ITU A|Z • Vol 13 No 2 • July 2016 • 87-99

Assessment of sound environment pleasantness by sound quality metrics in urban spaces

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Received: May 2016 • Final Acceptance: July 2016

Abstract

Purpose of this study is to generate Sound Quality Index (SQI) in order to estimate pleasantness of users with sound environment in urban spaces by employing sound quality metrics together such as loudness, sharpness and roughness, which are frequently stated in soundscape studies as it is directly related to human perception. For this purpose, binaural sound records have been conducted and quantitative data of loudness, sharpness and roughness of these metrics of the sound records has been calculated. 27 sound clips, containing different quantitative data of each of the three metrics, have been generated by picking them out of binaural sound records. Participants have listened to the sound clips at laboratory environment, and have been applied jury test. Correlations between pleasantness of users with sound environment and sound quality metrics have been determined by analyzing results from jury test and quantitative data of sound clips. SQI has been generated with a correlation model by using Regression Analysis method. In order to check the accuracy of the model, surveys have been conducted on users at the field and binaural sound records have been taken simultaneously to the surveys. Quantitative data obtained from sound records has been calculated by SQI, and pleasantness level of users with sound environment has been estimated. Results obtained from surveys conducted at the field and results estimated by SQI have been compared. Apart from quantitative data of sound records, effect of parameters that might affect pleasantness of users with sound environment in urban spaces has been determined.

Keywords
Jury test, Sound quality metrics, Sound records, Soundscape.

doi: 10.5505/itujfa.2016.75547

1. Introduction

Main condition to establish acoustic comfort is to clear indoor or outdoor places, where people are present, of unwanted and disturbing sounds (noises). What the noise is defined in today's legal practice is based on only the cumulative level. It is known that the size used in national and international literature is "A-weighted equivalent sound pressure level - L_{eqA}" (WHO, 2011) (T.C. Çevre ve Orman Bakanlığı, 2010). In many studies in recent years, it is emphasized that the sound level decrement, which is aimed by European Union environmental noise policy (EU Parliament and Council, 2002), has not been enough to improve life quality in urban and rural areas. In the studies, it has been revealed that the noise exposure situations on people did not match up with the expectations. Consequently, "soundscape" approach to urban acoustic comfort has come into light.

Pijanowski et al. (2011), in their study, have stated that the term of "Soundscape" had first been used by city planner Southworth in 1969 to indicate the acoustic features of cities; and that Schafer had fixed this word as "sound features of landscape" in 1977. And in ISO 12913-1 (2014), soundscape is defined as "acoustic environment as perceived or experienced and/or understood by a person or people, in context." First soundscape articles have started to be seen in 1999 (Davies, 2013).

During the evaluation of acoustic comfort via soundscape, both disturbance caused by noise and effects of different voices indigenous to the area studied can be taken into consideration. Sound environments of urban spaces can be measured objectively, and, at the same time, subjective data of users about the places they go can also be evaluated.

Rychtarikova and Vermeir (2013), in their soundscape study, emphasize that psychoacoustic parameters (sound quality metrics), which are directly related to human perception, should also be evaluated apart from standard acoustic quantities such as sound pressure level (SPL). The term of "sound quality" has been started to be used and it has been defined as "suitability of the sound to the specific technical purpose and/or task." For the evaluation of sound quality, psychoacoustic sizes have been revealed (Zwicker & Fastl, 1999). In the studies about urban spaces, it is observed that especially loudness, sharpness and roughness have been examined most frequently among sound quality metrics (Rychtarikova & Vermeir, 2013) (Özçevik, 2012) (Botteldooren et al., 2006).

Sound quality metrics are defined as mathematical model of soundscape.

Loudness is the nominative perception of sound intensity. Its unit is phon (P) and values are equal to the SPL values in 1 kHz. Zwicker and Fastl (1999) have stated that the relationship between loudness and sense-stimulant can be measured by answering the question how loud or soft a sound is. They emphasized that the sensory satisfaction also depends on the loudness.

Sharpness is the indicator of the spectral balance between low and high frequencies; and its unit is "acum". (Kang, 2007). Zwicker and Fastl (1999) have stated that sharpness sense could be associated to "density", and also, that it was closely related to sensory satisfaction as well. As it can be taken into consideration singly, sharpness of a sound can also be mixed with sharpness of another sound.

Roughness emphasizes the slow temporary changes at about 70 Hz in loudness and its unit is "asper" (Rychtarikova & Vermeir, 2013). Roughness is a modulation based metric that can be defined as squeaker, squaller and harsh. Wuthering sounds of electric razors or sewing machine can be cited as examples for gravelly sounds. A gravelly sound usually causes an unsatisfactory effect (Kang, 2007) (Zwicker and Fastl, 1999).

In this study conducted for urban spaces, Sound Quality Index (SQI) has been generated through Regression Analysis method to estimate pleasantness of users with sound environment by using sound quality metrics which are loudness, sharpness and roughness.

2. Methodology

In this study, regression model has been formed in order to estimate pleas-

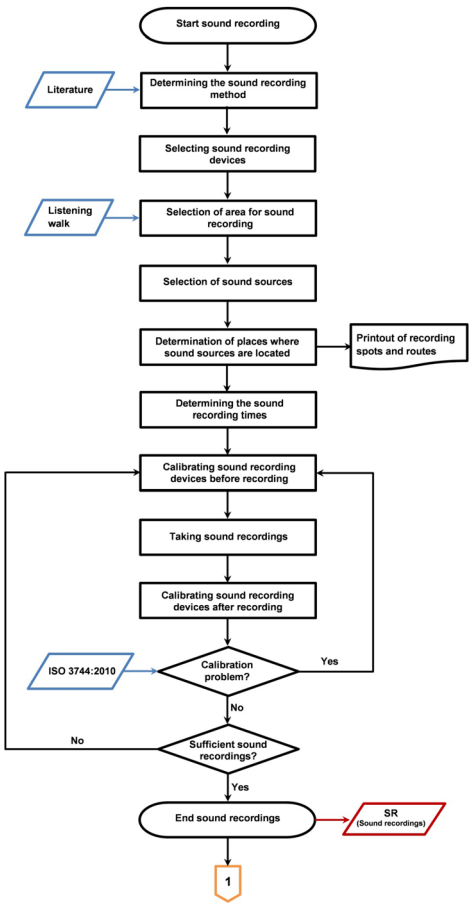

Figure 1. *Sound record flow chart.*

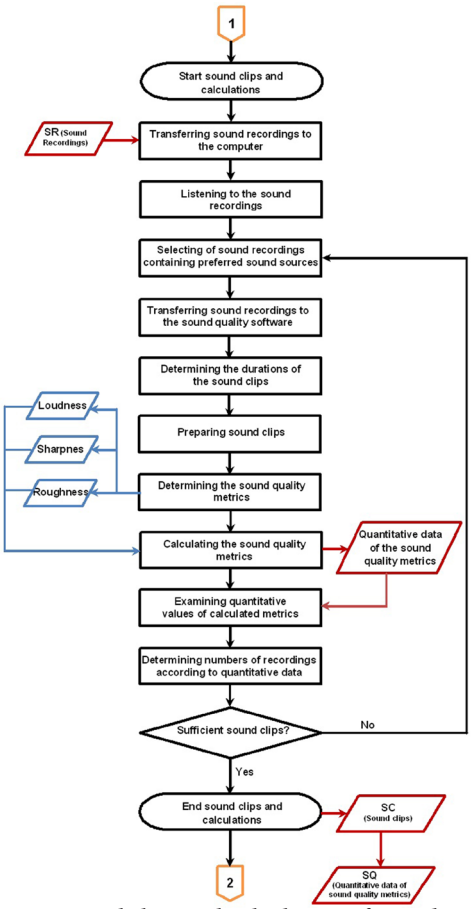

Figure 2. *Sound clips and calculation of sound quality metrics flow chart.*

antness of users with sound environment in urban spaces by using sound quality metrics. Model has been put into practice in three stages. At first stage, in order to obtain quantitative values of sound quality metrics, sound records have been taken in urban spaces (Figure 1). At the second stage of the study, sound clips have been constituted from sound records, and quantitative values of sound quality metrics of the sound clips (Figure 2). At the third stage, jury test has been applied on participants by having them listen to sound clips in laboratory environment, and SQI has been obtained by forming a regression model between subjective survey results and sound quality metrics (Figure 3).

2.1. Sound recordings

At the first stage of the study, sound recordings, which are needed to have participants listen during the survey application in laboratory environment and to acquire quantitative data of sound quality metrics belonging to field of study, have been taken by following the flow chart given in Figure 1. At the beginning of sound recordings, firstly, methods in the literature, which are used for sound recordings in soundscape works, have been examined. These recordings are taken by walking through a designated route at field chosen, or in a time containing all sound sources wished to be heard at a certain point (Sudarsono, Lam, and Davies 2016) (Rey Gozalo et al. 2015) (Aletta, Kang, and Axelsson 2016) (Rychtáriková and Vermeir 2013) (Brambilla et al. 2007) (Semidor 2006). Since sound recordings have been considered that they would be listened by participants in laboratory environment, it has been found suitable to make the records as in binaural form that might project the genuine sound environment. In this way, subjects, listening the sound recordings in laboratory environment, will be able to hear the sounds with right and left ears separately as if they were in the genuine environment. Recordings have been taken by using B&K 4101 binaural microphone set which was connected to

B&K 2270 hand-held dual sound measuring device.

In order to determine the area where sound recordings would be taken, listening-walks have been performed at many parts of Diyarbakır city center. By the impressions gained from these walks, the field of study has been chosen. Within the study, Suriçi region constituting the city center of Diyarbakır, which has thousands of years of history and has hosted many civilizations and cultures (Dağtekin, 2015), has been chosen as field of application to estimate pleasantness of users with sound environment. Suriçi region is one of the regions where many sound sources, which can be heard in urban spaces, can be found. It contains various sound sources consisting of not only traffic or human sounds but also soundmarks belonging to the region. Different sound sources, being able to be found together at places, allow us to acquire a large variety of quantitative data.

Apart from traffic and human sounds wished to be in the sound recordings, sound sources that constitute acoustic identity of the region -such as sounds of the azan, bell sounds and sounds of sherbet sellers, coppersmiths, ironsmiths etc.- have been designated and their locations at field of study have been determined. Spots and routes (Figure 4) where sounds recordings would be taken in these regions have been determined and printed out. For sound recordings to be able to provide detailed data on general sound environment, sound recordings have not taken only once but during weekdays (5 days) and at the weekend (saturday) as Akpınar et al. did (2013). Recordings have been taken at 07.30-09.00 in the morning, 12.00-13.30 at noon and 17.00-18.30 in the evening.

Before starting each record, microphone set has been calibrated by using B&K 4231 sound level calibrator. After the recording was done at the designated route or spot, the microphone set was recalibrated. Recordings have been repeated at routes or spots where calibration difference seemed to be exceeded 0.5 after controls conducted according to ISO 3744:2010. It has been controlled that if recordings were enough or not. In cases when recordings were thought as insufficient, sound recordings have been taken again. When there were enough, sound records have been completed.

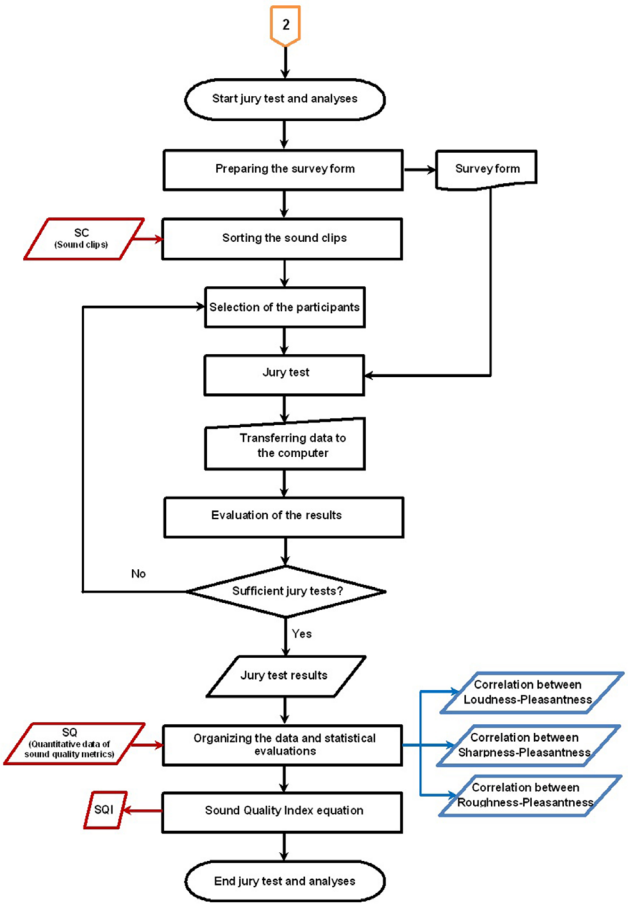

Figure 3. *Jury test and SQI acquisition flow chart.*

2.2. Sound clips and sound quality metrics calculations

At the second stage of the study, flow chart in Figure 2 has been followed to be able to prepare sound clips and to calculate sound quality metrics of sound clips. Binaural sound recordings taken in field of study have been trans-

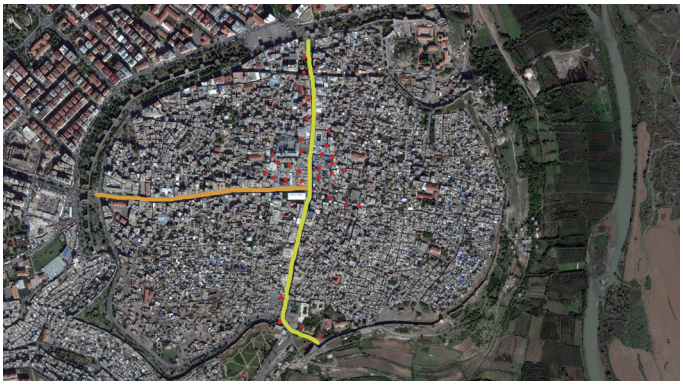

Figure 4. *Sound recording routes and spots.*

Table 1. *Quantitative values of metrics belonging to sound clips.*

Clip No	Loudness (sone)	Sharpness (acum)	Roughness (asper)
Clip 1	29,5	1,429	1,54
Clip 2	29,3	2,147	1,85
Clip 3	42,2	2,654	1,66
Clip 4	24,3	1,570	1,76
Clip 5	47,7	1,710	1,74
Clip 6	36,4	1,571	1,36
Clip 7	27,2	2,180	1,45
Clip 8	25,0	1,675	1,51
Clip 9	30,9	1,756	2,55
Clip 10	31,8	1,681	2,69
Clip 11	20,4	1,400	2,30
Clip 12	42,6	2,656	1,72
Clip 13	28,9	1,547	2,63
Clip 14	23,1	2,386	2,43
Clip 15	32,8	1,484	1,47
Clip 16	45,9	2,582	1,68
Clip 17	41,6	2,729	1,55
Clip 18	32,1	1,428	1,79
Clip 19	37,3	1,733	2,18
Clip 20	33,8	1,903	3,14
Clip 21	40,7	2,140	2,66
Clip 22	45,6	1,679	3,10
Clip 23	42,6	1,723	1,38
Clip 24	43,7	2,873	2,50
Clip 25	41,5	1,465	2,92
Clip 26	44,2	1,216	1,85
Clip 27	64,6	1,493	1,46

ferred to the computer, listened many times and sound recordings belonging to sound sources wished to be heard. Recordings have been transferred to PULSE Reflex software in order to be able to calculate quantitative data of sound quality metrics of sound recordings recorded binaurally at the field.

Since sound recordings are taken at designated routes and spots of the study field, recording times vary between 5mins and 30mins depending on the length of the routes or as to reflect the sound environment of the spot. As it is not convenient for the ones, who would participate the jury test which would be applied in laboratory environment, listening many sound recordings in long durations, sound recordings have been needed to be divided into clips. For this study, in order to be able to reflect the sound environment and in order for several sound sources to be heard at the same time as well, sound clips have been decided to be in 30sec length and sound clips have been prepared. Loudness, sharpness and roughness metrics among sound quality metrics have been decided to be used on the estimation model in this study, and quantitative data of sound clips have been calculated via PULSE Reflex. Recording numbers have been determined and sufficiency of clips has been checked by considering diversity of quantitative values of metrics in the sound clips. To be able to acquire clips having quantitative values of sound quality metrics in different levels and combinations, acquisition and calculation of sound clips have been repeated several times. 27 sound clips having different quantitative data of sound quality metrics in several combinations have been created (Table 1). In this way, sound clips for jury test to be conducted in laboratory environment and quantitative data belonging to clips to be used in calculations have been acquired and jury test stage have been proceeded.

2.3. Jury tests and sound quality index

At this stage of the study, a jury test in laboratory is needed in order to be able to create Sound Quality Index (SQI) by quantitative values of sound quality metrics. In Figure 3, SQI flow chart acquired from jury test and following analyses is seen.

For the ones who would participate the jury test survey sheets have been prepared where they can determine pleasantness of 27 different sound clips from 1 to 5 (1- Not pleasant; 5- pleasant). Sound clips prepared at the second stage have been sorted. Participants for jury test have been chosen among people who did not have hearing impairments and who were aged between 20 and 40. Participants have been briefed about the implementation before the survey and given survey sheets. Participants have listened to sound clips and have marked their pleasantness between 1 and 5 about the sound clips that they had listened. It took approximately 20-25 minutes for

each participant to be briefed before the survey, for them to listen to 27 different sound clips and to answer the survey. Pleasantness data of participants about sound clips have been transferred to computer and results have been evaluated. When the jury test conducted with 53 participants seemed to be enough, the results obtained have been organized for statistical analyses.

Data obtained from jury test and quantitative data of loudness, sharpness and loudness metrics of sound quality metrics belonging to sound clips have been compared. In order to be able to understand the relationship between pleasantness of participants with sound clips that they had listened and sound quality metrics, correlations have been created between them.

As is seen in Table 2, there is a negative correlation between pleasantness and sound quality metrics. While values of sound quality metrics increase, pleasantness of participants decreases (Figure 5). Highest correlation (0,514) is seen between pleasantness and loudness. The correlation between sharpness and pleasantness (0,386) is lesser than loudness metric but more compared to roughness metric. The lowest correlation of pleasantness is with roughness metric (0,118). It is seen that the correlations between pleasantness and sound quality metrics which are loudness, sharpness and roughness are statistically meaningful.

As Bayazıt (1996) have also mentioned, a regression analysis is conducted in order to determine the mathematical statement of the statistical relation between two or more random variables, to calculate the percentage of one of the variables caused by the change of other variables, and to estimate the value of dependent variable based on known values of independent variables. In this study, Sound Quality Index (SQI) has been created by multiple regression method and data in Table 3, by using results of jury tests and quantitative data of loudness, sharpness and roughness sound quality metrics belonging to sound clips. Sound Quality Index (SQI), determining the pleasantness of users with sound environment at urban spaces, is as in Equation 1.

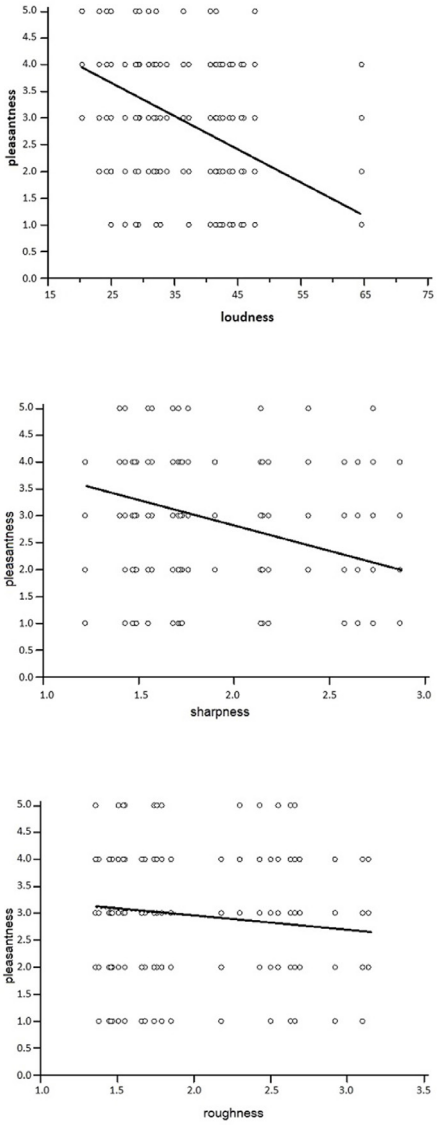

Figure 5. *Graphical display of the relationship between sound quality metrics and pleasantness.*

Table 2. *Correlations between sound quality metrics and pleasantness.*

		pleasantness	loudness	roughness	sharpness
pleasantness	Pearson Correlation	1	-,514(*)	-,118(*)	-,386(*)
	p		,000	,000	,000
loudness	Pearson Correlation	-,514(*)	1	-,105(*)	,152(*)
	p	,000		,000	,000
roughness	Pearson Correlation	-,118(*)	-,105(*)	1	-,040
	p	,000	,000		,132
sharpness	Pearson Correlation	-,386(*)	,152(*)	-,040	1
	p	,000	,000	,132	

** Correlation is significant at the 0.01 level (2-tailed).*

Table 3. *Multiple regression equation table.*

Independent variables	Coefficient	Std. Error	t	P
(Constant)	7,2936			
loudness	-0,05851	0,002522	-23,196	<0,0001
roughness	-0,3723	0,0425	-8,760	<0,0001
sharpness	-0,7792	0,05078	-15,346	<0,0001

$$SQI = 7{,}2936 - (0{,}05851 * X_1) - (0{,}7792 * X_2) - (0{,}3723 * X_3)$$

X_1 : loudness

X_2 : sharpness

X_3 : roughness

(1)

3. Field survey and results

In order to determine the accuracy of the data estimated by SQI, it should be tested with actual data. At this stage, a survey has been conducted on users in Suriçi region of Diyarbakır in order to determine their pleasantness with sound environment of the region where they were located. The survey conducted and the method followed for the comparison of survey results and data estimated from sound quality index have been given on flow chart in Figure 6.

In order for the study to be statistically meaningful, sample size should be paid attention. Kang and Zhang (2010) have stated that a sampling size of 100-150 could be enough for soundscape evaluation at urban outdoor places. In this case, at least 100 surveys should be conducted in the study. However, Çıngı (1994) emphasizes on that sample size should be determined by using an Equation 2 in order to be able to reach statistically meaningful results.

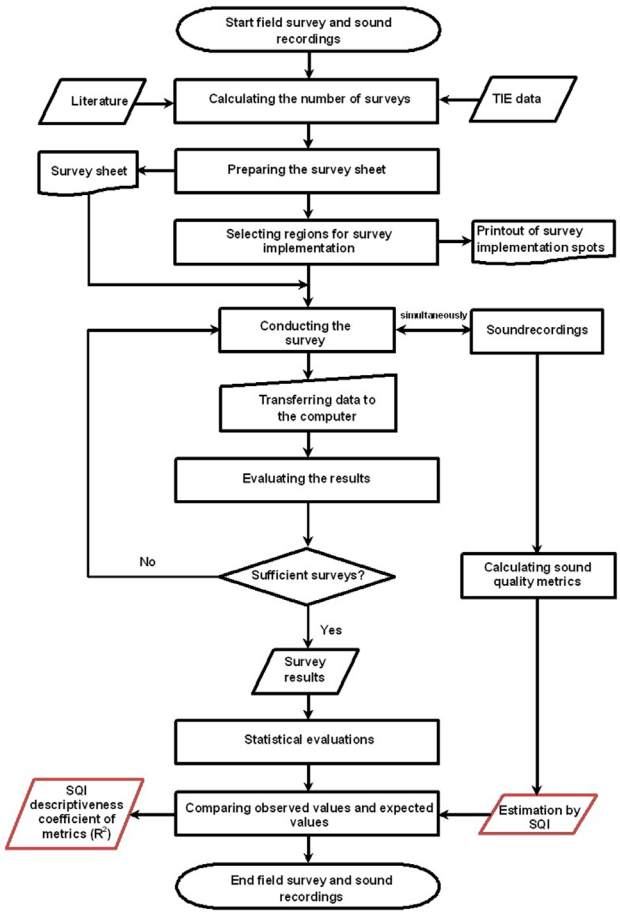

Figure 6. *Flow chart of comparison of field surveys and estimation by Sound Quality Index.*

$$n = Z^2 * N * P * Q / (N * D^2 + Z^2 * P * Q)$$

(2)

n= Sample size

Z= Confidence coefficient (This coefficient should be taken as 1.96 for a confidence of 95%.)

N= Main population size

P= Possibility of the desired feature being in the main population (Since the study is multi-purposed, this ratio has been taken as 50%.)

Q= 1 - P

D= Acceptable sampling error (Sampling error of 5% has been predicted for the study.)

At 15 neighbourhood units in Suriçi Region of Diyarbakır, registered population is 55,027 according to 2014 records (Url-1). When these numbers are considered, for the sampling error of 5%, the survey should be conducted on at least 381 people at the field of study according to Equation 2. Survey sheets have been prepared for the survey to be conducted in the field. Their genders, ages, educational levels, reason of coming to the field, coming frequencies, presence duration at the field and pleasantness with sound environment of the region, where they located, has been asked to the participant. Participants have been provided with options between 1 and 5 determining their pleasantness. Since many factors could affect their choices in pleasant with sound environment apart from sound sources, several factors have been sorted considering also the features of the region.

Since Suriçi region of Diyarbakır is a historical region, along with the sound sources, historical texture, touristic value, architectural structure features because of its characteristic architecture, and social and commercial structure because of city's feature of being social and commercial center have been given place in the survey among the factors. Additionally, landscape has also been considered among the factors with the thought that the park

zones established as a result of rehabilitation works conducted around the city walls in recent years might be a factor. Participants have been asked to sort the factors that might affect their pleasantness between 1 and 7.

Regions where surveys can be conducted have been decided by examining the areas where sound sources were located in Suriçi region of Diyarbakır, and these regions have been marked on the map. Since quantitative data of sound quality metrics and subjective evaluations of users would be tested in the study, survey study and sound recording work have been conducted simultaneously.

Field survey study has been conducted on 392 participants who did not suffer from hearing impairments. While transferring the data obtained from surveys to the computer, sound records have also been transferred to the computer and quantitative data of sound quality metrics of loudness, sharpness and roughness have been calculated. By using quantitative data obtained from sound recordings and Sound Quality Index, pleasantness of users with sound environment has been tried to be estimated. When survey data has been examined and decided as sufficient, results have been calculated statistically. Subjective data obtained from field surveys and data estimated by SQI have been compared.

As a result of analyses conducted, a correlation of 88% has been derived between pleasantness of users with the sound environment and data obtained from field survey study. As is seen in Figure 7, a confidence level of $R^2 = 0.7714$ has been acquired.

When the relationship between sound quality metrics, and SQI and actual data is examined, a negative correlation of 95% is seen between data obtained from SQI at pleasantness with sound environment for loudness metric and actual data obtained from the field (Figure 8). A negative correlation of 82% is seen between the data obtained from SQI at pleasantness with sound environment for sharpness metric and actual data obtained from the field (Figure 9). And a negative correlation of 67% is seen between the data obtained from SQI at pleasantness

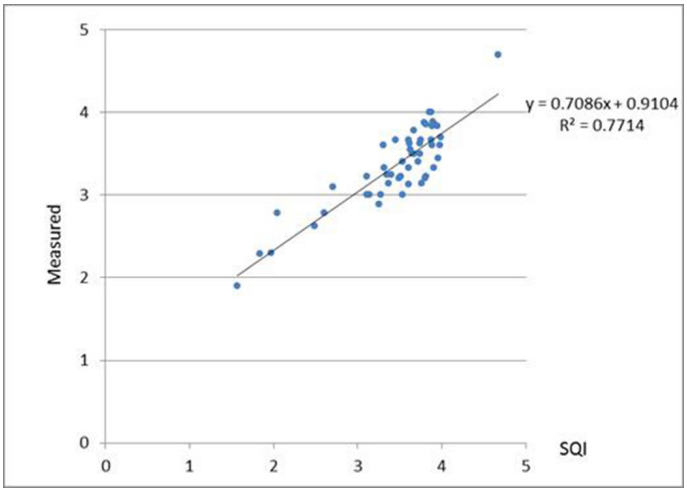

Figure 7. *Relationship between SQI and data measured.*

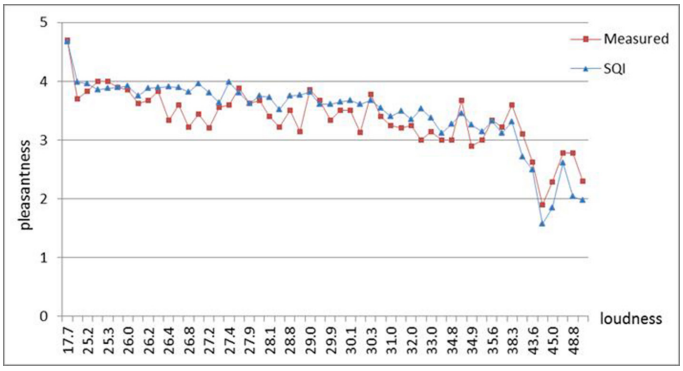

Figure 8. *Relationship between loudness and pleasantness.*

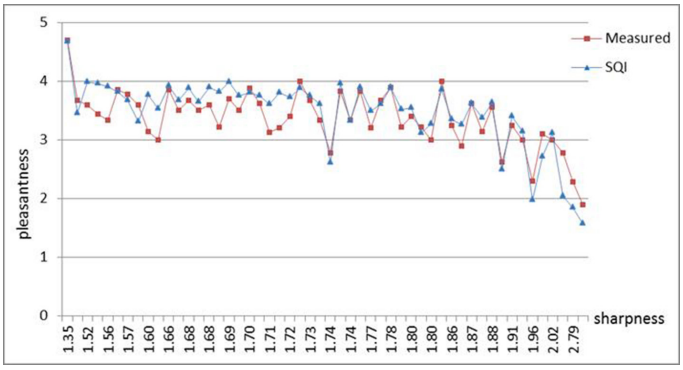

Figure 9. *Relationship between sharpness and pleasantness.*

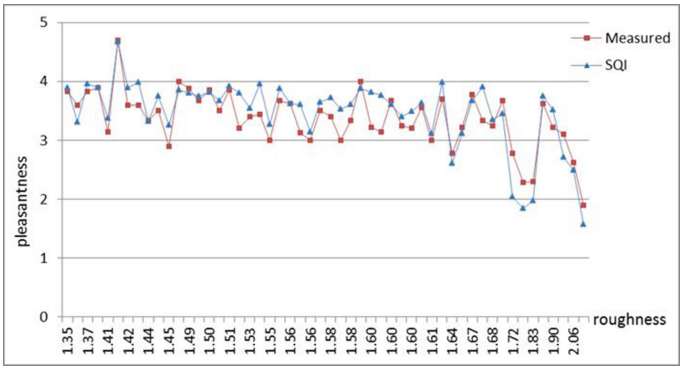

Figure 10. *Relationship between roughness and pleasantness.*

with sound environment for roughness metric and actual data obtained from the field (Figure 10).

A confidence level of approximately 77% has been acquired between Sound Quality Index and actual data. Apart from that, field survey results have been scrutinized in order to determine the parameters affecting other 23% left. In the field survey, participants have been asked of their genders, ages, educational status, reasons of being at the area, frequency of coming to the area and duration of being at the area. In addition, they have been asked to sort the factors affecting their pleasantness with sound environment. Other parameters which are effective on determining pleasantness with sound environment have been tried to be determined by using these data.

When pleasantness of participants is evaluated according to their genders, prevalence frequency in the answers differs from each other considerably.

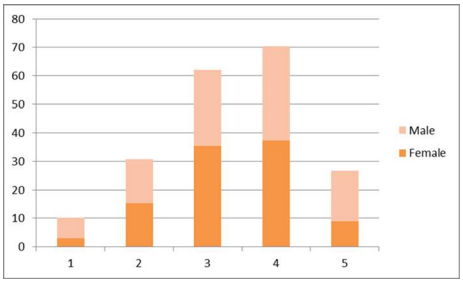

Figure 11. *Relationship between genders and pleasantness.*

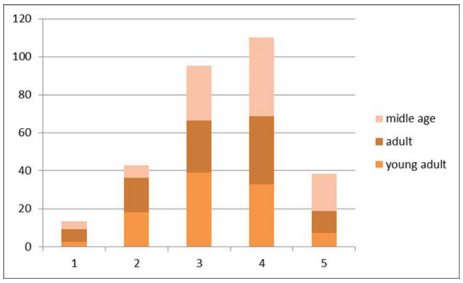

Figure 12. *Relationship between age groups and pleasantness.*

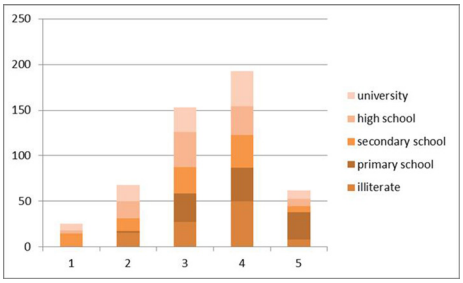

Figure 13. *Relationship between educational level and pleasantness.*

This difference is a statistically important difference (Chi-Square=11,599 p=0,021 p<0,05). While only 3% of the female have chosen the choice 1, 7.3 of the male participants have chosen the choice 1. Male feel more unpleasant compared to female. Majority of both female and male have expressed their pleasantness with sound environments as 4. While 37,3% of the female chose their pleasantness as 4, this rate is 33,1% with male (Figure 11).

With the thought that ages of the participants might also be effective on determining the pleasantness of sound environment, participants have also been asked of their ages during the surveys. Participants of the surveys between the ages of 19 and 64 have been divided into three groups (Department Of International Economic And Social Affairs of United Nation, 1982) (Eryılmaz, 2011). These have been classified as; 19-25: Young adults, 26-45: Adults, 45-64: Middle-aged. When the answers given have been examined in percentage, prevalence in the answers differs from each other significantly. This difference is a statistically meaningful difference. (Chi-Square=22,859 p=0,04 p<0,05). As is seen in Figure 12, pleasantness of young adults with sound environment is lower than other age groups; and pleasantness of middle-aged group with sound environment is higher. According to this study, it is understood that pleasantness of the participants with sound environment increases as their ages increase.

In the study conducted, it has been researched that whether the educational level of the people participating to the survey affects their pleasantness with sound environment or not. Educational level is divided into five groups as illiterate, primary school, secondary school, high school and university graduate. When the answers given have been examined in percentage, prevalence in the answers differs from each other significantly. This difference is a statistically meaningful difference. (Chi-Square=45,082 p=0,00 p<0,05). When the satisfaction preferences of participants at the field of study compared to their educational level are examined; while most of the high school graduates have chosen 3 as their satis-

faction preferences, most of other participants have chosen 4 (Figure 13).

With the thought that reasons of being at a place might affect the pleasantness with sound environment, participants have been asked of their reasons of coming to the place. For the people who work at Suriçi region of Diyarbakır, the term "worker" has been used, and answers such as wander, shopping, resting, eating&drinking have been added. For the ones who might have other reasons, the option "other" has been added. The option "others" has been chosen mostly by the ones who go to mosques or churches for praying or the ones who pass through the road to go their homes. When the answers given have been examined in percentage, prevalence in the answers differs from each other significantly. This difference is a statistically meaningful difference (Chi-Square=73,823 p=0,00 p<0,05). When Figure 14 is observed, the most dramatic result is seen with workers. People work at the region are affected negatively by sound environment and most of the worker participants (31,8%) have chosen 1 as pleasantness. On the other hand, pleasantness of the ones, who come to the area for wander, resting and eating&drinking, have been higher 4.

When participants have been asked of their frequency of coming to the area and the answers have been examined in percentages, prevalence in the answers differs from each other significantly. This difference is a statistically meaningful difference (Chi-Square=79,755 p=0,00 p<0,05). When Figure 15 is observed, it has seen that pleasantness of people who come to the area every day with sound environment have been expressed as 1. When the ones who have chosen 1 among the ones coming every day, it has been seen that majority was consisting of workers.

Since it is considered that duration of presence of the participants at the area might affect their pleasantness with sound environment as well as the frequency of coming to the area, they have been asked of their duration of presence at the area. When answers given to the choices of "less than 1 hour", "between 1-2 hours", "between 3-5 hours" and "6 hours and more" have been examined in percentage, prevalence in the answers differ from each other significantly. This difference is a statistically meaningful difference (Chi-Square=48,014 p=0,00 p<0,05). Majority of those who stay at the area 6 hours or more have chosen 1 as pleasantness (Figure 16).

In the study, in order to be able to determine the factors affecting the pleasantness of the participants with sound environment, they have been asked of the factors that might affect their choices in the survey and they have been asked to sort these factors.

When participants' sorting for each factor were observed in Figure 17, it has been seen that there might be other factors affecting pleasant with sound environment significantly apart from sound sources, as is expected. While 48,7 of the participants have stated sound sources as first among the factors, 36% of them, however, have stated historical texture as the first factor. Apart from these, architecture of the

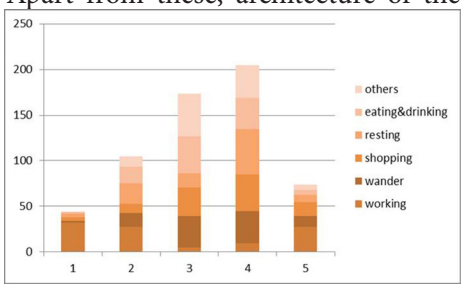

Figure 14. *Relationship between the reason of coming to the area and pleasantness.*

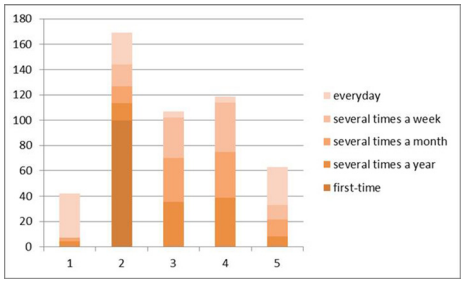

Figure 15. *Relationship between frequency of coming to the area and pleasantness.*

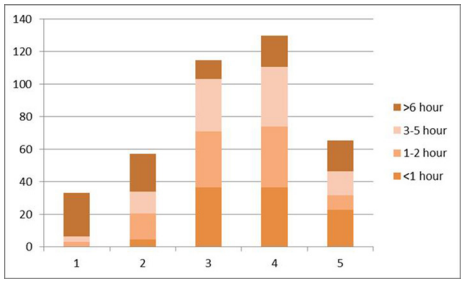

Figure 16. *Relationship between duration of presence at the area and pleasantness.*

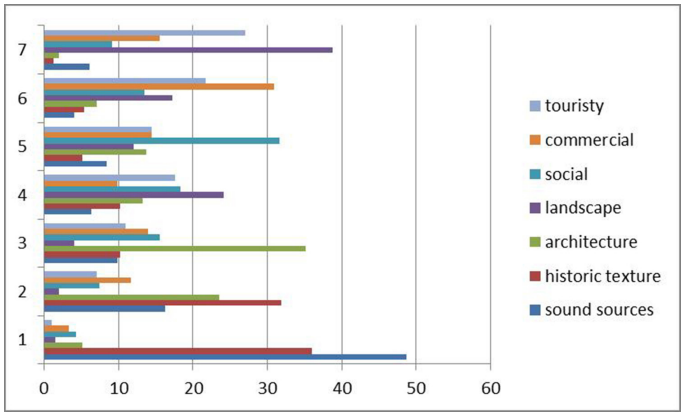

Figure 17. *Sorting preferences of the participants for factors affecting pleasantness with sound environment.*

place has been found important and 35,2% of the participants have stated the architecture as an third effective factor. While social structure has been evaluated as fifth, commercial structure has been placed at sixth by the participants. Landscape and touristic value have been found less effective compared to others and majority has placed the landscape to the seventh place.

4. Conclusion

In the study, with the approach of soundscape, pleasantness of users with sound environment at urban places have been tried to be estimated by SQI created. SQI has been created by sound quality metrics which are loudness, sharpness and roughness. Data acquired from field of study and data obtained from SQI have been compared. Estimation of pleasantness of users with sound environment has been acquired by SQI as confidence level of R^2=0.77, and this value is a suitable result statistically (Rumsey & Unger 2015). When other factors that might affect pleasantness of users with sound environment have been examined;

- A meaningful relationship has been observed between genders and satisfaction with sound environment. Male users might feel more unpleasant compared to female users.
- There is a meaningful relationship between age factor and pleasantness with sound environment. It has been determined that pleasant of young adults with sound environment has been lower compared to adult and middle-aged users.
- There has also been observed a meaningful relationship between educational levels and pleasantness with sound environment. Pleasantness of high-school graduated users with sound environment is lower compared to illiterate, and primary school, secondary school and university graduated users.
- There is a meaningful relationship between reason of users coming to the area and their pleasantness with sound environment. Pleasantness of users who come to the area to work is quite low compared to people who come for eating&drinking, wander, resting and shopping. Especially the ones who come to the area for wander, shopping and resting feel relatively higher pleasant.
- There is seen a meaningful relationship between frequency of users coming to the area and their pleasantness with sound environment. Pleasantness of most of the ones who have to come every day is pretty low.
- There is also a meaning relationship between the duration of users staying at the area and their pleasantness with sound environment. Pleasantness of the ones who stay at the area for more than 6 hours is quite low compared to the ones who stay lesser.
- Features of the region, where the users are located, play an important role, as well, among the factors affecting their pleasantness with sound environment. Region having a historical texture, apart from the sound sources located at the area, is an extremely important factor affecting the pleasantness. Also, architectural features of the area have an important effect on pleasantness of users with sound environment. It is seen that the area of which social structure is also active has an effect on the pleasant. Commercial structure, landscape and touristic value of the area have been at the latest places among the factors affecting pleasantness with sound environment.

Along with the quantitative data, pleasantness with sound environment at urban spaces should be evaluated together with historical, architectural,

social and cultural features of the place, and demographic structure of the users and reasons of utilization of the place.

In estimation model studies, which will be conducted in order to determine pleasantnesss, results would be more successful if models, where data containing distinctive features of the cities along with the quantitative data, are developed.

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