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## **A study on the adaptation of soundscape to covered spaces: Part 2**

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This study is the second part of a research on the adaptation of soundscape to covered spaces. A modern and a historical shopping center were compared and evaluated by means of subjective and objective evaluations. The consistency of the objective (time histories) and subjective (listening tests) findings showed that covered commercial areas may have a specific sound environment. The formation of streets is generally the basic spatial design concept that connects open and closed shopping areas. Therefore one of the studies that authors proposed at the previous paper was the comparison of open and closed shopping areas. In this study the soundscapes of a modern and a traditional street having shopping as a basic function will be determined by soundwalks and listening tests, and the findings will be compared with those of the previous studies.

## 1 Introduction

Soundscape, as is used for urban noise, is basically a qualitative approach aiming to reach clues to improve the “sonic environment”. A possible analogy can be assumed for the acoustical quality of some types of covered spaces having a function similar to urban spaces. Furthermore, it can be discussed that mentioned covered spaces may have a specific, distinctable and recognizable sound environment thus soundscape occurred both by the architecture and the sound sources. A further step of this extraction is that the acoustical comfort / sound quality of these spaces can not be dealt sufficiently via noise parameters. Thus in a previous study the authors proposed the possibility to evaluate their acoustical quality through soundscape studies [1].

Commercial centres where people gather for a limited time, like in urban spaces were selected as the built environments to work on in order to investigate the presence of soundscapes specific to covered spaces. Two shopping centres (a modern and a historical) located in Istanbul were chosen for the first step of this long-term study. A qualitative (listening tests) and quantitative (measurements with soundwalk method) approach was chosen for the study, similar to those used for environmental noise purposes in order to evaluate the soundscapes of selected shopping centres.

The objective and subjective findings of the preliminary study, showed that covered commercial centres seem to have a specific sound environment that could be visualized by time histories as well as by the subjective evaluations. The consistency of the subjective results about the perceptibility of the closed areas, the functional understanding of the areas and moreover the presence of the subjects calling the places by their proper name, encouraged to continue to the studies on the adaptation of soundscape to covered spaces.

This part of the study deals with the comparison of open and covered commercial areas that authors had proposed in the previous study, in order to enforce the findings of Part 1. Two commercial streets having different locations in Istanbul but also situated at two of the main commercial regions of the city are chosen to be evaluated and compared with the two shopping centers (Grand Bazaar and The Modern Shopping Center) which were analyzed in previous study. Istiklal Street has a specific structure based on its architectural design and variety of functional usage causing steady life in the area. Fuat Pasa (with cars) and Cadircilar (without cars) Streets are in the ancient center of Istanbul presently called as “historical peninsula”, as is Grand Bazaar.

This paper presents the second part of findings / results of the ongoing study to adapt the soundscape concept to covered spaces by using the multiple soundwalks in open commercial areas, recent and historical close shopping areas in order.

## 2 Study Areas and Sound Environments

Open and covered commercial centres have been formed due to the necessity of togetherness and / or concurrence of several goods as a matter of convenience. Spatial organizations, architectural designs and location in urban planning have been affected by the changes in life styles, urban development and requirements of land use based on / parallel with the growth of urban population. The formation of streets is generally the basic spatial design concept that connects open and covered commercial areas. Consequently, two commercial streets (a modern and a historical) are chosen for the second step of this long-term study.

Both of the commercial centres studied at the previous study as well as the two commercial streets investigated in this part, are in Istanbul. Grand Bazaar, built in 15th Century, is one of the most important examples of historical commercial centres for several reasons such as its importance in the urban planning of the city, its huge dimensions, but mostly because of the continuous usage for the same purpose for more than five centuries. The Modern Shopping Centre is the biggest shopping centre in the city as Grand Bazaar was once. It is designed with a new concept about gathering of social, cultural, artistic activities in a multi-storey building which is endowed with all boons of technology in different fields as security, hygiene, building physics, being up to date etc. İstiklal Street which intersects several streets having similar ambiance, is full of shops, restaurants, cafes, bars, night clubs, and it is the most important lifeline inter alia the culture, art and entertainment center of Istanbul since 19<sup>th</sup> century. It is densely used at all hours of the day as pedestrian lane that has a nostalgic tram which was the only means of transport in Istanbul once. Fuat Pasa (with cars) and Cadircilar (without cars) Streets are two of narrow commercial streets which are close to Grand Bazaar [2].

The main characteristic of soundscapes in historical commercial areas (Grand Bazaar as covered and Fuat Pasa and Cadircilar Streets as open ones) has been based on individual hails between the sellers and purchasers as a kind of sales approach, diversity of usage besides shopping, such as meeting, passing through etc. as in urban areas, configuration / arrangement of stalls grouped by type of goods.

The soundscape of the modern commercial areas (the Modern Shopping Center as covered and Istiklal Street as open ones) is formed by different ways of sales approaches supplied with music broadcast, advertisements and arrangements of shop front, togetherness of social, cultural, artistic activities, architectural solutions and styles with design concepts through the changes according to the intervention of technological development in all views of our lives.

### 3 Soundscapes of the Selected Commercial Areas

#### 3.1 Measurements

Soundwalk method providing the recordings has been used for this ongoing study, similar to those used for environmental noise purposes in order to evaluate the soundscapes of selected commercial areas. The recordings (maximum half an hour) were carried out with a 01dB Symphony Box system equipped with binaural headphones with microphones loaded by walking persons on the routes of selected areas with accompanying photos as shown in Figures 1 and 2. All of the recordings were done during week day and at the same time period of the day. The first 15 minutes of all recordings is chosen in order to facilitate the comparison.

The soundwalk in Grand Bazaar started at the gate opening to the main street of Bazaar then continued on passing through secondly roads, little squares with fountains and wells and lasted at another main gate. While in the Modern Shopping Center the soundwalk started at the pedestrian entrance, continued on respectively first, second and third floors which the last one is the food-court then back from the same floors starting from the third floor and ending at the entrance.

At the commercial streets, first recordings started at the entrance from Taksim Square and ended at the last stop of the historical tram called as Tunnel in Istiklal Street; second one started at Fuat Pasa Street which is open to traffic, continued to the Cadircilar Street only for pedestrian and ended close to the Yeniceriler Street one of the main traffic road also for tram in Historical Peninsula.

The data from the soundwalks are presented in the form of time history graphs which correspond to time and sound level representation of the soundscapes. The graphs in Figures 1 and 2 also report the 100 ms  $L_{Aeq}$  time histories of Grand Bazaar, the Modern Shopping Centre, Istiklal Street and Fuat Pasa (with cars) and Cadircilar (without cars) Streets respectively.

Different sources were present during the monitoring, including natural (voice, whistle, warble etc.), non natural (traffic, music etc.) and also sounds specific to various functions in each area such as sounds of tea glass, coins, plastic bags, copper treating, movement of furnishing and announcements occurred in covered commercial areas; high-level music broadcast, roadwork and sound of bicycle for loading occurred in open ones, as shown in the graphs.

The comparison between shopping centers and streets shows that types and numbers of sources that produce

sound events are considerably different. Sound sources in covered commercial areas are more varied and have different peculiarities than those at the open areas.

On the other hand, it is clearly seen from the graphs given in Figures 1 and 2 that the dynamic range of sound levels in the areas in which voice is the dominant sound source through the historical sales approach based on hails (Grand Bazaar and Cadircilar Streets –without cars-) is wider than those at the modern commercial areas. Because of the social density in Istiklal Street, pedestrians pass closely to the walking person equipped with binaural system. Consequently, voice automatically becomes dominant and dynamic range in Istiklal Street is similar to the historical commercial areas.

Together with the architectural peculiarities of the four working areas, these data can be interpreted as displaying the acoustical environment specific to two different covered and open spaces for each, in other words four different types of soundscapes. The basic reason of these distinctions are caused by the differences of spatial boundaries of areas and similarities of spatial design concept -‘the formation of streets’-. On closer examination, Grand Bazaar has relatively low ceilings, in fact vaults, narrow streets, the Modern Shopping Centre has high ceilings, big volume and flat surfaces, Istiklal Street is relatively wide road, a tram passing through and is bounded with higher buildings and Fuat Pasa and Cadircilar Streets are fairly narrow at human scale.

The overall analysis of data reported in Table 1 shows that the  $L_{Aeq}$  levels of the areas are almost equal and above 70 dBA (70 - 73 dBA in covered areas, 73 - 74 dBA in open areas) and comparable to a road with high traffic.

A deeper analysis for each area based on physical parameters and identification of events permits more considerations.  $L_{Amin}$  levels at modern shopping areas are higher compared to the historic ones, regarding also the state of open and covered, whereas  $L_{Amax}$  level is higher than 6 dB on average in shopping streets, compared to the recordings in the shopping centers. On the other hand, although  $L_{A50}$  levels are similar,  $L_{A5}$  and  $L_{A90}$  in shopping centers are 3 dB lower than in the streets. These data show that the background levels in selected areas disregarding the covered and open design are almost similar; however the variable structure of dynamic range of sound levels determines the sound environment specific to each area.

Area	Location	$L_{Aeq}$	$L_{Amin}$	$L_{Amax}$	$L_{A5}$	$L_{A50}$	$L_{A90}$
Grand Bazaar	Can.1	73.4	54.1	97.3	77.8	71.0	61.8
	Can.2	71.7	52.2	91.5	76.2	69.4	60.3
	<b>Overall</b>	<b>72.6</b>	<b>53.2</b>	<b>94.4</b>	<b>77.0</b>	<b>70.2</b>	<b>61.1</b>
Modern Shopping Centre	Can.1	68.8	58.2	81.6	72.2	67.8	63.4
	Can.2	70.2	59.6	86.8	73.4	69.3	65.1
	<b>Overall</b>	<b>69.5</b>	<b>58.9</b>	<b>84.2</b>	<b>72.8</b>	<b>68.6</b>	<b>64.3</b>
Istiklal Street	Can.1	73.8	62.6	90.9	78.6	71.1	67.3
	Can.2	74.8	64.3	89.2	79.2	72.5	68.8
	<b>Overall</b>	<b>74.3</b>	<b>63.5</b>	<b>90.1</b>	<b>78.9</b>	<b>71.8</b>	<b>68.1</b>
Fuat Pasa & Cadircilar Streets	Can.1	71.8	53.2	94.5	75.9	67.3	60.7
	Can.2	73.4	55.0	104.6	76.5	68.2	62.4
	<b>Overall</b>	<b>72.6</b>	<b>54.1</b>	<b>99.6</b>	<b>76.2</b>	<b>67.8</b>	<b>61.6</b>

Table 1: Values of the parameters considered for the comparison

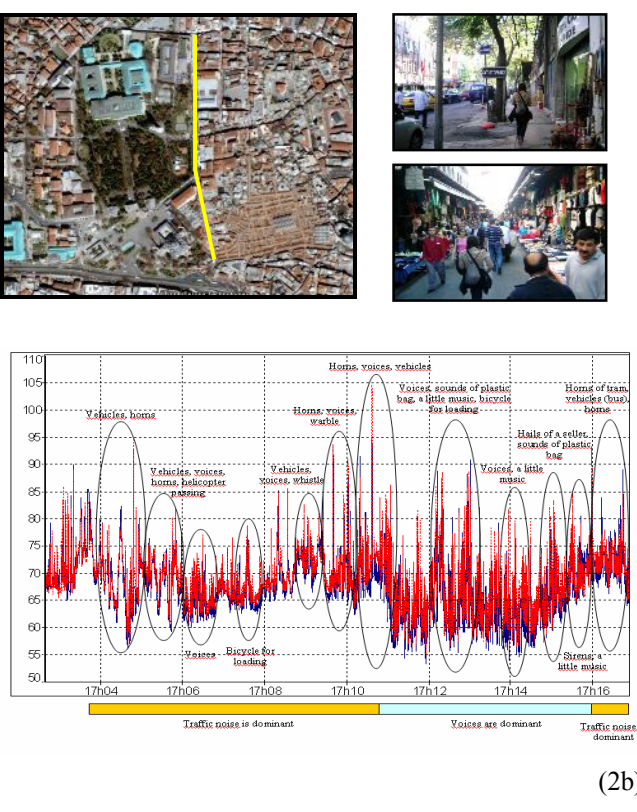
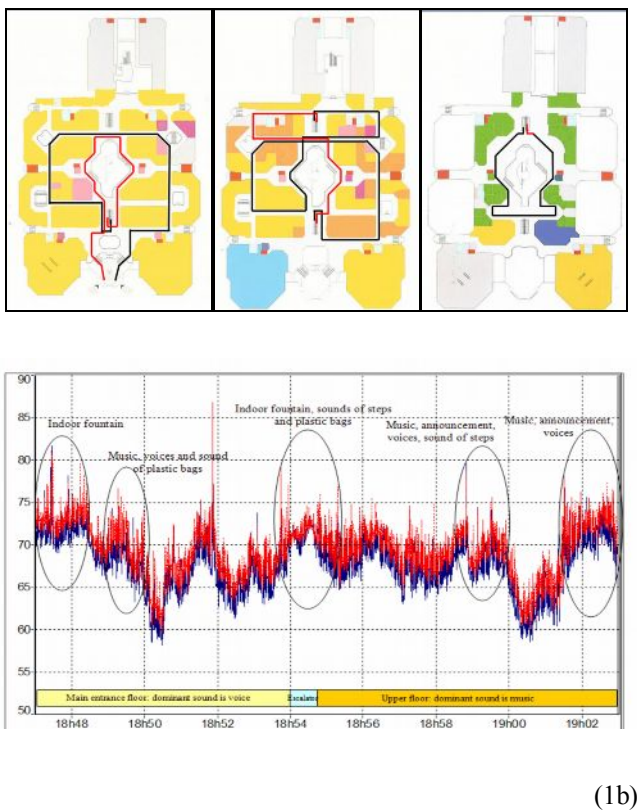
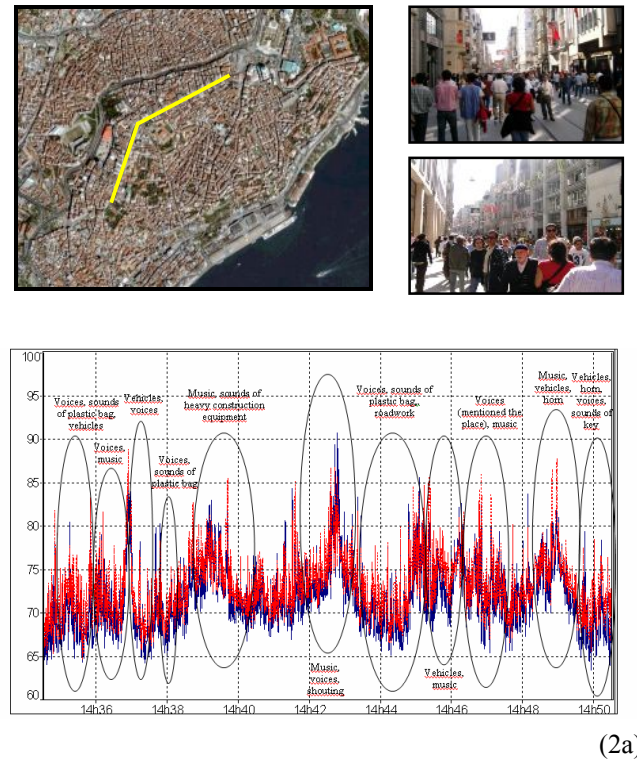
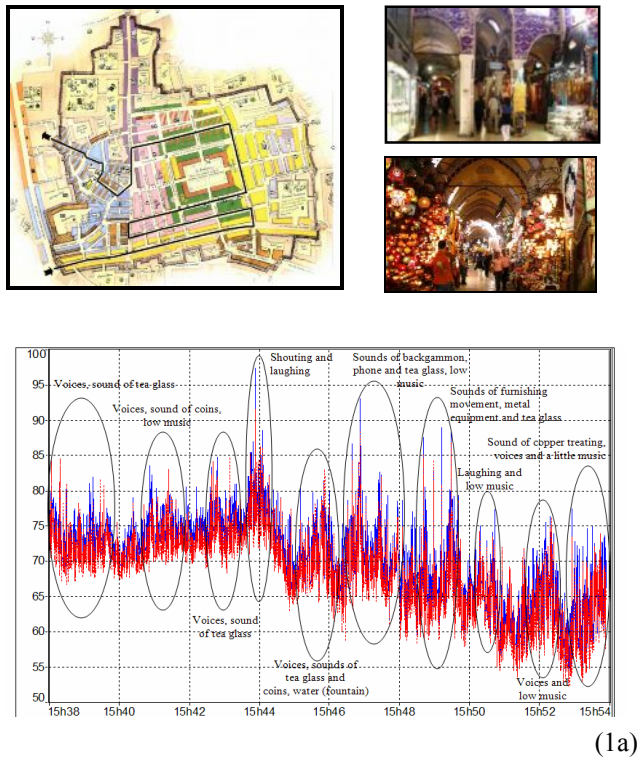


Fig 1. Routes, time history graphs with the type of sources producing sound events of the soundwalk in covered commercial areas with photos

(a. Grand Bazaar, b. The Modern Shopping Center)

Fig 2. Routes, time history graphs with the type of sources producing sound events of the soundwalk in open commercial areas with photos

(a. Istiklal Street, b. Fuat Pasa (with cars) and Cadircilar (without cars) Streets)

## 3.2 Laboratory listening tests

As an ongoing study, 10 more subjects aside from 10 subjects at prior tests were asked to describe what they heard regarding the records they listened for 5 minutes for each area at random array as different from applied before; in the laboratory environment. The 5 minutes' period was selected according to the records starting from the entrance of areas. As applied in Part 1, no information about the recordings was given to the subjects, they are only asked to write down what they heard and the analyses of the texts are done upon given parameters;

- the perceptibility of the open / covered areas
- the functional understanding of the area
- the determination of specific sounds
- subjective understanding of the areas including the subjects' evaluation of physical and psychoacoustical perception of the records.

In this frame, the inferences based on the writings of subjects can be listed as following.

- All subjects correctly defined the areas as covered and open.
- All subjects determined the functions of each area. 9 of the subjects for each described covered areas as a commercial place where people gather and also pass through like bazaar, terminal, passage etc., moreover 4 of the subjects called Grand Bazaar by its proper name and 5 of them called the Modern Shopping Center with its type of building. All of the subjects characterized open areas as a place like street or square. 4 of them called the Istiklal Street by its proper name and 7 of them defined Fuat Paşa and Cadircilar Street as a commercial street.
- The subjects were able to detect the same function depending on these different clues although there are sounds specific to the areas in all of the records. For example, in shopping centers, it was the sound of coins in Grand Bazaar, sound of plastic bag in Modern Shopping Center that they based their opinion about commercial function, whereas in shopping streets it was the sales approaches such as high level music broadcast in Istiklal Street, hails of a seller in Fuat Paşa and Cadircilar Streets.
- The subjects felt a sense of crowdedness because of the voices passing the walking person equipped with binaural system closely. They felt the same sense by defining the voices coming from a distance in the Modern Shopping Center. This result enforced the aspect about the difference of its dynamic range between those in all other areas. Whereas, because  $L_{Aeq}$  levels of the areas are almost equal although  $L_{Amax}$  level is higher in open areas, they mentioned / used different adjectives that signify the subjective comfort evaluations of each areas and that vary with the application of listening tests at random array. They used 'non-bothersome' for Grand Bazaar, 'noisy' - through intelligibility is not sufficient' for The Modern Shopping Center, 'colourful, active contrarily / besides intensive' for Istiklal Street, 'bothersome and boring' for Fuat Paşa and Cadircilar Streets. These adjectives that were used to describe what the subjects heard, give some crucial clues concerning psycho-acoustical data that can be used to evaluate / conserve / restore the acoustical environment quality.

## 4 Conclusion

Soundscape is a relatively new concept that covers the overall effect of the sounds specific to the area under consideration. The soundscape of a specific milieu may cover desirable and / or undesirable components yet it may provide detailed information about the given natural or built environment. Many scientists mention that soundscape evaluation must take into account acoustical but also sensory, aesthetic, geographical, social, psychological and cultural modifying parameters [3, 4, 5, 6, 7]. However, a generally accepted soundscape approach has so far not yet been established [8].

Soundwalk method (a qualitative-quantitative approach) proposed by Semidor [9] providing the binaural recordings which is used both for the evaluation of physical factors and for human judgments, is chosen for the study, similar to those used for environmental noise purposes in order to evaluate the soundscapes of selected areas.

The objective and subjective findings of this study (considering Part 1), aiming the adaptation of soundscape concept to covered spaces, showed that covered commercial areas have a specific soundscape that can be evaluated by the soundwalk method disregarding the state of environment as open and covered.

Subjective results which are the determining cause of spatial definition and environmental sound quality complement the insufficiencies of the evaluation of time history graphs. The consistency of the subjective results of two parts of this long-term study can be shown as follows,

- the perceptibility of the covered areas through four different recordings which were done at two open and two covered ones,
- the functional understanding of the areas, the presence of the subjects calling the places by their proper name and informing the records were made in a route at each area,
- the determination of specific sounds in each area that can also be used for functional understanding supported the goal of this study.

Entertainment areas, shopping malls, airports, train stations are some other examples beside commercial areas that may have a specific, distinctable and recognizable sound environment thus soundscape occurred both by the architecture and the sound sources. Detailed studies aiming the comparison of the objective and subjective data that will be obtained from multiple soundwalks in open and covered areas having different function are planned by the authors in order to justify the adaptation of the soundscape concept to covered spaces.

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