Analysis on factors affecting community responses to transportation noises in Japan using the Socio-Acoustic Survey Data Archive, SASDA

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ABSTRACT

Socio-Acoustic Survey Data Archive (SASDA), established in 2011 under the INCE/JAPAN, is a data archive that accumulates social survey data on community responses to transportation noises in Japan. At the present, SASDA possesses more than 20,000 samples from more than 20 surveys conducted in Japan for the noise sources of road traffic, conventional and high-speed railway, civil and military aircraft. Using these raw data, this study examined the effects of 11 personal and situational variables on five kinds of disturbance and annoyance responses in two ways: analysis of variance (ANOVA) and statistical test based on binomial distribution (binomial test). As a result, sensitivity to noise and neighborhood satisfaction showed significant effects with ANOVA on all of response variables in 30-70% of the datasets. Living room opening to noise source caused a significance increase in listening or speech disturbance. Elder groups (≥60) were less annoyed or disturbed in listening/talking but tended to be more disturbed in sleeping than younger groups. Females tended to be more disturbed in TV or telephone listening than males as females responded higher than males in about 60-70 % of the datasets.

1. INTRODUCTION

Community response to transportation noises can be only limitedly predicted by physical descriptors such as a variation of indices based on A-weighted sound pressure level (L_{Aeq}, L_{den}, L_{max} or etc.) because the responses may be affected by personal, situational, social, or cultural factors. Accumulation of social surveys that include noise exposure level and objective and subjective data of each resident is fundamentally necessary for the evaluation of the effects of these factors. Fields (1993) presented a result of meta-analysis in which he examined the findings in the publications from 136 social surveys. Fields' study was followed by Miedema & Vos (1999) who performed secondary analysis on the survey datasets accumulated in a data archive in TNO in the Netherlands. TNO data archive is known as the first and largest (known as more than 100,000 sample) data archive pertaining to community response to transportation noise. Though the existence of the TNO archive must be significant because it possesses sufficient volume of data that can be an academic back born for the noise policies in European countries, however, the data are mostly

come from surveys in European and American countries and therefore the results found in the TNO data might not be applicable to Asian counties that have different social and cultural background. Moreover, most of Asian countries are developing now and the increasing transportation noise is an immediate problem for these counties. Based on this background, a technical subcommittee on "Socio-Acoustic Survey Data Archive (SASDA)" was formed in the Institute of Noise Control Engineering/ Japan (INCE/J) in 2009, and SASDA have run since 2011 with more than 20,000 samples of datasets from surveys in Japan (Yokoshima et.al., 2011).

We have examined dose-response curves or annoyance and disturbance reactions in Japan as a trial to utilize SASDA (Yokoshima et.al., 2012, Ota et.al., 2013). The present study is another trial to perform a secondary analysis utilizing SASDA, with the purpose to evaluate the effect of personal and situational factors on annoyance/disturbance responses to transportation noise in Japan.

2. ANALYSIS

Datasets

The datasets used in the analysis are listed in Table 1, which are social survey data mainly on road traffic, conventional and high-speed railway and civil aircraft noise in Japan. Each of them contains the residents' responses to questionnaire and the noise exposure level. Several datasets were divided into subsets when different regions far away each other were surveyed or different steps or alternatives of answer were used in an individual survey, and consequently, in total, 42 sets of data were analysed separately.

Items for analysis

11 personal and situational factors (explanatory variables) were selected for the analysis among questions that are commonly used over the datasets, such as sex, age, house structure, living room opening to noise source, sensitivity to noise and so on. Also five annoyance and disturbance responses were selected as response variables (Table 2).

Methods and preprocessing

The analysis was performed for not combined data of different surveys but for each of the datasets because the question text or number of steps of evaluation scales varied between the datasets. The effect of the explanatory variables on the response variables were examined with two types of analysis: analysis of variance (ANOVA) and binomial test. Binomial test is a simple method in which explanatory variables are binarized and the mean values of a response variable calculated for the two categories of each of the explanatory variables are compared for each of the datasets. Then the bias of the number of the datasets in which either of the two categories is greater can be evaluated on a binomial distribution as significant or not with the hypothesis of an equal probability of occurrence. Since ANOVA also requires the explanatory variables to be categorized, all the explanatory variables were binarized into two categories for both analyses as shown in Table 2.

Another preprocessing was performed on the response variables: elimination of the effect of noise exposure. This process is needed to examine the effects of explanatory variables that possibly moderate the noise exposure – response relation. Thus a linear regression analysis was performed for each of the response variables with the noise level ($L_{Aeq,24h}$) as the regressor, and the residual values were subjected to the main analyses.

4. RESULTS

The result of ANOVA and binomial tests are summarized in Table 2.

Among the explanatory variables, noise sensitivity and neighbourhood satisfaction were found to have effect on almost all of the annoyance and disturbance responses. This result of noise sensitivity coincides with the previous studies (Fields, 1993; Miedema & Vos, 1999). Also the number of the datasets in which significant differences due to neighbourhood satisfaction were found to be fewer for talking/listening/sleep disturbance than those for general annoyance presumably

Table 1: Datasets for analysis

SASDA-ID	Survey year	Area	Sample
JPN003RT	1994-1995	Kumamoto	387
JPN005RT	1996	Kumamoto	837
JPN007RT	1997-1998	Hokkaido	780
JPN009RT	1998	Kanagawa	353
JPN010RT	1999-2000	Kanagawa	866
JPN011RT	2000-2002	Kanagawa	320
JPN011RT	2000,2002	Nagoya	202
JPN011RT	2000,2005	Shizuoka, Nagano	112
JPN011RT	2000-2001,2006	Osaka, Hyogo	311
JPN011RT	2001-2002,2005	Chiba	385
JPN016RT	2003-2004	Hokkaido	274
JPN011RT	2003-2005	Tokyo	652
JPN011RT	2004,2006	Fukuoka, Kitakyushu	163
JPN011RT	2005	Saitama	125
JPN002CR	1994-1995	Kumamoto, Fukuoka	1828
JPN006CR	1997	Kanagawa	310
JPN012CR	2001	Hokkaido	1454
JPN014CR	2002	Fukuoka	1612
JPN017CR	2003	Nagoya	130
JPN017CR	2003-2004	Tokyo	658
JPN017CR	2003-2004	Chiba	243
JPN017CR	2003-2004	Kanagawa	289
JPN017CR	2006	Osaka	300
JPN017CR	2006	Kumamoto	91
JPN004HR	1995	Kanagawa	469
JPN004HR	1996	Kanagawa	401
JPN013HR	2001-2003	Kanagawa	1242
JPN015HR	2003	Fukuoka	724
JPN018HR	2003	Tokyo	129
JPN018HR	2004	Saitama	156
JPN018HR	2004,2006	Kanagawa	226
JPN018HR	2004,2006	Fukuoka, Kitakyushu	330
JPN018HR	2005-2006	Shizuoka, Nagano	304
JPN018HR	2006	Tochigi	139
JPN018HR	2006	Osaka	60
JPN019CA	2003	Tokyo	386
JPN019CA	2004	Fukuoka	255
JPN019CA	2005	Miyagi	120
JPN019CA	2006	Osaka	90
JPN023CA	2006	Kumamoto	415
JPN021MS	2004-2006	Kanagawa	1376
JPN001OT	1982-1994	Aichi	2051

RT: Road Traffic, CR/HR: Conventional / Highspeed Railway, CA: Civil Aircraft, MS: Multiple source, and OT: others (unspecifield environmental noises)

because such disturbances would be affected mostly by acoustic factor. Datasets with a significant difference due to living room opening to noise source were more often seen in talking/listening disturbance than in general annoyance or sleep disturbance.

As for age, elder people were less annoyed or disturbed in listening/talking but tended to be more disturbed in sleeping. The previous studies rejected the effect of sex but in this result, some unbalance of responses was seen between male and female: there are 11 (6+5) datasets with significant difference in talking/listening disturbance and females were more disturbed than males in 9 (5+4) out of the 11 datasets. Oppositely in all the three datasets with significant difference in general annoyance, males responded higher than females. Possibly, females would have more often chance of telephoning or TV watching at home.

5. CONCLUSIVE REMARKS

The analysis in this study was one of our first trials of secondary analysis for utilizing large amount of datasets in SASDA. There are several points of discussion in the method of meta-analysis such as the preprocessing manipulations of the datasets,

Table 2: Summary of statistical tests

			Response variable				
Explanatory Variable	Category	Test	General annoyance	Telephone disturbance	TV listening Disturbance	Difficulty falling asleep	Premature awakening
Age	<60 - ≥60	ANOVA	(9-2)/41	(7-3)/39	(10-2)/40	(1-5)/35	(1-2)/31
		Binomial	26-15*	26-13*	30-10**	13-22	11-20
Sex	Male - Female	A	(3-0)/41	(1-5)/39	(1-4)/40	(1-1)/34	(2-0)/32
		B	25-16	14-25	13-27*	20-14	17-15
Number of people in family	<3 - ≥3	A	(1-0)/37	(1-3)/35	(0-4)/36	(1-1)/30	(0-0)/28
		B	14-23	14-21	12-24*	20-10*	19-9*
Years of residence	<10 - ≥10	A	(3-1)/40	(2-1)/39	(3-1)/40	(2-1)/32	(1-2)/31
		B	18-22	17-22	20-20	20-12	14-17
Hours at home	<12 - ≥12	A	(1-0)/8	(0-0)/7	(0-0)/8	(1-0)/8	(0-0)/7
		B	7-1*	3-4	4-4	4-4	4-3
House structure	Light - Heavy	A	(2-2)/35	(2-1)/32	(2-1)/33	(2-0)/25	(1-0)/25
		B	17-18	20-12	20-13	12-13	13-12
Living room opening to noise source	Yes - No	A	(2-0)/7	(6-0)/7	(6-0)/7	(3-0)/7	(2-0)/7
		B	7-0**	7-0**	7-0**	5-2	6-1
Home ownership	Yes - No	A	(4-1)/33	(1-0)/31	(1-2)/32	(1-1)/23	(1-0)/23
		B	18-15	11-20	12-20	8-15	11-12
Car ownership	Yes - No	A	(2-1)/29	(0-0)/28	(0-0)/28	(0-1)/19	(0-1)/19
		B	26-13	19-9*	20-8*	7-12	11-8
Neighborhood satisfaction	High - Low	A	(0-28)/37	(1-14)/36	(1-15)/37	(1-10)/31	(1-8)/28
		B	0-37**	3-33**	4-33**	11-20	9-19*
Noise sensitivity	High - Low	A	(25-0)/34	(16-0)/34	(17-0)/34	(9-0)/28	(8-1)/26
		B	33-1**	34-0**	34-0**	19-9*	19-7*

(x-y)/z in the ANOVA results indicates that total number of the datasets that contain the explanatory variable (z) and number of the datasets that support higher response of the left (x) and right (y) category group at 5% significance.
(p-q) in the Binomial test results indicates that the number of datasets in which left (p) or right (q) category group responded higher than the other did, and * or ** indicates 5% or 1% significanse of the bias, respectively, which is evaluated on a binomial distribution supporsing an equal probablity of occurrence.

which was not discussed much in this study but may affect some of the results. Still, the results can be regarded as a successful example of the advantage of the existence of a social survey data archive as they indicated the effects of several personal and situational variables more confirmatively than a single survey would do. Now SASDA project is trying to enlarge its scope from inside Japan to over Asian countries where community noise problem is becoming more serious.

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