Effect of Soundscape Dimensions on Human Acoustic Comfort on Streets of Pune.

Goal 11- Sustainable Cities and Communities

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Abstract:

The International Organization for Standardization (ISO) defines Soundscape as the 'acoustic environment as perceived or experienced and/or understood by a person or people, in context'.

The term soundscape was first referred to by R. Murray Schafer in 1969. In 1977 he defined soundscape as an acoustic field of study that consists of events that are heard not objects seen.

Urban sounds are often defined as 'unwanted'. Till today sound is not perceived as a positive, informative or explorative manner. In urban planning, public spaces are gaining vital importance. It adds quality to urban life. Effect of soundscape changes with changes in demography, activity, temporal factors & spatial factors. Various studies have shortlisted dimensions of the soundscapes, such as relaxation, communication, spatiality, dynamics, preference, familiarity, pleasantness, eventfulness, background or foreground, calmness, etc. It is found that human comfort is very subjective & its response to soundscape is influenced by temporal, spatial & emotional dimensions. Human beings respond to their immediate environments in a variety of ways, with emotions playing a major role. This study aims to study the interrelation between soundscape dimensions and human acoustic comfort on the mixed-used urban streets in Pune City. It also tries to understand various factors influencing soundscape dimensions.

Out of various soundscape dimensions, pleasantness, eventfulness & familiarity are studied to understand their effect on human acoustic comfort.

The methodology adopted for the study includes a questionnaire-based survey. This work attempts to identify the interrelationship of these soundscape dimensions & public perception. This study will be useful in planning the streets in urban areas with the soundscape approach.

Keywords

Acoustic Comfort; Soundscape Dimensions; Urban Streets

Introduction:

The term Soundscape has been used by many disciplines from medicine to sociology. The word 'Scape' refers to an 'area, Space, scene or view'. So the word Soundscape means 'Sounds occurring over an area.'. This term was first used by Southworth, an urban planner in 1969. He used the term 'Soundscape' to refer to the acoustic properties of cities which help people to relate to certain spaces. (Farina, 14 March 2011)

Pollution in large cities is an ever-growing problem due to increasing population and increase in vehicles.

One major reason that urban environments are facing is the increase in traffic flow. The increasing use of vehicles has led to more low-frequency sounds, resulting in permanent and continuous background noise (Ruocco, 1974, Attenborough et al., 1976)

Increasing urbanization has an adverse impact on the acoustic environment. Soundscape has to be measured and analyzed through the human perception of the acoustic environment. Hence, the measurement methods should focus on collecting not only physical but perceptual data which contain information on how humans perceive the acoustic environment. The local planning and design should take a holistic approach to analyze the quality of the acoustic environment. The soundscape concept has significant practical implications in terms of policy as well as the design process. The soundscape concept was largely used in countries such as Greater London, Berlin, Stockholm, and Antwerp, which are actively promoting practical examples of soundscape projects around the world. In India, the incorporation of soundscape aspects in urban planning is found to be lacking. *(N H Abdul Hamid, 2022).* This research is an attempt to highlight the importance of soundscape dimensions and public perception in the planning of urban streets.

Urban planning management practices have shown that most city regulations are insufficient as they mainly aim at maximum noise-weighted levels and therefore focus on physical measurements, such as permissible sound levels in decibels, neglecting human experiences & perceptions of sounds. *(Manon Raimbault, October 2005)*

A city that would please all of the senses would be ideal, in terms of aesthetics. In spite of this to date, designs are visually dominated, and the non-visual aspects of the physical environment are the least considered characteristics. This is mainly because they are so intangible, being invisible, transitory, and difficult to talk about. In addition to visible activity and spatial form, a city has sounds, smells, textures, and myriad sensations of microclimate, and the perception of these hidden dimensions may greatly affect the interpretation of the visual information presented by the cityscape. *(Southworth, 1967)*

Soundscapes are always variable in space and time and can be viewed from a global to a local situation. The soundscape of a specific space could become an acoustic image of a city. (Manon Raimbault, October 2005)

Under the 'Accessible India Campaign' it becomes important that an inclusive approach is also practiced in the planning process. Soundscape can prove to be one of the important points of consideration in street planning for visually impaired people when most of the stress is given to the visual aspects.

The soundscape approach can give not only pleasantness, and uniqueness but also place identity to some parts of the streets. This may be useful in the way finding in urban planning. Thus, all three aspects that are under consideration in this research are very important in the urban planning aspects. Few spots on the streets can be identified for the soundscape-based planning intervention, which can add to the uniqueness or the identity of the place.

The soundscape focuses on how people experience their surrounding acoustic environments. In most of the research conducted in this field, tangible parameters of sound such as Intensity, Sound Pressure, Frequency or reverberation are measured. Intangible parameters of sound such as perception, preference, comfort & values are not addressed.

Sound helps one to understand a particular place and find one's way. The qualitative perspective of sound, which includes sonic diversity and acoustic ecology, is a neglected area of urban design. In addition to controlling noise, introducing pleasant sounds is very important.

Smart cities are required to engage with local communities by promoting a user-centered approach to deal with urban life issues and ultimately enhance people's quality of life. Soundscape promotes a similar approach, based on individuals' perception of acoustic environments.

From the smart cities' perspective, the "quality" of the acoustic environment for the listener is more relevant. Thus, methods to provide information about how acoustic environments are actually perceived at a local scale and individual level need to be explored. Exploring the relationship between the audio-visual characteristics of streetscapes, and acoustic comfort in pedestrian environments would be beneficial for designing sustainable, healthy, and pedestrian-friendly streets.

The acoustic environment is a critical component of the urban environment due to the direct impact on physical and mental health, e.g. a bad acoustic environment increases the risk of hypertension and heart attack (Stansfeld et al., 2005, Hoffmann et al., 2006) while pleasant sounds promote public health (Andringa & Lanser, 2013). Additionally, music scenarios significantly increase the perception of safety & social presence.

Literature Review:

The concept of soundscape started increasingly gaining importance, particularly among researchers and urban planners due to the pioneering work of Southworth & Schafer who significantly contributed by questioning that 'modern cities should sound like & not only look like.' (Francesco Aletta, 2018)

The results of many studies have shown that, all soundscape dimensions have a higher impact on visual perception. So it could be a very helpful indicator for a better understanding of soundscapes by urban planners, architects, and landscape architects in designing acoustic environments. In turn, it will impact and contribute to the quality of urban life. An urge to improve acoustic environment in urban areas is leading to increasing interest in the soundscape approach to mitigate noise pollution issues. Several studies have shown that the soundscape approach can manage unwanted sound and transform it into resource sound. Urban streets have a very vital role in this approach. (N H Abdul Hamid, 2022)

Many of the researchers have studied soundscape dimensions in terms of urban open spaces. Various soundscape dimensions are identified and studied in various research all over the world.

Keiji et al. found that three major dimensions, preference, activities, and sense of daily life, affect soundscape evaluation. Kang and Zhang found four main soundscape dimensions for urban open

spaces namely relaxation, communication, spatiality, and dynamics. Aletta et al. suggested that two major dimensions which are pleasantness and calmness affect soundscape, and a third potential dimension is the appropriateness of a soundscape to a place. They also found distinguishable or indistinguishable, background or foreground, and intrusive or smooth are three important dimensions in terms of sound sources. Sudarsono revealed that three reliable soundscape dimensions are relaxation, dynamics, and communication, which are consistent with the previous study conducted by Kang and Zhang While the above studies are useful for understanding soundscape from different dimensions, it is important to examine systematically the relationships between acoustic comfort and soundscape dimensions, which is also vital for implementing the soundscape approach in urban planning and design. Moreover, previous studies have mainly been developed in low-density cities, and it is needed to examine the situations in high-density cities. out of various studies, Axelsson. made 100 subjects to evaluate 50 different soundscapes and found three main dimensions of soundscape evaluation: pleasantness, eventfulness, and familiarity.

The conventional noise control engineering methods only aim at reducing sound levels, while the soundscape approach acknowledges the nature of sounds. Therefore, there is an urgent need to shift from noise reduction to a soundscape approach. This will make it possible to assess the quality of the overall sound environment for overall human comfort. Much research work has been carried out in soundscape evaluation, but still, there is a further need to study soundscape perception, especially the effects of various sounds on stress levels, positively or negatively. There is a general accord that, for the assessment of acoustic environment it is not appropriate to rely only on physical measurements alone but human experiences in context should also be taken into account. (KANG, 2017)

One approach is evaluating overall soundscape quality with human comfort, with the help of various soundscape dimensions into consideration. Out of which taking into consideration social Indian context the study is limited to only three dimensions of the soundscape namely, pleasantness, eventfulness & familiarity.

Of which pleasantness is the general minimum expected requirement for the healthy well-being of the city dwellers. India is a social community, and the street plays a vital role in the social life of citizens. streets act as an extended space for various celebrations on streets such as Ganesh Utsav, Dandia, Dahi Handi, Diwali & many more. This adds eventfulness. The last dimension of familiarity is also studied in this research for the neighborhood concept of city planning where it is expected to have place identity as one of the prime requirements of urban design.

Pleasantness:

Pleasure means joyful, happy, satisfied, contented, or feel good. Pleasure expresses itself in terms of overall responses that we can instantly recognize in ourselves and in others - smiles, chuckles, meaningful gestures, a warm tone of voice, and positive verbal expressions. (Yang, May 2005)

pleasantness of sounds, which is based on an instantaneous overall impression emerging from various sound attributes as well as individual preferences and experiences. Sound environment is quite subjective, it is influenced by various factors so it becomes important to understand the pleasantness of soundscape to be incorporated in urban planning.

Eventfulness:

The research of Axelsson identified three main soundscape dimensions. He studied 50 respondents and identified 116 possible adjectives to describe these dimensions.

It included “comfortable”, “appealing”, and “inviting” describing the pleasantness component. The eventfulness component comprised adjectives such as “lively”, “full of life”, and “mobile”. The familiarity component included “commonplace”, “common”, and “real” (Gale, Ednie, & Beeftink, 2021)

Soundscape pleasantness refers to the emotional magnitude of the sound perception, while soundscape eventfulness is attributed to the intensity of the sound perception (Erfanian, Mitchell, Kang, Aletta, 2019)

Like Russell's model structure, the common model of representing soundscape is a bi-dimensional circumplex model with pleasantness on the X-axis and eventfulness on the Y-axis, proposed by Axelsson, Nilsson, Berglund (2010). (Mercede Erfanian, June 25, 2021)

Similarly, the soundscape entails two main perceptual attributes: pleasantness and eventfulness that are different from the physical properties of the acoustic environment and by which the listeners appraise the quality of sounds (International Organization of Standardization Technical Specification, 12913-3:2019)

Familiarity:

It has been noticed that familiarity of the listener with the sonic environment explains the way the sound is perceived. In music research, it is known that the familiarity of the sound plays an important role in the process of engaging emotionally and potentially liking it, an observation that is recently confirmed by brain research. Sounds that are expected at a place are more easily recognized. (Dick Botteldooren)

However, expectations may play a role at another level in the appraisal process. Matching expectations is a key factor in learning. If this prediction matches the events that actually occur, the learning brain is rewarded. A sonic environment that results in rewards thus contains expected sounds , thus in this way leads to a more pleasant experience. (Dick Botteldooren).

Thus it is found that all the three dimensions of sound, pleasantness, eventfulness & familiarity have coordination with each other. A person feels pleasantness when he is associated with eventfulness. his brain reacts positively to the familiarity which in turn gives a feeling of pleasantness. Eventfulness triggers the familiarity with the soundscape. so all these dimensions influence each other hence it becomes important to study these dimensions to understand and implement soundscape approach in urban planning.

Rådsten-Ekman, Axelsson, and Nilsson (2013) conducted a listening experiment in order to explore how sounds of water, varying in degree of pleasantness, influence the overall pleasantness and eventfulness of acoustic environments dominated by road-traffic sound. They found that overall pleasantness increased when a highly pleasant water sound (sea waves) was added to the road- traffic sound. For less pleasant water sounds (stream or waterfall), no effect, or a decrease in pleasantness, was found. In addition, pleasant water sounds increased the perceived eventfulness.

A foundation for rapid extraction of meaning from a familiar environmental sound was observed even when sounds were not consciously attended. Thus the soundscape theory has to account for this dual effect: congruent and familiar sounds are less likely to trigger attention but they are also the most probable object of voluntary attention focusing during listening is search or story listening. (Dick Botteldooren)

AIM:

Identify public perception towards pleasantness, eventfulness & familiarity of soundscape in mixed use urban streets of Pune City, Maharashtra.

OBJECTIVES:

- To identify public perception towards street sounds in terms of pleasantness, eventfulness & familiarity.
- To examine the relationship of demographic parameters towards perception of street sounds.
- To study soundscape dimensions, pleasantness, eventfulness and familiarity as perceived by People.
- To develop design guidelines for the development of urban streets wrt soundscape dimensions.

METHODOLOGY:

The research was carried out with the help of a survey method. It included a questionnaire survey as a tool to investigate the acoustic comfort of people using this street. A pilot study was conducted for tool testing for the expected outcome of the study. The questionnaire was modified as per the understanding of the subjects, as the respondents were students, commuters, vendors of different ages, income groups, occupations, etc. After the necessary changes, this questionnaire was circulated through an online platform. A total of 57 responses were collected and analyzed. The data obtained from the respondents was cross-validated through the expert panel. The expert panel included urban planners, architects, residents & an acoustician.

2.1. CASE STUDY:

Pune is an upcoming metropolitan city of Maharashtra. The selected street is the sample street of any Indian city. This street lies in the mixed land use area of Pune in Sahakar Nagar. The total street under the study is considered from Gajanan Maharaj Temple till Taljai Circle.

Figure 1: Area Under Study

Like any other street of Pune, this the street also shows residential, and commercial areas, temples, clinics, banks, slums, street hawkers, vegetable vendors, bus stops, etc. It shows that this street is representative of the impact of soundscape on the street. The approximate length of the street is 800mts. & width of the street is 18m.

This research was carried out through an online questionnaire survey. The respondents selected for this questionnaire were regular users of this street. These users were regular commuters, shopkeepers, and residents of these streets. A total of 57 responses were collected for this research. The questions in the online survey were designed to address a diverse group of participants in terms of gender, age, occupation to understand the relationship of acoustic comfort and soundscape dimensions, pleasantness, eventfulness & familiarity.

Out of total 57 respondents 61% were female & 39% were male respondents. 75% respondents were in the age group of 18 to 40, rest 25% were in the other age group. So the maximum user were in the age of 18-40.

ANALYSIS & DISCUSSION:

Nearly 47% of people found that horns and traffic noise is the most dominant sound on the street. This turns into irritation. It has been found that 80.0 % of people found street sounds disturbing during the evening time.

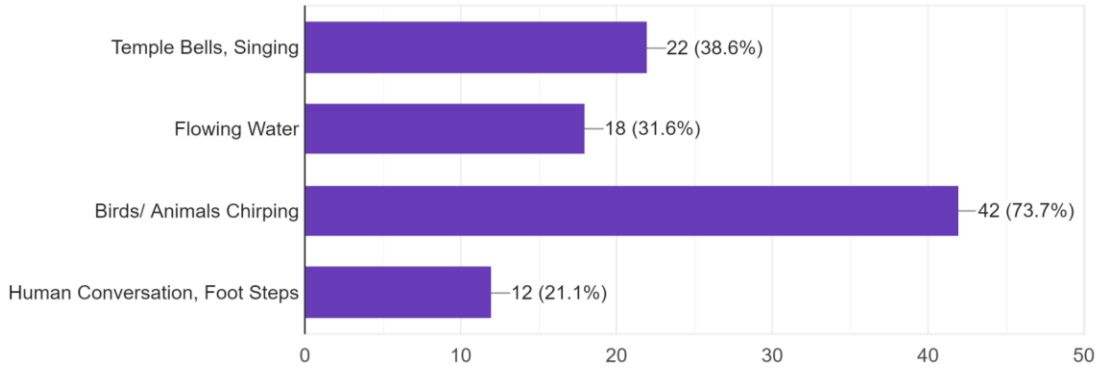

Figure 2: Graph indicating Preference of sounds by respondents.

73.7% of respondents preferred birds and animal sounds on roads, and 31.6% preferred flowing water sounds. Thus, in all 65.5% of respondents preferred natural sounds as compared to other sounds such as temple bells, human conversation, etc. It proves that people preferred biophonic sounds over anthrophonic sounds.

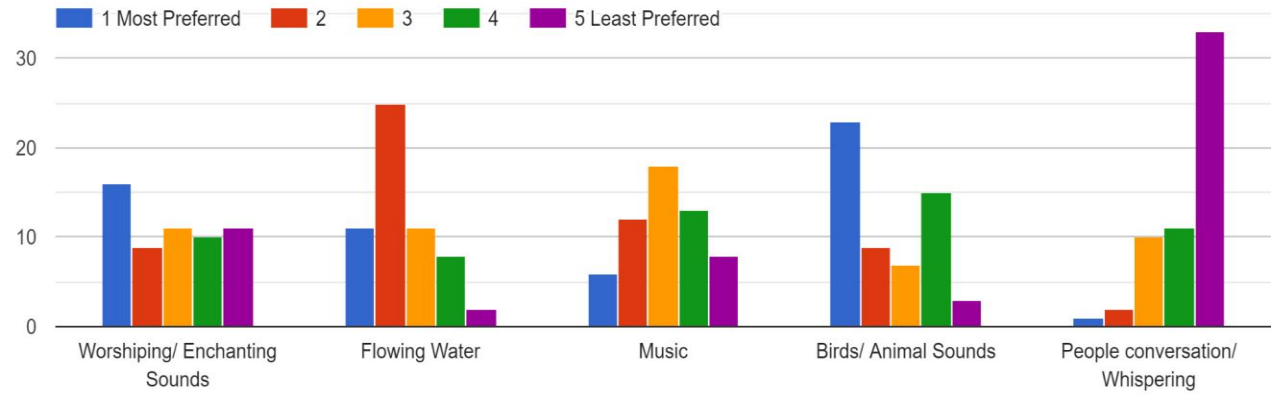

Figure 3: Out of many choices' respondents preferred biophonic sounds such as flowing water & birds, and animal sounds.

When the people were asked to rank the sounds on a scale of 1-5 most of the people preferred birds and animal sounds. Worshiping or enchanting sounds were also preferred by the users on the first preference. It was followed by flowing water.

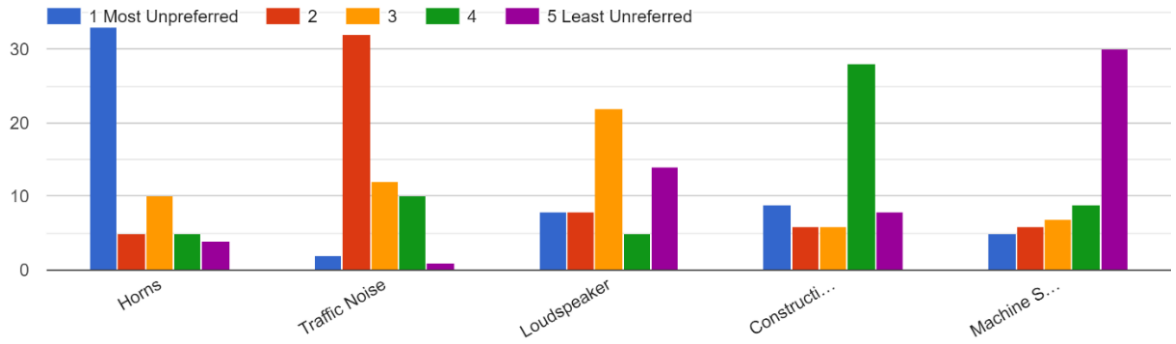

Figure 4: Horns and traffic noises are among the most unpreferred sounds on the street.

Being a very busy street horns and traffic sounds are the most dominant and least preferred sounds on this street. Presently it is observed that horns and traffic sounds are the most dominant sounds on this road.

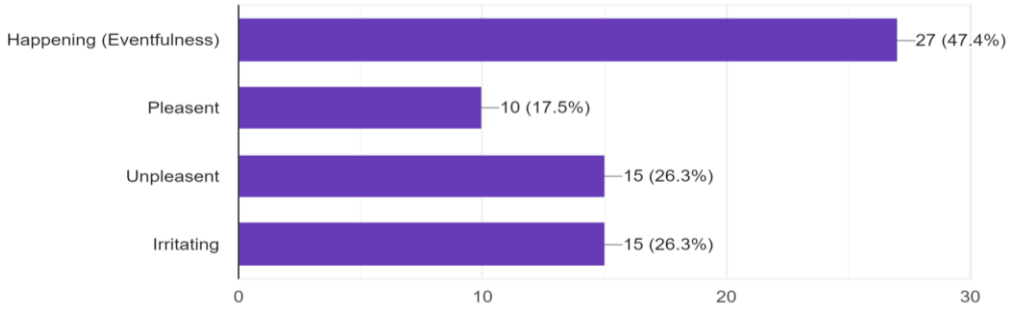

Figure 5: Respondents reacted positively to the sound created during festival seasons as being eventful.

47.4% of people reacted positively to the sound created during festival seasons as being eventful. 26.3% of the people found it to be unpleasant & irritating. Interestingly 17.5% found festival sounds to be pleasant also.

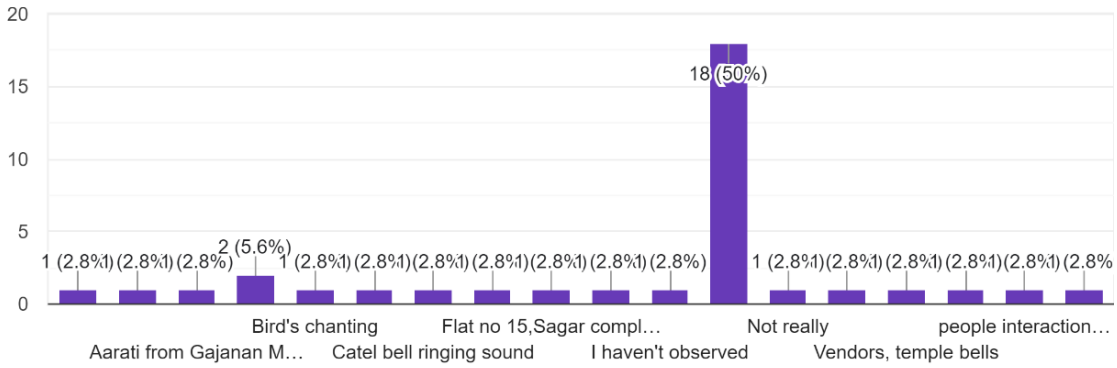

Figure 6: Graph indicating unique sounds on the street under study.

People do not find any uniqueness of sound on the street. There was no distinguishable or unique sound on the street.

CONCLUSIONS:

Streets are the key factor in the urban planning process. Traffic is the obvious salient factor describing the environment of cities. As per the smart city planning principles livable and pedestrian-friendly streets are the need of the city. The soundscape approach in the early planning stage of city planning is an essential aspect. Currently, traffic sounds and horns are the most dominant sounds on the street. But still, people prefer to hear biophonic sounds, these sounds were rated in high order while ranking. This element of sound has to be incorporated into the soundscape approach. Horns and traffic sounds are among the least preferred sounds on the road. Widening of roads, and identifying 'No Honking Zones' may help to improve the situation. Moreover, findings from this study can also be useful in the designing of the horn sounds.

People preferred the eventfulness dimension of the sound during festival seasons. A demographic parameter is the most important aspect in the study of soundscape. It is observed that people prefer social interaction on the streets during festival seasons. 27% of the respondents found sound in the festival season to be eventful. Almost 10% of the respondents found this to be pleasant. This indicates a positive response to the sound generated during the festival seasons. Since 75% of the respondents are in the age group of 18-40 years, this shows that the younger population prefers such sounds during the festival seasons. The expert panel does not support the eventfulness associated with soundscape during festival seasons.

People did not notice any unique or distinctive sound on this street which could give a place identity to the street. This is also an important feature of city planning. As per the study of Raimbault, urban soundscape can be described in two categories, namely descriptive listening and holistic listening. Descriptive listening refers to the identification of specific acoustic sources or events. Holistic listening refers to the soundscape as a whole without any particular sources. Presently the soundscape of the street lies in the holistic listening category, by which people are unable to identify any uniqueness of sound on the street. This phenomenon as referred to by Schafer, is called 'Sonological

Competence.' This ability is deteriorating in the current urban context. We do not recall consciously having heard any sounds. All the results of the survey were cross-validated by the expert panel opinion.

Efforts should be made for the shift from holistic to descriptive listening while designing soundscapes for streets.

All three dimensions of the soundscape are important to achieve the goal of human acoustic comfort. The pleasantness of sound, dominated by biophonic sounds is preferred by the users. Eventfulness which is influenced by sociocultural aspects is also an important dimension in a social country like India. Familiarity which can also be expressed as place identity is currently missing a dimension in the overall street soundscape. It should be positively and cautiously incorporated in the planning process. Soundscape gives a feeling of safety and familiarity which may contribute to the uniqueness. This may lead to place identity.

So while designing the soundscape of streets various parameters such as human comfort, safety, and distraction of drivers should also be taken into consideration.

Sound perception can be treated as one of the tools or measurements for designing pedestrian-friendly streets.

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