

Sounds in the urban square: qualitative influences on users' lives

Cristiane Calzavara Machado

Mestranda, UFJF, Brasil
cristiane.calzavara@arquitetura.ufjf.br

Klaus Chaves Alberto

Professora Doutor, UFJF, Brasil
klaus.alberto@ufjf.edu.br

Sabrina Andrade Barbosa

Professora Doutora, UERJ, Brasil
sabrina.barbosa@uerj.br

SUMMARY

Noise pollution is a worldwide public health problem that directly influences the population's quality of life. The study of the soundscape in public spaces seeks to identify the perceptions of users and how it influences the experience in a given place. Thus, the aim of this study is to characterize the soundscape of Parque Halfeld square in Juiz de Fora, indicating how visitors assess the acoustic quality of this space. From on-site sound pressure levels measurements in the square and application of a questionnaire about the sound perception based on the Swedish SSQP (Swedish Soundscape-Quality Protocol), the results address the noise levels and the relationships between the users' characteristics and the types of sounds perceived, as well as the related feelings. This study indicates that age, reason, and frequency of visits are some of the factors that most influence the perception of the soundscape and central areas of the square, a region with lower levels of sound pressure, are more pleasant in acoustic aspects. The questionnaire applied is also a contribution of this study to future research in the country. Given the pandemic scenario and the greater use of open spaces, this study can contribute to the planning of squares based on people's perception of the soundscape.

KEYWORDS: Soundscape. Noise. Urban Squares.

1 INTRODUCTION

According to the World Health Organization (WHO, 2018), noise pollution is the second most dangerous pollution in the world, only behind the air pollution, being considered a major global public health problem that directly influences the quality of life of the population. Noise pollution can cause discomfort, stress, lack of concentration, hearing loss, deafness, cardiovascular diseases, among others (BEGOU; KASSOMENOS; KELESSIS, 2020; OH; SHIN; KIM; SHIN, 2019). As a result, there is a growing number of studies that have related noise and soundscape of public spaces to quality of life and well-being in different locations, such as in China (TAO; KOU; CHAI; KWAN, 2020), Spain (DÍAZ; LÓPEZ-BUENO; LÓPEZ-OSSORIO; GÓNZÁLEZ *et al.*, 2020), Sweden (ANDERSSON; ÖGREN; MOLNÁR; SEGERSSON *et al.*, 2020) and Portugal (ALVES; SILVA; REMOALDO, 2015). Public spaces are places used for physical activity, rest, reading, walks, relaxation, cultural events, and contemplation, being a space that promotes the user's well-being (KOOHSARI; MAVOA; VILLANUEVA; SUGIYAMA *et al.*, 2015; LYNCH, 2007). Thus, it is important to identify how the sounds influence the cognitive and emotional response and personal behaviour and social interactions in the environment in which we live (PERIS; FENECH, 2020). Thus, the study of acoustic comfort becomes an important aspect for planning public space in cities.

Not only excessive noise levels compromise the quality of life, but also qualitative aspects of sounds have been considered in research dealing with urban noise. The term 'soundscape' described by Murray Schafer (SCHAFFER, 2001) deals with the study of sound considering individuals integrated into the environment or as part of it (KOGAN; TURRA; ARENAS; HINALAF, 2017). Each environment has its own soundscape. Thus, local sound quality contributes to the quality of the space and the user experience. Although the soundscape is treated as a complex study with qualitative treatment, it is important as it helps in the quality of the environment, social well-being, and urban planning (REHAN, 2016).

Some studies on the subject jointly assess soundscape and noise, as the case of research carried out in Hong Kong investigating 25 public spaces of various types and sizes (LIN; LAM, 2010). The results showed that sources and sound pressure levels vary with time and place and although road traffic sounds predominate, visitors typically prefer bird and water sounds.

The authors also confirmed that the sound pressure level was negatively related to the subjective assessment of the acoustic quality of the analysed spaces. Furthermore, the authors indicated that the presence or absence of desired sounds is a significant determinant of visitors' subjective assessment of acoustic quality. On the other hand, in a study that focused on the impact of the soundscape on the perception of tranquillity FILIPAN; BOES; DE COENSEL; LAVANDIER (2017) assessed the participants' perception considering three groups: people who associate tranquillity with silence, with natural hearing sounds or social relationships. The results showed that tranquillity was more related to natural sounds or silence.

In related research, public spaces with large areas are often investigated as in the study carried out in the parks Arenes de Lutece, Champ de Mars and Jardin des Tuileries in Paris, France (JO; JEON, 2020), West Lake Park in Fuzhou, China and in Seoul Forest Park, Olympic Park and Sunyudo Park in Seoul, South Korea (JEON; HONG, 2015). However, there are surveys carried out in squares, as in the case of Mariatorget Square in Stockholm, Sweden (AXELSSON; NILSSON; HELLSTRÖM; LUNDÉN, 2014), Piazza del Marchese Paolo in Città di Castello in Italy (ASDRUBALI; D'ALESSANDRO; SBERNA; BALDINELLI, 2012) and the Peace Garden and Barkers Pool squares in Sheffield, England (YANG; KANG, 2005). In Brazil, there are still few studies that consider noise levels with the perception of the soundscape in urban squares. The work of Soares and Coelho (SOARES; COELHO, 2016) stands out, comparing two botanical gardens (Jardim Botânico Rodrigues Alves and the Zoobotanical Garden of the Emilio Goeldi Museum) and a square (Praça Batista Campos) in Belém-PA, with parks in Portugal. The authors showed that the park's soundscape depends on different characteristics such as geography, climate, urban architecture, park infrastructure, sound sources and, mainly, on the expectations of visitors for the planned activities.

On the other hand, soundscape studies have as constraints the lack of standardization on the collection of user perception data, which makes comparative analysis in different geographic contexts difficult. However, protocols have been considered to avoid these mismatches. Among them, the SSQP (Swedish Soundscape-Quality Protocol) stands out, which was used in several studies carried out in different places such as Montreal, in Canada (TARLAO; STEFFENS; GUASTAVINO, 2021), Córdoba and Rosário, in Argentina, Lund, in Sweden and Valdivia, in Chile (HINALAF; PÉREZ; ARENAS; KOGAN, 2016). One of the first studies with the application of the protocol was in the city of Estolcomo, Sweden (AXELSSON; NILSSON, 2010).

Thus, further studies are still needed to investigate the soundscape of smaller public spaces such as urban squares. In Brazil, these spaces have a strong presence in cities and due to their small size, compared to parks, are well distributed in the urban environment, being spaces with greater impact on people's daily lives. The aim of this study is to characterize both the sound pressure levels and the soundscape of Parque Halfeld square in Juiz de Fora, indicating how visitors assess the acoustic quality of this space. This was the first urban square of the city. It is located in the central region and stands out as one of the most vital in the city.

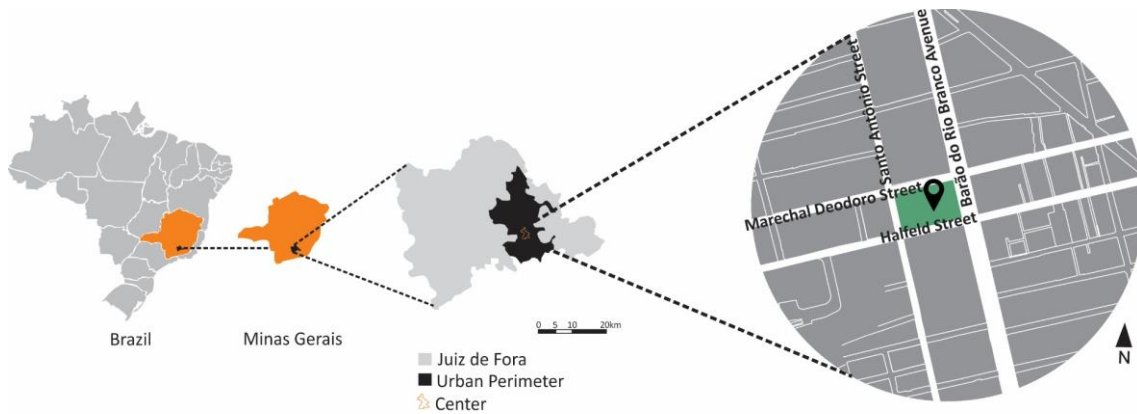
2 METHODOLOGY

The methodological approach is divided into four main stages: (i) Characterization of the urban square analysed, (ii) Noise level measurements, (iii) Application of the adapted SSQP protocol and (iv) Data analysis.

2.1 Characterization of the urban square

The Halfeld Parque was chosen based on its vitality, location and historical value for Juiz de Fora, a city in the Zona da Mata of Minas Gerais, with approximately 570,000 inhabitants. This square is located in the central area between four important streets: Halfeld Street, Marechal Deodoro Street, Santo Antônio Street and Barão do Rio Branco Avenue, as shown in Figure 1.

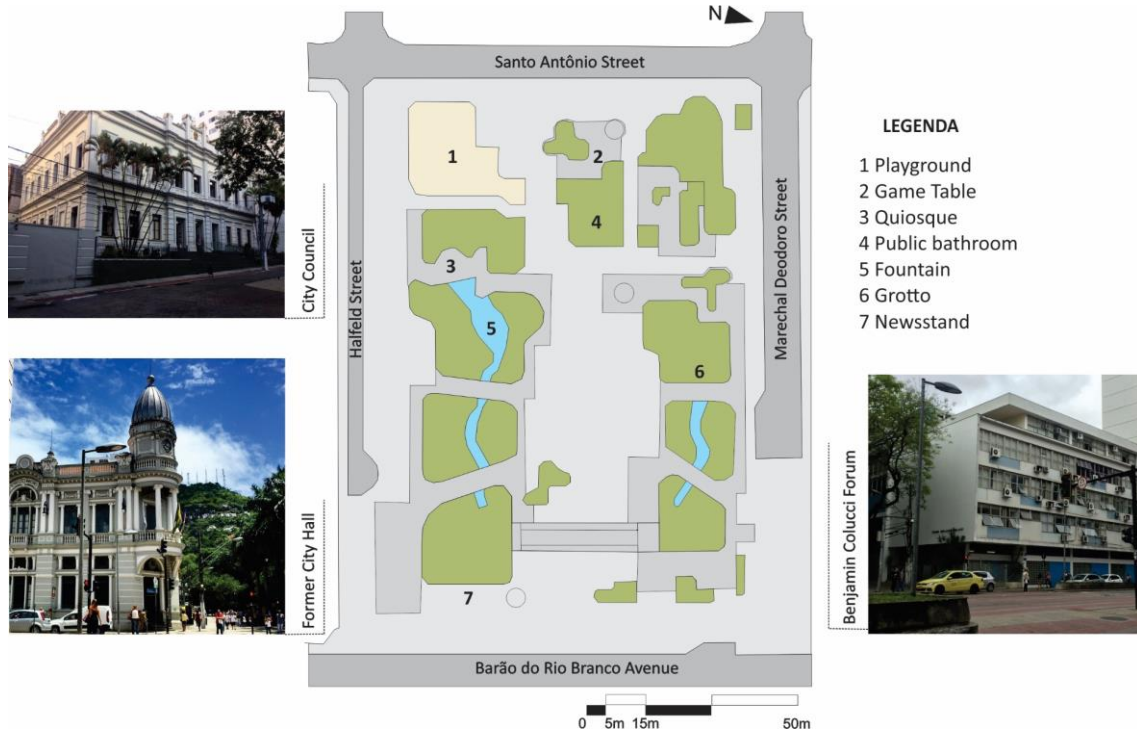
Figure 1: Schematic map of the square's location



Source: AUTHORS, 2021.

The square, which underwent a process of revitalization in 1979 from the Rosa Kliass project, has a total area of 10,533.14 m². Its immediate surrounding has mixed use and important buildings for the city, such as the City Council, the former City Hall, and the Benjamin Colucci Forum, as can be seen in the schematic plan in Figure 2. The square has an expressive vitality with a constant presence of users in meetings, manifestations, events, fairs, among other relevant activities in the central area of the city. Figure 3 shows internal views of the square collected on the days of visits.

Figure 2: Schematic floor plan



Source: AUTHORS, 2021.

Figure 3: Internal views of the square



Source: AUTHORS, 2021.

2.2 Data collection

The definition for the days and times of on-site data collection were based on a study previously carried out in the square (BERALDO; SENRA; CASSANI; ALBERTO *et al.*, 2019). The research deals with the evaluation of the vitality of public spaces and it was observed that the Parque Halfeld square, as it is in the central area, is more used during the weekdays. Thus, the days of data collection were Friday (March 12th, 2021), Wednesday (March 24th, 2021) and Friday (March 26th, 2021). Sampling times were between 10 am and 5 pm, under favourable weather

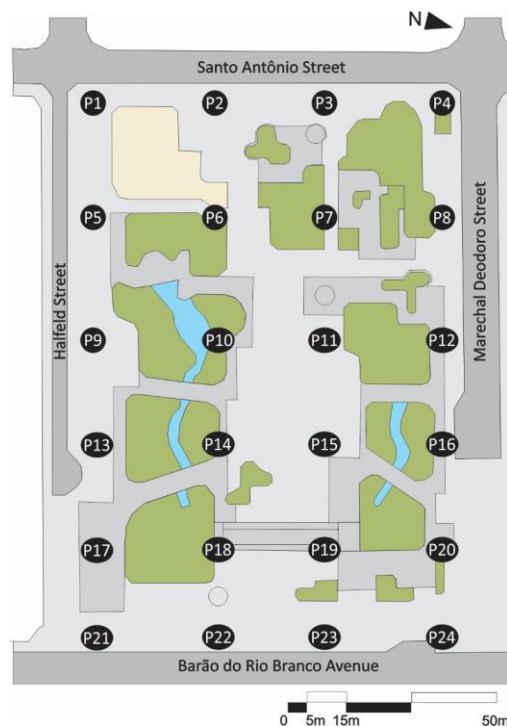
conditions, with sunny days and no wind. Data collection complied safety protocols of the World Health Organization and Ministry of Health.

2.2.1 Noise Level Measurements

For the measurements of the sound pressure levels, the recommendations of NBR 10.151 (ABNT, 2019) were followed. A sound meter from Instrutherm model DEC – 460 was used. The measurements were taken simultaneously with the application of the questionnaires in 24 points of the square, as can be seen in Figure 4. The 24 points were distributed in order to contemplate all areas of the square through a 30m x 30m mesh. The measurements took place on March 12th, 2021, between 10 am and 11 am and March 24th, 2021, between 3 pm and 4 pm. In each measurement, the sound meter was positioned 1.5 m above the ground in slow mode, A-weighted, and the results were manually recorded on a previously printed map of the square. The measurement time at each point was approximately two minutes, three measurements were taken within this time and the average value was calculated.

The measured values were compared to the limits of the standard NBR 10.151/2019 'Acoustics - Measurement and evaluation of sound pressure levels in inhabited areas - General purpose application', which determines the maximum sound pressure level limit of 55 (dB) for daytime in a predominantly residential mixed area. Following the 1999 guidelines update, WHO (2018) recommends that sound levels of 45 to 55 (dB) should be the limits for outdoor areas.

Figure 4: Noise levels measurements spots



Source: AUTHORS, 2021.

2.2.2 Questionnaire application to assess users' perceptions

The SSQP (Swedish Soundscape-Quality Protocol) assesses and classifies acoustic environments according to the perception of its users and has been used in other studies in the area. However, it has been considered inadequate for not addressing the soundscape in a broad way (AXELSSON, 2015). Therefore, in this study, the protocol was adapted with new questions for a better understanding of the space. The added questions sought to examine the preferences of perceived sounds and the feelings aroused in relation to them. Participants were randomly verbally approached by researchers. The application of the questionnaire was approved by the Ethics Committee for Research with Human Beings of the Federal University of Juiz de Fora, number 4,570,421. The questionnaire consisted of the following questions:

- **How often do you visit this square weekly?**
- **Gender**
- **Age**
- **How is your hearing health?**
- What is your average length of stay here in the square?
- **What is the reason(s) for your visits to this square?**
- *Do you like or not to hear urban noises?
- *What can you hear right now?
- Name three sounds you can identify
- *There are any specific sounds here in the square that make you feel more or less comfortable?
- **On a scale of 1 to 5, being 1 a little bother and 5 bothering a lot, how much does the volume of sounds in this square bother you?**
- Which place do you consider the most pleasant in this square in relation to the sound?
- Which place do you consider the least pleasant of this square in relation to the sound?
 - **Which of these feelings describes the soundscape for you in this square? Chaotic, Exciting, Eventful, Calm, Annoying, Uneventful, Monotonous and Other.**

In bold are the questions based on the SSQP (Swedish Soundscape-Quality Protocol). The remaining questions were elaborated from the most common questions in soundscape studies. The questions marked with an asterisk were adapted from the questionnaire provided from the study that was carried out soundwalks in the cities of Manchester and London in England (BRUCE; DAVIES, 2014).

2.3 Data analysis

From the data collection, the results were registered in tables in the Excel 2020 Software. From the data, graphs and diagrams were developed in order to indicate the sound pressure levels in the square areas, characterize the study sample, indicate the relationships between the characteristics of users and their sound perceptions and identify the relationships between the soundscape and the physical aspects of the square.

3 RESULTS AND DISCUSSIONS

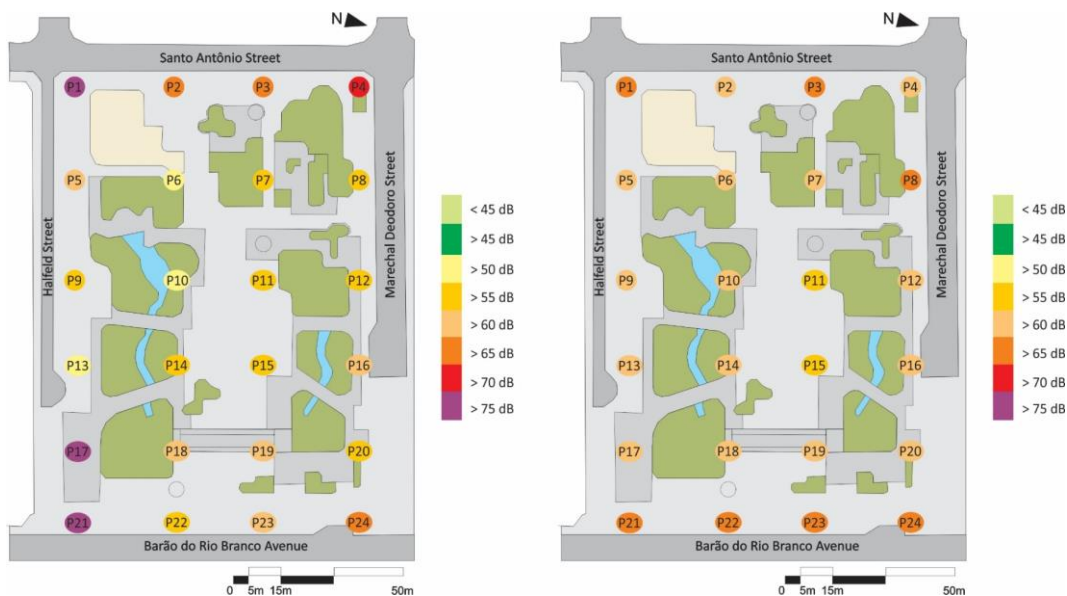
In this section, the results of the collected noise levels and the applied questionnaires will be presented, discussed, and related.

3.1 Noise measurements

In the measurements carried out on the morning March 12th it is observed that the spots at the ends of the square had the highest levels of sound pressure, as shown in Figure 5. The highest noise was recorded at a point located on Barão do Rio Branco Ave. (P21 = 77.9 dB(A)) and the minimum noise was noted at P10 (52.1 dB(A)), located in the central part of the square. Points P6 = 54 dB(A), P7 = 55 dB(A), P10 = 52.1 dB(A), P11 = 55 dB(A) and P13 = 54.1 dB(A) are the points within the limit established by the World Health Organization of up to 55 dB(A). All of them are located in the central part of the square.

From the measurements taken in the afternoon of March 24th, the maximum noise level was recorded at the same spot of the previous measurement, at P21 (68.93 dB(A)), which is located at the intersection of Barão Rio Branco Ave. and Halfeld Street. On the other hand, the minimum noise was registered at P11 = 58.7 dB(A) in the central part of the square. On that day, all points were above the limit established by the WHO. In Figure 6, it can be seen that on March 12th, when the measurements were taken in the morning, the square has an average of 59.9 dB(A), lower than that recorded on March 24th, which had an average of 63.5 dB(A). However, on both days, the average sound pressure level of the square is above to that established by the WHO, which is similar to other studies that also investigated the sound levels of squares (FARGHALY; HEMEIDA; MAMDOUH; ATEF, 2017; LIN; LAM, 2010; SOARES; COELHO; COSTA; COELHO, 2012).

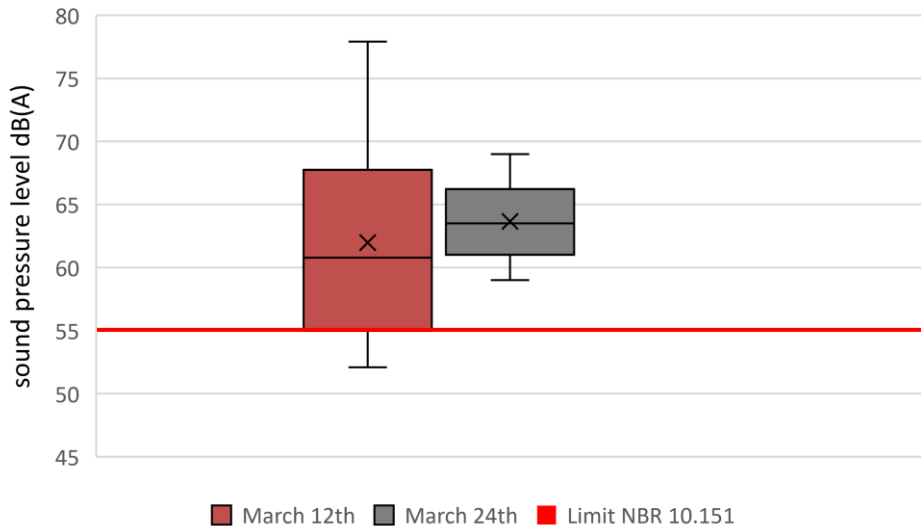
Figure 5: Measurements take on March 12th and March 24th



Source: AUTHORS, 2021.

It is also noteworthy that there were differences in the intensity of sound pressure at the points measured between the two days. On the March 24th there was a smaller variation in the noise compared to the March 12th, as can be seen in Figure 6, which shows the data distribution, where the "x" represents an average. It is also noticed that lower noise values were measured in the central area of the square in the morning, which may be due to a greater presence of people in the square in the afternoon.

Figure 6: Noise levels distributions on the measurements' days

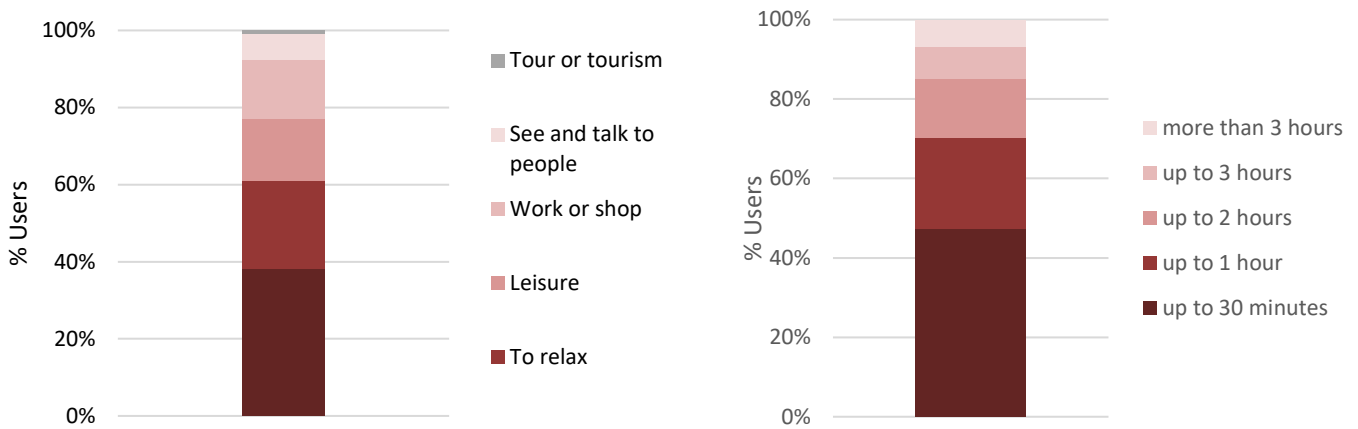


Source: AUTHORS, 2021.

3.2 Sample characteristics

From the square users, 74 were interviewed, 50% (n=37) male and 50% (n=37) female. Regarding age, 38% (n=28) are between 18 and 29 years old (young people), 38% (n=28) between 30 and 59 years old (adults) and 24% (n=18) over 60 years old (seniors). Regarding the frequency of visits to the square, 28% of respondents reported attending at least 5 days a week. This may be related to the reasons for the visits, as spending time was the reason cited by 40 people. As it is a central square in the city, users reported visiting it to wait for a friend or some appointment. In addition, nine people work in the square and, therefore, attend it regularly. It is interesting to note that although the square is central and has high noise levels, many of the responses indicated that the visits are also related to the search for leisure and relaxation during lunch hours, as they work close to the square, as can be seen in Figure 7.

Figure 7: Reason for visiting / Length of stay



Source: AUTHORS, 2021.

In average people stay in the square for up to 30 minutes, as shown in Figure 7. The five users who responded that they stay in the square for more than 3 hours are those who work at the place.

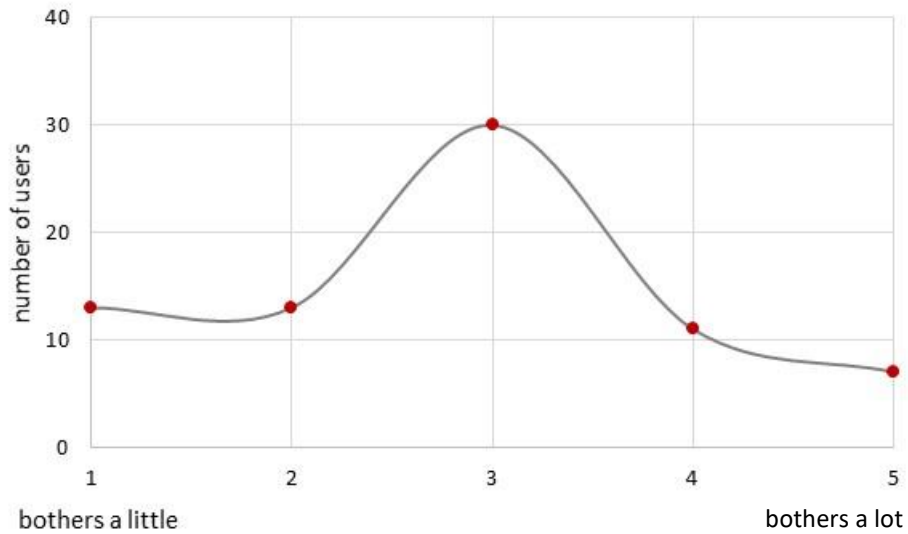
3.3 Soundscape perception

When asked about how much the volume of the sound bothers them, 30 users indicated the mean value of 3, according to the Likert scale, which varies between 1 “bothers a little” and 5 “bothers a lot”, as observed in

Figure 8. Users reported being used to the background sound of the square, only being bothered by some impact sound such as horns, sirens, construction works, among others.

Twenty-six users indicated that the noise in the square did not bother them (those scored 1 and 2 on the scale) and 54% (n=14) of these were women and 46% (n=12) were men. Only one of the respondents has mild hearing loss, a 75-year-old woman. Of the interviewees, 18 users indicated that they were very uncomfortable with the noise in the square (they scored 4 and 5 on the scale) with 61% (n=11) being men, and 39% (n=7) women. Regarding age, young people account for 34% (n=6) of respondents, 50% (n=9) adults and 16% (n=3) elderly respondents. Thus, it is noticed that younger users and adults are more bothered by the sound than older users.

Figure 8: How much the sound bothers



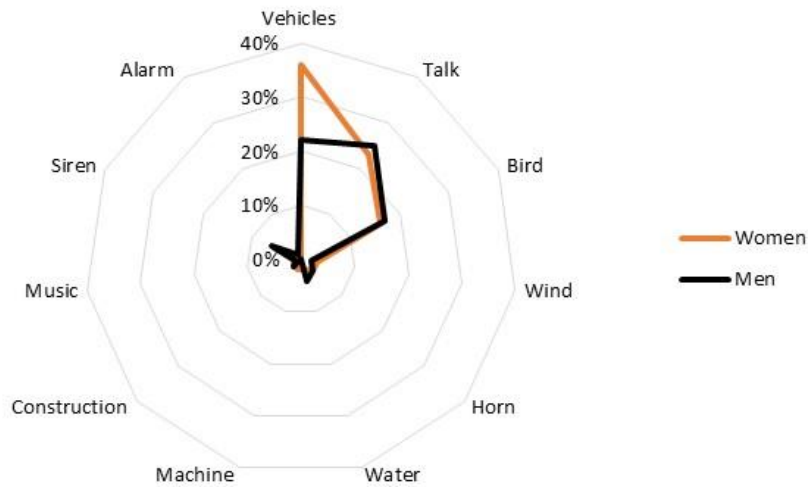
Source: AUTHORS, 2021.

Data on the frequency of use of the square were analysed in order to verify whether this factor influences the perception of sound. As a result, it was found that users who do not frequent the square are more aware of natural sounds such as birds, water, and wind. Those who attend between 6 and 7 days a week are more conscious of the sounds of vehicles and conversations. This may also be related to the expectations of visitors for the planned activities, as observed by Soares and Coelho (SOARES; COELHO, 2016). It is noticed that at Halfeld Parque those who frequently use the space on a daily basis, whether for work or during their lunch break from work, do not pay attention to natural sounds, unlike those who go to relax or spend a moment of leisure.

Regarding the different types of sounds perceived by visitors, there was a parity regarding natural sounds perceived by both genders. However, it is highlighted that women perceive more vehicle sounds, while siren sounds were slightly more identified by men, as can be seen in

Figure **9**. Sounds such as alarm, music, construction, siren, and machine were cited only once, being noticed by few people at the time of the interview.

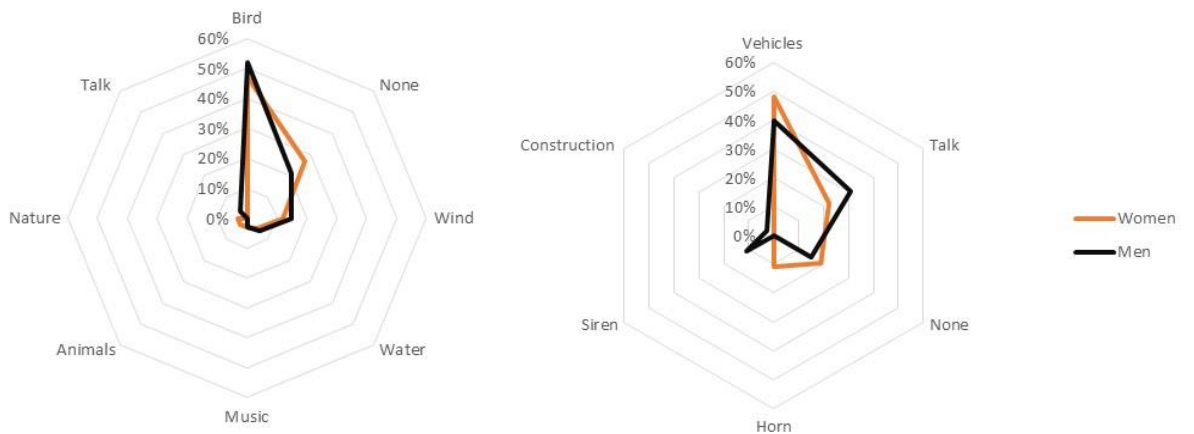
Figure 9: Most perceived sounds



Source: AUTHORS, 2021.

Figure 10 shows the sounds considered more or less comfortable between men and women. It is observed that the sounds of birds are considered the most comfortable for both genders. On the other hand, while vehicle noise is more noticeable and less comfortable for both women and men, conversation sounds are the second most noticeable and least comfortable for both genders.

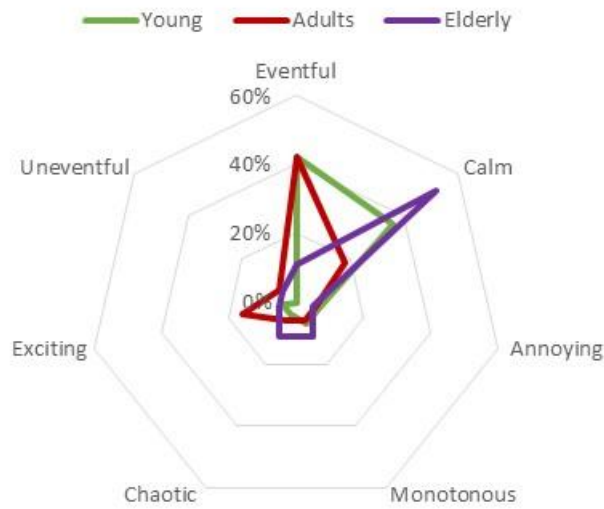
Figure 10: Most comfortable sounds / Least comfortable sounds



Source: AUTHORS, 2021.

Feelings in relation to the square's soundscape were also analysed. For young people, the feelings that most characterize the square are divided between "agitated" and "calm" and for adults, "agitated". On the other hand, for the elderly, the prevailing feeling is calm as can be seen in Figure 11.

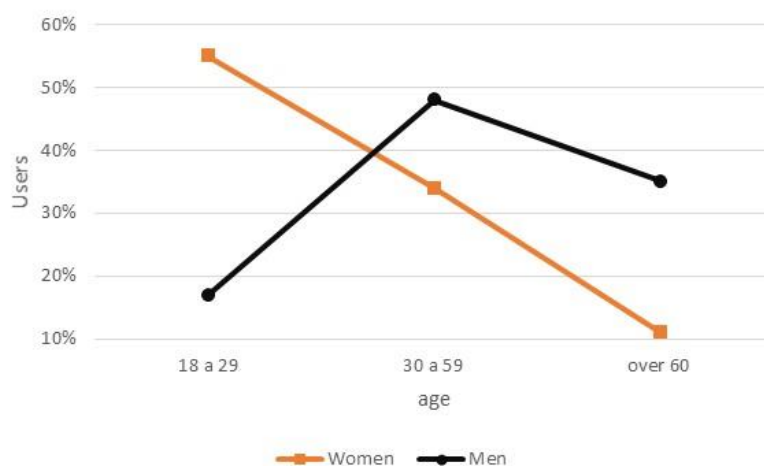
Figure 11: Soundscape feelings



Source: AUTHORS, 2021.

In relation to the question about liking or not listening to urban sounds, there was no relevant difference in the answers, as 51% (n=38) of respondents reported that they do not like it and 49% (n=36) like to hear the noises. It is also noticed that comfort in relation to urban sounds drops in relation to age among women, although a relationship was not observed among men, as observed in Figure 12.

Figure 12: Like to hear urban noises

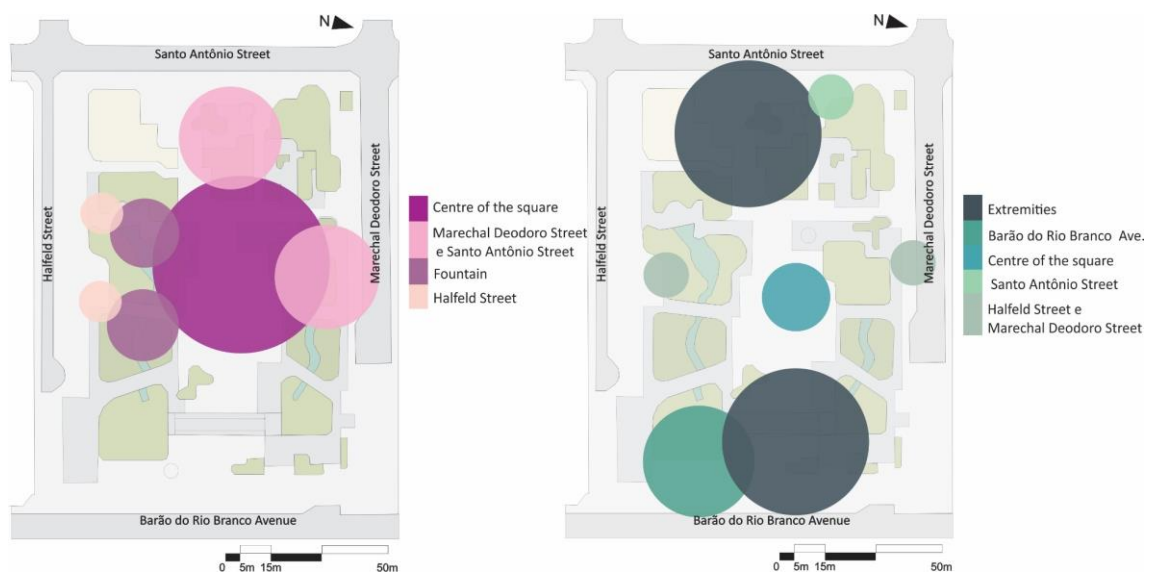


Source: AUTHORS, 2021.

3.4 Relationship between the soundscape and the physical aspects of the square

It is observed that users who spend more time in the square choose places closer to its centre to stay. The centre of the square and the edge of Marechal Deodoro st. are considered the most pleasant places by the interviewees in terms of sound, as they are calmer places and possible to contemplate the natural sounds of birds, water, and wind. On the other hand, as less pleasant places, people identified the extremities of the square (between Barão do Rio Branco Ave. and Santo Antônio St.). The Barão do Rio Branco Ave. also stand out due to the number of vehicles and mechanical sounds such as horns and sirens, which generate stress and irritability, as can be seen in Figure 13. In this, the dimension of the circles is related to the number of responses for each location in the square.

Figure 13: Most pleasant places / Least pleasant places



Source: AUTHORS, 2021.

4 CONCLUSION

The present study characterized the soundscape of Parque Halfeld square in Juiz de Fora from on-site measurements of sound pressure levels and the application of questionnaires on the perception of the soundscape based on the Swedish SSQP (Swedish Soundscape-Quality Protocol). It was observed that the levels of sounds pressures in the square vary with time and location. On average, the measured sound pressure levels are above the limits established by NBR 10151:2019 and the World Health Organization. It is noticed that one of the factors that influences the perception of the soundscape is the frequency of visits by users. Users who attend few times a week tend to notice natural sounds. On the other hand, those who attend every day notice more the sounds that bother them, such as the sound of vehicles. Another highlight in this study is that noise annoyance may be related to the age of visitors.

It is also noteworthy that the adaptation of the Protocol SSQP and the inclusion of additional questions were important to deepen the understanding of the influence of the soundscape in people's expectations in the local context and could serve as a reference for

further research in the field. However, one of the limitations of the research is due to the limited number of visits carried out in the square. In addition, it is also indicated new studies that contemplate a greater number of squares in the city, considering neighbourhoods with different types of use and squares with different areas of activities.

In the face of the pandemic scenario caused by COVID-19, squares are gaining more and more importance, as the population has replaced closed spaces for outdoor areas. Thus, the planning of such spaces can influence people's perception of the soundscape, impacting the well-being and quality of life of its visitors.

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