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Noise Annoyance by Gender, Age, Education, Profession, Time of Day: A Survey in Samsun, Turkey

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***Abstract*— A detailed analysis on the possible association between noise annoyance type and noise annoyance time slice with gender, age, education and profession was carried out in Samsun, Turkey. The survey and analysis presented in this study serve as the first province-wide example of a noise annoyance survey in Turkey. The correlations between the categorical variables were investigated through contingency analysis.**

The results show that traffic noise is the most annoying noise in Samsun and the subjects are mostly annoyed by traffic noise and during daytime (07:00–19:00). The null hypothesis of no association between the age groups and the time slice of noise annoyance was rejected. While people with ages <25 are mostly annoyed by noise within the daytime, people > 60 are mostly annoyed by noise in the night-time. The correlation between the profession and noise type was also found to be statistically significant. The unemployed, pensioners, housewives and people engaged in farming and trade are less annoyed by traffic noise than they are by non-traffic noise. Workers, instructors and students are more annoyed by traffic noise than they are by non-traffic noise.

Keywords—Noise annoyance, survey, contingency analysis, correlation analysis

I. INTRODUCTION

Environmental noise has been known to have numerous adverse effects on health, hearing ability, physiological and psychological state and job performance [1–3]. The investigation of noise pollution consists of the sources of noise the areas they affect and the noise levels as well as the noise annoyance as reported by people. While many studies exist in noise modelling and determining the geographical range and level of noise pollution, quantitative research about noise annoyance and its possible associations with other factors is extremely limited. The most obvious factor affecting noise annoyance is noise level. Several studies have found a positive correlation between annoyance and sound level [4–6]. However, the association of noise annoyance with personal traits such as gender, age, education, profession is still an ongoing and disputed topic.

Noise annoyance can be defined as the feeling of displeasure with noise [7]. Besides displeasure, noise annoyance also includes 'many other variables relating to the source and the context in which it is experienced' [8]. In this respect, the perception of noise could also be affected by individual social and economic variables which create the noise annoyance. It has been reported that demographic factors such as age, sex, and socioeconomic factors could not explain the difference in annoyance between individuals [9]. On the other hand, it has been shown that age could be a factor for the reported annoyance level [10]. The relation between noise exposure and the social indicators such as education and income has been analysed in several studies and it was found that noise exposure could be dependent on such socioeconomic parameters [11,12]. Similar studies focusing on the relation between socioeconomic factors and noise annoyance were also conducted and it was found that only weak effects may exist between socioeconomic variables and noise annoyance [13,14]. It was found that there is considerable difference between employed and unemployed people in their annoyance in reaction to noise [1]. That study also reveals that noise annoyance experienced by men is more than it is among women and the difference is more significant in the 45–64 age group. Another study has shown that attitudinal factors towards noise and noise pollution among white-collar employees working in Tehran have a large impact on noise annoyance [15].

In this study, possible associations of environmental noise annoyance with gender, age, education and profession in the major metropolitan city of Samsun were addressed. In particular, possible correlations of noise annoyance type and noise annoyance time slice with gender, age, education and profession were investigated through statistical analysis. The data was collected through an online survey and 432 people participated in the survey. The survey and analysis presented in this study serves as the first province-wide example of a noise annoyance survey in Turkey.

II. MATERIAL AND METHODS

The employed methodology consists of collecting user responses through an online questionnaire and the relevant statistical analyses.

A. Survey Data

The questionnaire is the most common and direct method for collecting data about noise annoyance [16,17]. A web interface was designed to conduct the survey which was completed by 432 people. The subjects were asked to answer six questions. In addition to their gender, education, profession and age, two questions directly related to noise were also asked. The first question was 'Which type of noise source is the most annoying?' and the second was 'Which time period of a day are you annoyed by noise the most?' The distribution of ages and genders of the subjects are shown in Figure 1. It can be observed that people between the ages of 18 and 25 showed the most interest in the survey. The second age group with the largest response to the survey was 35–45. About 75% of the subjects were found to be men.

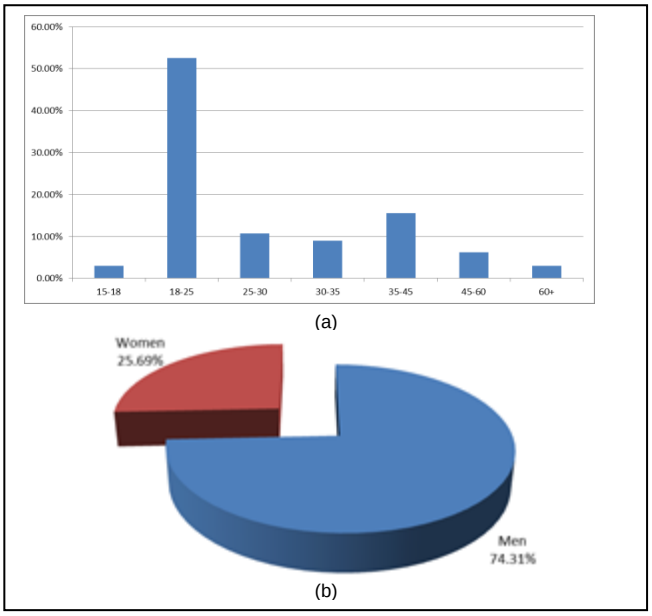

Fig. 1. (a) The age interval and (b) the gender distribution of the subjects in the survey

The professions and the education of the subjects are given in Figure 2. It can be seen that most of the subjects opted for 'other' for their profession. Taking into account the age interval distribution of the subjects, it is thought that the students and younger participants checked 'other' for the question on profession in the survey.

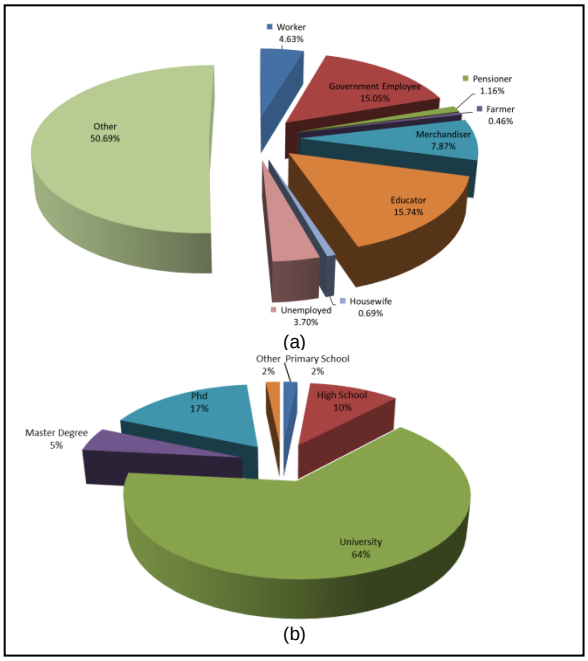

Fig. 2. (a) The profession and (b) the education distribution of the subjects

More than 85% of the subjects have a university degree. Since the survey is web-based, it is expected that the education levels of the participants are relatively high. About one fifth of the subjects also have a graduate degree which implies that people in the university also showed an interest in the survey (Figure 3).

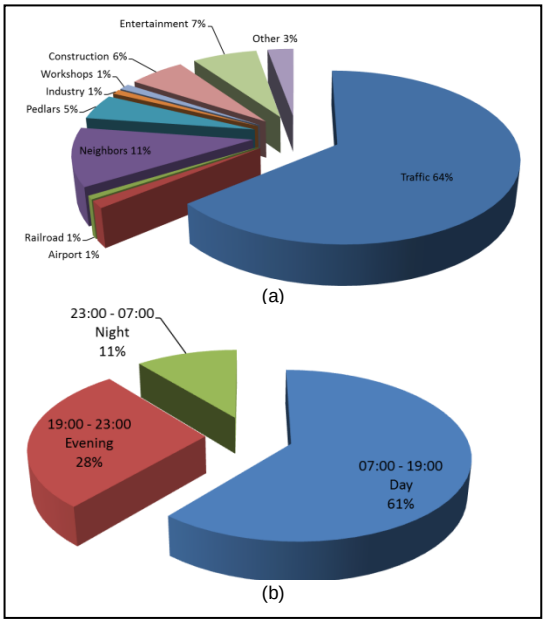

Fig. 3. Noise annoyances (a) by noise source (b) by time period

The most annoying noise source was found to be traffic, with 64.1%. The second most annoying noise was found to be the neighbours, with 11.1%. The time period in which the noise is most annoying was found to be in the daytime between 07:00 and 19:00. Considering that the most annoying noise type is traffic, it can be said that people in Samsun are mostly annoyed by traffic noise in the daytime. For those who are annoyed by traffic the most, the most annoying

noise type during day daytime is traffic with 71.5% as shown in Figure 4.

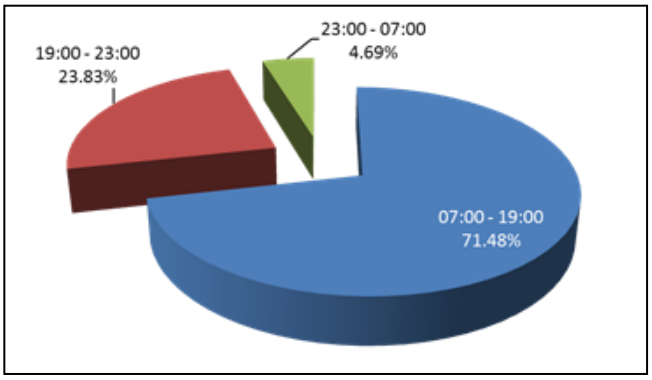

Fig. 4. Most annoying time period for those who are annoyed by traffic the most

B. The Methodology

Since the survey consists of categorical data, the possible associations of noise annoyance type and time slice with each trait were investigated through contingency analysis. Contingency table analysis is an efficient method of analysing the association between two categorical variables [18]. In this method, n possible responses of the noise annoyance type/time slice and r possible responses of each variable (gender, age, education, and profession) constitutes a cross-tabulation which has n x r combinations for each association table. Each cell of these contingency tables contains the observed frequencies of the categorical responses. Possible associations between the categorical variables are analysed by using the observed and the expected frequencies that would be anticipated when there is no association between the categorical variables [19]. The contingency analyses were carried out on the null (H0) and the alternative hypotheses (Ha) which were built upon whether there is a significant correlation between the noise annoyance type/time slice and a particular variable. The constructed hypotheses were tested through the well-known Pearson chi-square statistics to reveal any significant association [20].

The null (H_0) and the alternative hypotheses (H_a) for contingency analysis were constructed as follows:

H_0: There is no association between *x* variable and the type/time slice of noise annoyance.

H_a: There is an association between *x* variable and the type/time slice of noise annoyance.

Where x is gender, age, education and profession.

The null hypothesis was tested through the well-known Pearson chi-square statistics, which is calculated according to:

$$\chi^2 = \sum_{i=1}^{n_k} \sum_{j=1}^{n_l} \frac{(p_{ij} - m_{ij})^2}{m_{ij}} \quad (1)$$

where *nk* is the number of categories in the k-th variable, *nl* is the number of categories in the l-th variable, *pij* is the frequency in the i-th row and j-th column of the contingency table (cell frequency), *mij* is the expected frequency under the assumption of independency.

The validity of the chi-square test depends on both the sample size and observations for each cell (cell frequency). It was suggested that no more than 20% of the cell frequencies should be less than five [21]. For cell frequency considerations and further inference, the categorical variables were transformed and recoded. For instance, the noise type was further categorized as traffic and non-traffic noise, age was recoded as younger and older than 30. After the recoding, possible associations between categorical variables are reinvestigated.

III. ANALYSIS

Contingency analyses were carried out to investigate the possible associations of the noise type and the time slice of annoyance with the personal variables. The hypotheses about possible associations were constructed between the four variables (gender, age, education, profession) and the two categorical noise annoyance variables (noise annoyance type and noise annoyance time slice). Therefore, a total of eight contingency analyses were carried out. The minimum cell frequency was chosen as five and two analyses (between profession and noise annoyance time slice, and between education and noise annoyance time slice) were excluded from the analysis due to the low cell frequency.

A. Gender and The Time Slice of Noise Annoyance

The observed and percent counts for the time slice of noise annoyance per gender are given in Table 1. A chi-square test was performed to test the null hypothesis of no association between the time period of noise annoyance and gender. The value of Pearson's chi-square statistic was found to be 1.994 and significance value p = 0.369. Since, p > 0.05 the null hypothesis of no association between gender and the time period of noise annoyance was accepted.

TABLE I. THE RELATION BETWEEN TIME SLICE OF NOISE ANNOYANCE AND GENDER AND AGE

	04:00-19:00 Day (n=264) n (%)	19:00-23:00 Evening (n=121) n (%)	23:00-07:00 Night (n=47) n (%)	p value
Gender				
Men (n=321)	202 (62,9)	87 (27,1)	32 (10)	0,369
Women (n=111)	62 (55,9)	34 (30,6)	15 (13,5)	
Age				
<25 (n=240)	163 (67,9)	53 (22,1)	24 (10)	0,000
25-35 (n=85)	42 (49,4)	37 (43,5)	6 (7,1)	
35-60 (n=94)	58 (61,7)	28 (29,8)	8 (8,5)	
>60 (n=13)	1 (7,7)	3 (23,1)	9 (69,2)	

B. Gender and Noise Annoyance Type

A direct analysis for the association between gender and the type of noise annoyance reveals that 45% of cells have frequencies of less than 5. For cell frequency consideration, the categorical variable 'noise type' was transformed and recoded as traffic and non-traffic noise. The observed and expected numbers for the type of noise annoyance per gender after recoding are shown in Table 2.Avoid combining SI and CGS units, such as current in amperes and magnetic field in oersteds. This often leads to confusion because equations do not balance dimensionally. If you must use mixed units, clearly state the units for each quantity that you use in an equation.

TABLE II. THE RELATION BETWEEN THE TYPE OF NOISE ANNOYANCE AND GENDER, AGE, EDUCATION AND PROFESSION

	Traffic (n=1108)	**Non-Traffic (n=598)**	**p value**
Gender			
Men (n=321)	211 (65,7)	110 (34,3)	0,235
Women (n=111)	66 (59,5)	45 (40,5)	
Age			
15-18 (n=13)	7 (53,8)	6 (46,2)	0,042
18-25 (n=227)	144 (63,4)	83 (36,6)	
25-30 (n=46)	29 (63)	17 (37)	
30-35 (n=39)	27 (69,2)	12 (30,8)	
35-45 (n=67)	49 (73,1)	18 (26,9)	
45-60 (n=27)	18 (66,7)	9 (33,3)	
60+ (n=13)	3 (23,1)	10 (76,9)	
Education			
Primary School (n=14)	5 (35,7)	9(64,5)	0,135
High School (n=47)	26 (57,8)	19 (42,2)	
University (n=279)	186 (66,7)	93 (33,3)	
Master Degree (n=21)	12 (57,1)	9 (42,9)	
PhD. (n=73)	48 (65,8)	25 (34,2)	
Profession			
Workers (n=20)	14 (70)	6 (30)	0,0001
Goverment Employees (n=65)	50 (76,9)	15(23,1)	
Unemployed/Pensioner/Housewife (n=24)	6 (25)	18 (75)	
Trade/Farming (n=36)	15 (47,1)	21 (58,3)	
Instructors (n=68)	45 (66,2)	23 (33,8)	
Students (n=219)	147 (67,1)	72 (32,9)	

After transforming the noise types into traffic and non-traffic types, a chi-square test was performed to test the null hypothesis of no association between the type of noise annoyance and gender. The value of Pearson's chi-square statistic was found to be 1.411 and significance value p=0.235. Since, $p > 0.05$, the null hypothesis of no association between the gender and the type of noise annoyance was accepted.

C. Age and Noise Annoyance Type

For cell frequency consideration, the noise type was recoded again as traffic and non-traffic noise. The expected and observed counts for the type of noise annoyance and age are given in Table 2. A chi-square test was performed to test the null hypothesis of no association between the type of noise annoyance and age. The value of Pearson's chi-square statistic was found to be 13.070 and p=0.042. Since, $p < 0.05$, the null hypothesis of no association between the age intervals given and the type of noise annoyance was rejected. As shown in Table 2, the people of the youngest group (15–18) and of the oldest group (> 60) are less annoyed by traffic noise than expected, while the people of middle age are more annoyed by traffic noise than expected. This is attributed to the fact that the oldest and the youngest group of people are less exposed to the traffic noise since they do not go to work regularly.

When the age groups are regrouped into 15–25, 25–35 and 35+, no significant association of age groups with the time slice of the noise was found. $\chi 2$ (4, N = 432) = 14.452 and p = 0.35 > 0.05. A further attempt was made to generalize the association of noise annoyance and the age as being younger or older than 30 reveals that there is no association between the ages and the noise type which is statistically significant: $\chi 2(1, N = 432) = 0.515$, p = 0.473 > 0.05. The expected and observed cell frequencies are given in Table 2.

D. Age and the Time Slice of Noise Annoyance

To analyse the relation between the age groups and the time slice of noise annoyance (Table 1), a contingency table was formed. A chi-square test was performed to test the null hypothesis of no association between the type of noise annoyance and age groups. The value of Pearson's chi-square statistic was found to be 62.817, with 6 degrees of freedom and with significance value p=0.0004. Since $p < 0.05$, the null hypothesis of no association between the age groups and the time slice of noise annoyance was rejected. As is clear in the table, while people aged <25 are mostly annoyed by the noise within daytime, people older than 60 are mostly annoyed by noise in the night-time. People between the age of 25 and 60 are mostly annoyed by noise during the evening.

I. *Education and Noise Annoyance Type*

The possible association of the type of noise annoyance and the education of the subject was investigated. The expected and observed counts for

the type of noise annoyance and the education of the subjects are given in Table 2. A chi-square test was performed to test the null hypothesis of no association between the type of noise annoyance and education. The value of Pearson's chi-square statistic was found to be 7.012 and with p=0.135. Since p > 0.05 the null hypothesis of no association between education and noise type was accepted.

II. *Education and Noise Annoyance Time Slice*

Since, about 27% of cells have an expected count of less than 5, the relation between the time slice of noise annoyance and education was not analyzed.

III. *Profession and Noise Annoyance Time Slice*

Analysing the relationship between the professions of the subjects and the time slice of noise results in cell frequencies of less than 5.

IV. *Profession and Noise Annoyance Type*

For the analysis of the possible association between the noise type and profession, the professions were regrouped and transformed to provide sufficient frequency in each cell. The relation between type of noise annoyance and education are given in Table 2. The chi-square test reveals that there is an association between the profession and the type of noise annoyance. The Pearson chi-square test value is 29.769 and p=0.0001 < 0.05. Thus, the null hypothesis is rejected and the alternative hypothesis suggesting an association between profession and the type of noise is accepted. The unemployed, pensioners, housewives and people engaged in farming and trade are less annoyed by traffic noise than they are by non-traffic noise. Workers, instructors and students are more annoyed by traffic noise than they are by non-traffic noise.

IV. Results and Discussion

The most annoying noise source was found to be traffic noise, with 64.12%. The second most annoying was found to be the neighbours, with 11.11%. The time period in which the noise is most annoying was found to be 07:00–19:00. Taking into account that the most annoying noise is traffic, it can be said that people in Samsun are mostly annoyed by traffic noise in the daytime. When daytime is taken into account, the percentage of traffic noise as the most annoying noise type becomes larger, with 71.5%. Other studies have also shown the dominance of traffic noise in noise sources [22,23].

The results show that the null hypothesis of no association between the gender and the time period of noise annoyance should be accepted at 5% significance level. A further recoding of noise type as traffic and non-traffic still produced no statistically significant association of noise type with gender. The result verifies that there is none or weak correlation between gender and noise annoyance [9,12]. On the other hand, it was found in another study that noise annoyance in men is felt more than it is among women and the difference is more significant in the 45–64 age group [1].

Pearson's chi-square results show that there is an association between the age intervals given in the survey and the type of noise annoyance. The youngest (15–18) and the oldest group (> 60) are less annoyed by traffic noise than expected, while the people of middle ages are more annoyed by the traffic noise than expected. This is attributed to the fact that the oldest and the youngest group of people are less exposed to traffic noise since they do not go to work regularly. On the other hand, a further attempt to generalize the association between the people who are younger and older than 30 reveals that there is no statistically significant association between age and the noise type. It has been shown that age could be a factor for the reported annoyance level [10]. The results also show that there is a strong correlation between age and the time slice of noise annoyance at more conservative significance levels (p=0.0004). While people aged <25 are mostly annoyed by noise during the daytime, people > 60 are mostly annoyed by noise in the night-time. People between the ages of 25 and 60 are mostly annoyed by noise during the evening.

No association between education and the noise type was found within 5% significance level. The analysis between education and the time slice of noise annoyance could not be examined since about 27% of cells have an expected count of less than 5 in the contingency table. While a web-based survey presents a fast direct and access to quantitative data, the education level of the participants may have been high. About one fifth of the subjects also have a graduate degree, which implies that people in the university also showed an interest in the survey.

Results show that the alternative hypothesis suggesting an association between profession and the type of noise should be accepted at an even more conservative level of significance (1%). The unemployed, pensioners, housewives and people engaged in farming and trade are less annoyed by traffic noise than they are by non-traffic noise. Workers, instructors and students are more annoyed by traffic noise than they are by non-traffic noise. It was found that there is considerable difference in the noise experienced by employed and unemployed people [1]. On the other hand, it was observed that most of the subjects opted for 'other' for their profession. Taking into account the age interval distribution of the subjects, it is considered that the students checked 'other' for the question on profession in the survey. In this respect, an analysis of a possible correlation between profession and noise annoyance time slice could not be performed due to the low frequency cells in the contingency table.

V. CONCLUSION

Similar to several studies, it was found that traffic noise in the Samsun area is the most annoying noise. The results show that people in Samsun are mostly annoyed by traffic noise during the daytime (07:00–19:00). No statistically significant association was found between noise annoyance and gender or education. The relation between age and noise annoyance type could not be verified and more data and analysis is needed since different age groupings and noise types produced inconsistent results. On the other hand, there is strong evidence that while people of ages <25 are mostly annoyed by noise within the daytime, people older than 60 are mostly annoyed by noise in the night-time. People between the age of 25 and 60 are mostly annoyed by noise during the evening. The correlation between profession and noise type was also found to be significant. The unemployed, pensioners, housewives and people engaged in farming and trade are less annoyed by traffic noise than they are by non-traffic noise. Workers, instructors and students are more annoyed by traffic noise than they are by non-traffic noise.

The study was carried out in Samsun, Turkey and both the survey and analysis presented in this study serve as the first province-wide example of a noise annoyance survey in Turkey. Samsun is a developed and industrialized city located by the seaside. It is believed that different conditions in different cities could present diverse sensitivities to noise annoyance. However, Samsun is considered to be a very good example of noise annoyance with diverse characteristics: seaside location, entertainment business, developed industry, large population. In this respect, the study on the environmental noise could serve as a model for many similar cities near the Black Sea and the Mediterranean.

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