Social surveys on community response to road traffic in five cities in Vietnam

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ABSTRACT

Social surveys on community response to road traffic noise have been performed since 2005 in five major cities in Vietnam: Hanoi, Ho Chi Minh City, Da Nang, Hue and Thai Nguyen. The total sample size and the average response rate were 4966 and 64%, respectively. The noise exposures ranged from 61 to 83 dB in L_{den}. The exposure-response relationship was drawn with logistic regression curve based on all the socio-acoustic survey data, which can be proposed as the representative exposure-response relationship for road traffic noise in Vietnam. This curve showed that Vietnamese respondents were about 5 to 10 dB less annoyed by road traffic noise than those of EU and Japan. Exposure-response curves for general annoyance, awaking, falling asleep, conversation, telephone-listening, TV/Radio listening, reading/thinking, and rest disturbances were also drawn. Annoyance in the two largest cities, Hanoi and Ho Chi Minh City, were higher than those in the other three cities. Sleep disturbance was severer than listening and the other activity disturbances in all the cities. The distribution pattern of annoyance was consistent with those of environmental factors such as residential satisfaction. This finding suggests that noise annoyance is strongly affected by or interacted with the evaluation of residential environment.

Keywords: Road traffic noise, Social survey, Developing country
I-INCE Classification of Subjects Number(s): 66

1. INTRODUCTION

Developing countries including Vietnam are facing serious noise problems caused by the expansion of transportation and the increase of traffic volume. Noise annoyance is not only influenced by noise exposure but also by cultural backgrounds. Hence it is necessary to accumulate social survey data in each country to formulate the effective noise policy. Since enough number of social surveys have not been conducted in South East Asian countries, this research project has been performed in Vietnam since 2005 to contribute to noise policies in developing countries. The traffic condition in Vietnam is quite different from those in developed countries in that the main traffic is numerous motor bikes with frequent horn sounds.

In this paper, the results of social surveys for inhabitants along the roads in five major cities of Vietnam are reported and compared among the cities (Hanoi, Ho Chi Minh City, Da Nang, Hue and Thai Nguyen.) The exposure-response relationship was drawn with logistic regression curve based on all the socio-acoustic survey data, which can be proposed as the representative exposure-response relationship for road traffic noise in Vietnam and compared with European and Japanese ones. The exposure-response curves for awaking, falling asleep, conversation, telephone-listening, TV/Radio listening, reading/thinking, and rest disturbances were drawn and compared in the same way. In addition, effects of demographic variables, environmental factors, attitudinal factors and sensitivity on noise annoyance were examined by using multiple logistic regression analysis.

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2. METHOD

2.1 Social survey

Social surveys have been performed with face-to-face interview in Vietnam as shown in Table 1 and Figure 1: five road traffic, three aircraft and two railway noise surveys. Table 2 shows the basic information of these cities at the time when the surveys were performed: the number of survey sites, the sample size and response rate. The response rates of two biggest cities, Hanoi and Ho Chi Minh, are smaller than the other three cities.

The questions on noise annoyance followed the ICBEN method with a five-point verbal scale and an 11 point-numeric scale. The question wordings with a five-point verbal scale was as followed "Thinking about the last 12 months or so, how much does road traffic noise bother, disturb, annoy you when you are at home, not at all, slightly, moderately, very, or extremely?" The question wordings with an 11 point-numeric sale was as followed, "Thinking about the last 12 months or so, what number from 0 to 10 best shows how much you are bothered, disturbed or annoyed by road traffic noise?", and the answer was chosen between 0 and 10, 0 means "Not at all" and 10 means "Extremely annoyed".

Main questionnaire items were housing, residential, and personal factors, and they were evaluated with a unipolar or bipolar five-point verbal scale, e.g. 1 means "Not at all" and 5 means " Extremely bad" or 1 means "Extremely good" and 5 means " Extremely bad".

The total number of respondents was 4966, and the average response rate was 64%. Table 3 shows the socio-demographic data, whose distribution was almost the same among the five cities. There were slightly more female respondents than males. Most of the respondents were in their 20s, and the older they were, the smaller the sample sizes were.

Table 1 – Social survey of transportation noise in Vietnam

Year	City	Noise source
2005	Hanoi	Road traffic
2007	Ho Chi Minh	Road traffic
2008	Ho Chi Minh	Aircraft
2009	Hanoi	Aircraft
2010	Hanoi	Railway
2011	Da Nang	Aircraft, Road traffic
2012	Hue	Railway, Road traffic
2013	Thai Nguyen	Road traffic

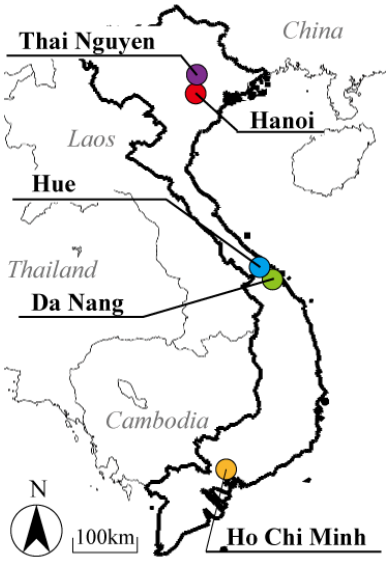

Figure 1 - The map of Vietnam

Table 2 – Basic information on five cities

City	Population (thousand)	Area (m^2)	Number of survey locations	Number of respondents	Response rate (%)
Hanoi	3,230	1000	8	1502	50
Ho Chi Minh	6,650	2095	8	1471	61
Da Nang	950	1255	6	492	82
Hue	330	83	7	688	98
Thai Nguyen	330	190	10	813	81

Table 3 – Distribution of demographic variables: number of respondents (%)

City	Gender		Age					
	Male	Female	20s	30s	40s	50s	60s	70s+
Hanoi	718 (49.1)	745 (50.9)	443 (29.7)	349 (23.4)	306 (20.5)	214 (14.3)	121 (8.1)	60 (4.0)
Ho Chi Minh	723 (49.5)	737 (50.5)	406 (27.7)	388 (26.5)	324 (22.1)	197 (13.5)	99 (6.8)	50 (3.4)
Da Nang	237 (49.6)	241 (50.4)	141 (29.2)	91 (18.8)	99 (20.5)	79 (16.4)	39 (8.1)	34 (7.0)
Hue	321 (47.5)	355 (52.5)	161 (23.7)	117 (17.2)	122 (17.9)	128 (18.8)	87 (12.8)	65 (9.6)
Thai Nguyen	388 (48.7)	409 (51.3)	181 (22.5)	203 (25.3)	146 (18.2)	144 (17.9)	87 (10.8)	42 (5.2)
Total	2387 (49.0)	2487 (51.0)	1332 (27.1)	1148 (23.3)	997 (20.3)	762 (15.5)	433 (8.8)	251 (5.1)

2.2 Noise measurement

Twenty-four-hours noise measurements were performed at the survey sites in the five cities as follows. A microphone with omni-weather screen was placed at a point 1.2m high and 2m away from the house facade. This was connected to a sound level meter (RION NL-21, NL-22), and $L_{\mathrm{Aeq,1s}}$, equivalent continuous A-weighted sound pressure level per second, was recorded every second. Table 4 shows the results of noise measurements. They were from 61 to 83 dB in L_{den}, and from 50 to 73 dB in LAeq,22-07.

2.3 Statistical analysis

A logistic regression analysis was applied to investigate the relationships between road traffic noise exposure and community response. The dummy variables of highly annoyed or not and very disturbed or not, were used as the dependent variables in the logistic regression model, equation (1). People who responded to any of the top three categories from 11-point numeric scale were counted as %highly annoyed, %HA, and those for the top two categories from five-point verbal scale were counted as %very disturbed. While $L_{\mathrm{Aeq,22\text{-}07}}$ was used as the independent variables for sleep disturbance, $L_{\mathrm{Aeq,07\text{-}22}}$ was used for other disturbances and annoyance.

$$\text{"\%HA" or "\%very disturbed"} = 1/[1 + \mathrm{e}\text{^}\{-(\alpha + \beta \times L_{\mathrm{den}})\}] \times 100\ [\%] \quad (1)$$

Multiple logistic regression models, equation (2), were specified in order to test the effects of demographic variables and environmental factors on noise annoyance. Dummy variable of each factor with L_{den} were applied to the model alternately as independent variables. People who responded to any of top three categories from unipolar five-point verbal scale and top two categories from bipolar five-point verbal scale were counted as negative response to each factor.

$$\text{"\%HA"} = 1/[1 + \mathrm{e}\text{^}\{-(\alpha + \beta_1 \times \text{"}L_{\mathrm{den}}\text{"} + \beta_2 \times \text{"Dummy variables of each factor"})\}] \times 100\ [\%] \quad (2)$$

Table 4 – Noise exposure levels

City	Survey site ID									
	RT1	RT2	RT3	RT4	RT5	RT6	RT7	RT8	RT9	RT10
$L_{\text{Aeq, 22-07}}$										
Hanoi	73	67	71	69	65	72	73			
Ho Chi Minh	69	71	75	70	72	71	74	76		
Da Nang	60	60	57	66	63	61				
Hue	58	59	65	50	62	70	66			
Thai Nguyen	64	69	64	67	65	51	55	66	70	67
$L_{\text{Aeq,24h}}$										
Hanoi	77	72	75	72	68	69	73			
Ho Chi Minh	73	76	79	70	75	76	76	77		
Da Nang	67	65	63	72	72	67				
Hue	67	69	70	58	69	76	71			
Thai Nguyen	70	73	70	71	71	58	61	70	74	71
L_{den}										
Hanoi	81	76	79	77	73	74	79			
Ho Chi Minh	77	80	83	78	79	80	82	83		
Da Nang	70	69	66	76	76	71				
Hue	70	71	74	61	72	80	75			
Thai Nguyen	73	77	73	75	74	61	64	74	78	75

3. RESULTS

3.1 Exposure-response relationships for noise annoyance

Table 5 shows the result of logistic regression analysis in each city modeling the probability of %HA and Figure 2 shows the exposure-response curves for road traffic noise in the five cities with plots at survey sites which are widely spread. The noise exposures ranged from 61 to 83 dB in L_{den}. Annoyance in the two largest cities, Hanoi and Ho Chi Minh City, were higher than those in other three cities.

Table 5 – The result of logistic regression analysis modeling exposure-response relationships

City	Parameter	Estimate		SE	95% Lower CI	95% Upper CI
Hanoi	Intercept	-10.387	***	1.611	-13.576	-7.256
	L_{den}	0.131	***	0.021	0.091	0.172
Ho Chi Minh	Intercept	-7.137	**	2.136	-11.344	-2.966
	L_{den}	0.084	**	0.027	0.032	0.136
Da Nang	Intercept	-32.963	***	5.337	-44.686	-23.464
	L_{den}	0.421	***	0.071	0.293	0.577
Hue	Intercept	-12.735	***	2.783	-18.344	-7.445
	L_{den}	0.141	**	0.037	0.070	0.216
Thai Nguyen	Intercept	-28.907	***	3.848	-36.793	-21.791
	L_{den}	0.370	***	0.051	0.276	0.475
Vietnam	Intercept	-15.306	***	0.728	-16.751	-13.898
	L_{den}	0.188	***	0.009	0.170	0.207

*** p-value <0.1%, ** p-value <1%, * p-value <5%

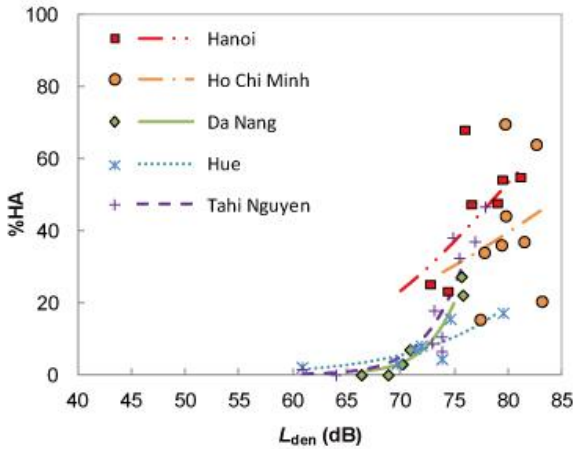

Figure 2 - Comparison of exposure-response relationships among cities

The exposure-response curve based on all the socio-acoustic survey data is shown in Figure 3, which can be proposed as the representative one for road traffic noise in Vietnam. In addition, exposure-response curves for road traffic noise annoyance in EU and Japan are drawn in Figure 3. This figure shows that Vietnamese respondents were about 5 to 10 dB less annoyed by road traffic noise than those of EU and Japan.

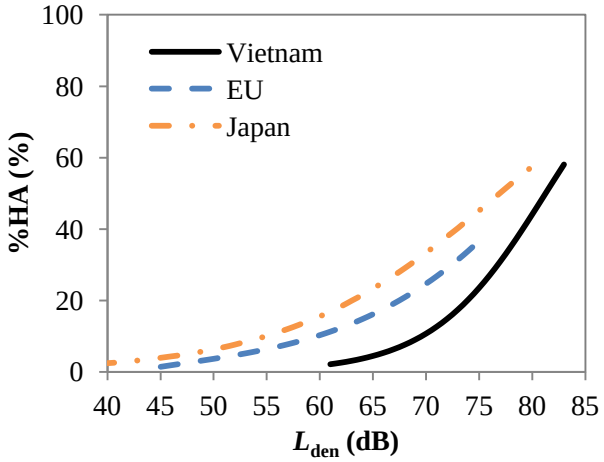

Figure 3 - Comparison of exposure-response relationships among countries

3.2 Exposure-response relationships for activity disturbance

Exposure-response relationships for awaking, falling asleep, conversation, telephone-listening, TV/Radio listening, reading/thinking, and rest disturbances are shown in Figure 4. It shows that sleep disturbance was severer than listening and the other activity disturbances. Only curves based on all the combined data are shown because almost the same trend was obtained among all cities.

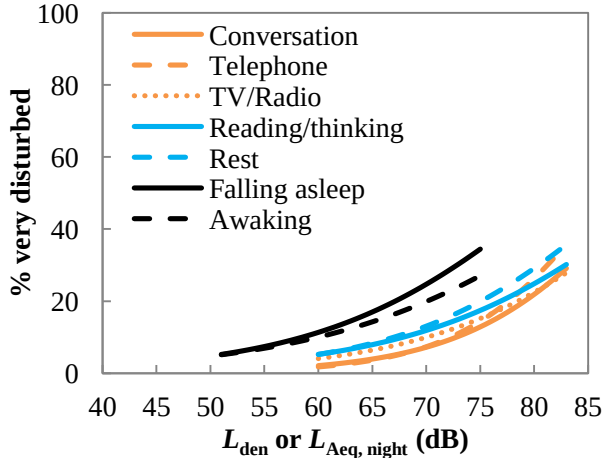

Figure 4 - Comparison of exposure-response relationships for each activity disturbance

3.3 Effects of demographic variables and environmental factors on noise annoyance

Multiple logistic regression models were applied to test the effects of demographic variables and environmental factors on noise annoyance. As a result, demographic variables, gender and age, were not significant in all cities. Any of satisfaction for "surrounding environment and natural green" and "surrounding street and sceneries and buildings" and "view from the house" were significant when all the socio-acoustic survey data were used. On the other hand, those factors were not significant some cities. A clear difference among cities was observed for preference to the living area. Table 6 shows the result of multiple logistic regression analysis in each city modeling the effect of preference to the living area. This table shows significant in the two largest cities, Hanoi and Ho Chi Minh, and not significant in other three cities. While residential satisfaction affects noise annoyance significantly in two higher annoyed cities, it does not affect in less annoyed cities. This finding suggests that noise annoyance is strongly affected by or interacts with environmental factors.

Table 6 – The result of multiple logistic regression analysis modeling the effect of preference to the living area

City	Parameter	Estimate		S.E.	95% Lower CI	
					Lower	Upper
Hanoi	Intercept	-9.080	***	1.645	-12.333	-5.880
	L_{den}	0.129	***	0.021	0.089	0.171
	Preference to the living area	-1.208	***	0.243	-1.701	0.745
Ho Chi Minh	Intercept	-6.572	**	2.155	-10.814	-2.364
	L_{den}	0.082	**	0.027	0.030	0.135
	Preference to the living area	-0.467	*	0.205	-0.869	-0.065
Da Nang	Intercept	-31.737	***	5.409	-43.580	-22.072
	L_{den}	0.418	***	0.072	0.290	0.576
	Preference to the living area	-1.099		0.616	-2.288	0.174
Hue	Intercept	-12.253	***	2.827	-17.938	-6.864
	L_{den}	0.141	**	0.037	0.070	0.216
	Preference to the living area	-0.535		0.512	-1.462	0.585
Thai Nguyen	Intercept	-28.881	***	3.869	-36.803	-21.718
	L_{den}	0.373	***	0.051	0.278	0.479
	Preference to the living area	-0.296		0.326	-0.919	0.366
Vietnam	Intercept	-14.696	***	0.738	-16.161	-13.268
	L_{den}	0.188	***	0.009	0.170	0.207
	Preference to the living area	-0.662	***	0.125	-0.907	-0.417

*** p-value <0.1%, ** p-value <1%, * p-value <5%

3.4 Effects of noise sensitivity and attitudinal factors on noise annoyance

Effects of noise sensitivity and attitudinal factors on noise annoyance were examined in the same way as environmental factors. Following factors were examined; noise sensitivity, vibration sensitivity, the frequency of using cars, the frequency of using motorbikes, how good is the use of cars for the society, how good is the use of motorbikes for the society, how safe are cars, how safe are motorbikes.

Vibration sensitivity was not significant in Da Nang city and significant in any other cities. Noise sensitivity was significant in all cities as shown in table 7. This finding suggests that noise annoyance is strongly affected by or interacts with noise sensitivity.

Table 7 – The result of multiple logistic regression analysis modeling the effect of noise sensitivity

City	Parameter	Estimate		S.E.	95% Lower CI	
					Lower	Upper
Hanoi	Intercept	-8.498	***	1.676	-11.811	-5.236
	L_{den}	0.109	***	0.021	0.067	0.152
	Noise sensitivity	-1.592	***	0.223	-2.049	-1.172
Ho Chi Minh	Intercept	-7.354	**	2.310	-11.905	-2.846
	L_{den}	0.091	**	0.029	0.034	0.147
	Noise sensitivity	-1.549	***	0.155	-1.861	-1.251
Da Nang	Intercept	-27.505	***	5.561	-39.588	-17.488
	L_{den}	0.354	***	0.074	0.220	0.515
	Noise sensitivity	-1.524	**	0.418	-2.408	-0.749
Hue	Intercept	-10.450	**	2.960	-16.448	-4.855
	L_{den}	0.122	**	0.040	0.047	0.202
	Noise sensitivity	-2.294	***	0.396	-3.144	-1.570
Thai Nguyen	Intercept	-26.932	***	3.921	-34.98	-19.693
	L_{den}	0.346	***	0.052	0.251	0.453
	Noise sensitivity	-0.468	*	0.222	-0.910	-0.038
Vietnam	Intercept	-12.446	***	0.793	-14.019	-10.909
	L_{den}	0.156	***	0.010	0.136	0.176
	Noise sensitivity	-1.635	***	0.099	-1.832	-1.444

*** p-value <0.1%, ** p-value <1%, * p-value <5%

Five factors; the frequency of using cars, the frequency of using motorbikes, how good is the use of cars for the society, how safe are cars, and how safe are motorbikes, were not significant when all the socio-acoustic survey data were used, but one factor; how good is the use of motorbikes for the society, was significant as shown in Table 8. However, this was not significant in the two least annoyed cities; Da Nang and Hue. This finding suggests that noise annoyance is strongly affected by or interacts with "how good is the use of motorbikes for the society."

4. CONCLUSIONS

This paper summarizes the results of social surveys in five major cities of Vietnam as follows:

1) The exposure-response relationships for road traffic noise in two largest cities, Hanoi and Ho Chi Minh, were higher than those in the other three cities.
2) Vietnamese people were about 5 to 10 dB less annoyed by road traffic noise than those of EU and Japan.
3) Sleep disturbance were severer than listening and the other activity disturbances in all the cities.
4) Effects of demographic variables on noise annoyance were not observed in all cities.
5) Differences in noise annoyance among cities may be caused by environmental and attitudinal factors:, residential satisfaction, attitude to motorbike, and noise sensitivity.

Table 8 – The result of multiple logistic regression analysis modeling the effect of "how good is the use of motorbikes for the society."

City	Parameter	Estimate		S.E.	95% Lower CI	
					Lower	Upper
Hanoi	Intercept	-10.131	***	1.653	-13.403	-6.919
	L_{den}	0.130	***	0.021	0.089	0.172
	Motorbike is good for society	-0.350	**	0.109	-0.565	-0.136
Ho Chi Minh	Intercept	-6.970	**	2.171	-11.244	-2.731
	L_{den}	0.086	**	0.027	0.033	0.139
	Motorbike is good for society	-0.668	***	0.111	-0.886	-0.452
Da Nang	Intercept	-33.953	***	5.384	-45.757	-24.360
	L_{den}	0.435	***	0.072	0.307	0.592
	Motorbike is good for society	0.0527		0.329	-0.589	0.707
Hue	Intercept	-12.540	***	2.778	-18.142	-7.260
	L_{den}	0.138	**	0.037	0.067	0.213
	Motorbike is good for society	0.114		0.299	-0.464	0.715
Thai Nguyen	Intercept	-31.233	***	4.185	-39.803	-23.487
	L_{den}	0.395	***	0.055	0.293	0.508
	Motorbike is good for society	0.658	**	0.244	0.191	1.148
Vietnam	Intercept	-14.689	***	0.741	-16.161	-13.257
	L_{den}	0.183	***	0.009	0.164	0.202
	Motorbike is good for society	-0.356	***	0.068	-0.488	-0.223

*** p-value <0.1%, ** p-value <1%, * p-value <5%

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REFERENCES

1. European Commission (2002). Position paper on dose response relationships between transportation noise and annoyance
2. H. Fukushima et al. (2011). Social Survey on community response to railway noise and vibration in Hanoi, Proc. of The 40th International Congress and Exposition on Noise Control Engineering (internoise 2011), Osaka, (CD-ROM)
3. H.Y.T. Phan et al. (2010). Community response to road traffic noise in Hanoi and Ho Chi Minh City, Applied Acoustics, Vol. 71 (2), pp.107-114
4. Nishimura M, Kondo M, Iwamoto K, Tsujimoto Y. Active attenuation of impulsive noise from a railway tunnel exit. Proc INTER-NOISE 94; 29-31 August 1994; Yokohama, Japan 1994. p. 1383-8.
5. T.L. Nguyen et al. Community response to aircraft noise in Ho Chi Minh City and Hanoi, Applied Acoustics, Vol. 72(11), pp.814-822, 2011.11