having bedroom window facing the road were more disturbed by road traffic noise.

The effect of moderators on annoyance was investigated, and the results were consistent to the previous studies (Miedema & Vos 1999, 2003). Moreover, multiple regression analysis suggested that the moderators were strongly associated with noise annoyance, especially in Ho Chi Minh city, the moderators contributed more to the prediction of noise annoyance.

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