Investigation and Optimization Research of Soundscape in Linyi University Campus, Shandong, China

Qianda Zhuang [1,2,] *, Zekun Shang [1]
*Corresponding author: gs56070@student.upm.edu.my

[1]Department of Landscape Architecture, Faculty of Design and Architecture, Universiti Putra Malaysia, UPM, Serdang, Selangor, 43400, Malaysia

[2]Department of Landscape Architecture, Faculty of Agriculture and Forestry, Linyi University, Linyi, Shandong, 276000, China

Abstract: As an important part of the landscape, campus soundscape has an important impact on campus life for teachers and students. Taking the campus of Linyi University as an example, this paper explored the current situation and constituent elements of the campus soundscape through the soundwalk approach and instrument measurement. The results show that the sound levels of the teaching area, teaching auxiliary facilities area and green area of Linyi University basically meet the national standards, while the dormitories, restaurants, sports fields and other areas exceed the standard due to a large number of students and relatively concentrated influence, and the main gate always exceeds the standard due to the influence of traffic flow and external traffic. There are abundant elements of soundscape on the campus of Linyi University, which can be divided into four categories: natural sound, artificial sound, traffic sound and mechanical sound. The frequency of talking, footstep, motorbike and bird song was the highest on weekdays and rest days. Due to a number of electric bicycles that exist, the sound of electric bicycles has a bad impact on the overall landscape image of the campus. Finally, some suggestions are put forward in terms of increasing public transportation on campus, isolating sound sources outside campus, reducing noise in the dormitory area and protecting and mining natural sound elements.

Keywords: Soundscape; Campus; Linyi University

1 Introduction

The concept of the soundscape was first proposed by the Canadian composer R. Murray Schafer in the 1960s [1]. It refers to sounds that are worth appreciating and remembering in nature and urban and rural spaces. A field of research that intersects landscape disciplines. The research of soundscape in China began in the 1990s. The research field has gradually expanded from soundscape to architecture, urban planning, landscape architecture and other disciplines. The research objects have become more extensive, including urban parks, tourist attractions, historical districts, classical gardens, traditional villages, school campuses, and other spaces [2-8]. Among them, the campus space provides teachers and students with a healthy, suitable teaching and living environment, which has certain requirements for the visual landscape and puts forward higher requirements for the soundscape on the campus.

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The campus soundscape is the interaction between teachers and students and the campus's natural environment, and it is an important part of the campus landscape. At present, research on soundscape has been carried out in many fields. The intensity, type of sound and its relationship with environmental factors are the focus of researchers' attention [9]. Different soundscape elements have different emotions and attention effects on teachers and students [8], and also have certain green plant guidance and improve natural healing power. The high-quality shaping of the campus soundscape is conducive to improving the coordination of the campus and strengthening the perception of the visual landscape of teachers and students. It will also play an important guiding role in campus planning and design. The core of campus soundscape evaluation should be the coordination of sound preference and site characteristics, and the campus soundscape planning and design through the evaluation results.

Linyi University is located in Linyi City, Shandong Province, China. The campus accommodates more than 40,000 teachers and students. In the current situation of the covid-19 epidemic, the campus is relatively closed, therefore, the campus landscape including soundscape is more urgent for students and teachers in terms of pressure relief. This paper takes Linyi University as the research area and investigates the campus soundscape through the soundwalk approach and instrument measurement, thus sorting out the campus soundscape situation and its components, exploring the existing problems of the campus soundscape, and finally putting forward strategies for soundscape optimization.

2 Research methodology

2.1 Research area

Linyi University is located in Lanshan District, Linyi City, Shandong Province. The campus of Linyi University covers an area of 400 hectares. There are about 40,000 teachers and students on campus. The green area is 1.016 million square meters. The green area rate is 61.19%, and the green coverage rate is 67.93%. It was planned by EDSA company, USA as an ecological campus with rich natural resources and a strong academic atmosphere. The campus has complete functional areas, high vegetation coverage, diverse campus landscape elements, and rich soundscape resources.

2.2 Research method

The soundwalk approach was designed by Schafer in the 1960s on the soundscape research, using people as a research tool, through participants' elaborate perception of environmental sounds, to identify the soundscape and its constituent elements[6,10]. Now it has become one of the most popular methods in the field of soundscape[4,6,10-11]. The participants were selected with 4 college students with strong aural sensitivity, including 2 girls and 2 boys, aged 19-23 years old.

The soundwalk approach was carried out on weekdays and weekends, November 2021 when the weather was clear and breezy. The measurement time is from 9:00 to 10:00 in the morning, from 2:00 to 4:00 in the afternoon, and from 8:00 to 10:00 in the evening. To fully understand the loudness of campus sound, the research also uses instruments to measure the sound level of each sampling point. The measuring experimental sound level meter is Hongcheng Technology

HT-8351, and the instrument has passed the calibration before using. According to the "Environment Quality Standard for noise" (GB3096-2008) in China, the distance from the ground is more than 1.2 meters, the distance from the body is more than 0.5 meters, and the surrounding reflectors are more than 3.5 meters. The 4 participants walked quietly on the predetermined route at an average speed and stopped at the predetermined location. One student reads the instrument data from different directions, and one student records the 30s equivalent continuous A sound level (Leq) measurement under the A weighting network at 16 sampling points on campus, the measurement was performed every 30 seconds. To reduce the experimental error, a total of 10 measurements and average values were taken at each location. At the same time, other people listened to and recorded the sound source, and kept quiet during the experiment. The sampling location for measurement is located in the gate of the campus, teaching area, experimental area, sports area, dormitory area, library and other student gathering areas and tourist spots, all of which are highly used spaces (Figure 1, Table 1). Through the soundwalk, the following data can be obtained.

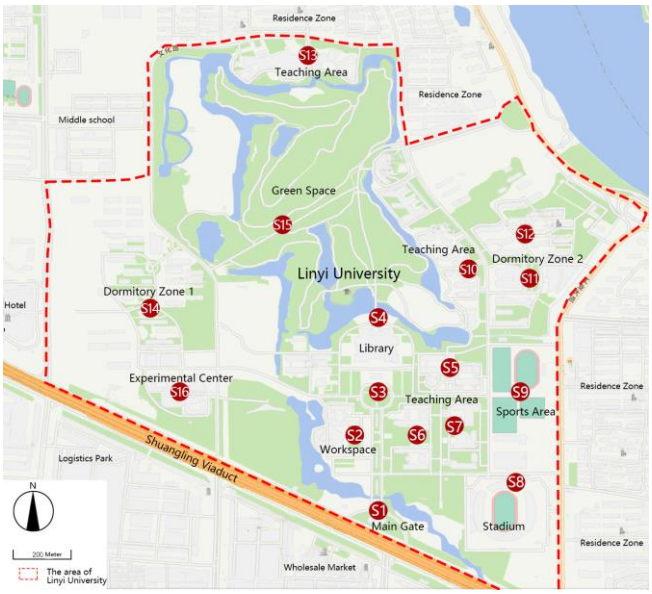


Figure 1 Location distribution of sampling points

Table 1 Location description of sampling points

Number	Location	Classification	
S1	South gate	Gate	
S2	Workspace	Workspace	
S3	Square in front of the library	Teaching Facilities Area	Auxiliary
S4	Library Square	Teaching Facilities Area	Auxiliary
S5	Ruisi Building	Teaching Area	
S6	Wenxin Lake	Greenspace	
S7	Mingyi Building	Teaching Area	
S8	Stadium	Sports Area	

S9	Basketball court	Sports Area	
S10	Zhiyuan Building	Teaching Area	
S11	Second restaurant	Restaurant	
S12	Dormitory Zone 2	Dormitory	
S13	Art Center	Teaching Area	
S14	Dormitory Zone 1	Dormitory	
S15	Central green space	Greenspace	
S16	Laboratory building	Teaching Facilities Area	Auxiliary

1)Perceived loudness of individual sound (PLS)refers to the loudness of each type of sound heard by the subjects during the Soundwalks.

2)Perceived occurrences of individual sound (POS) refers to the number of times each type of sound appears during the Soundwalks. According to the sound samples collected during the soundwalks, statistics are made at 30s intervals, and the number of occurrences of each sound is recorded and classified.

Table 2 Measured average value of sampling points Leq (Unit dB)

Investigation time		S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S13	S14	S15	S16
weekdays	morning	62.41	49.42	64.10	48.64	47.53	47.59	47.40	54.33	56.69	51.63	52.63	58.80	46.44	50.67	46.80	53.01
	afternoon	67.70	58.89	52.51	54.46	57.89	60.56	61.50	60.53	58.81	48.94	59.59	58.82	42.25	63.43	65.08	52.80
	night	55.84	51.69	51.84	46.87	61.23	49.39	48.78	56.94	60.37	53.27	57.71	58.14	46.54	51.76	50.18	53.93
weekends	morning	60.92	48.73	65.61	53.89	49.77	49.39	49.31	61.11	59.24	52.02	52.27	53.22	41.29	53.83	50.80	56.08
	afternoon	59.28	47.38	51.91	49.39	45.80	46.94	43.87	63.98	552.33	51.75	53.86	58.03	43.80	47.37	49.54	50.85
	night	65.76	50.20	56.16	47.78	47.97	48.67	46.04	51.72	54.45	46.47	53.28	58.47	42.01	47.73	51.89	53.63

3 Results and Discussion

3.1 Perceived loudness of individual sound analysis

1) Sound level measurement data at sampling points

As shown in Table 2, the average of the 30s equivalent continuous A sound level (Leq) under the A weighting network in the morning, afternoon and evening of working days and rest days of the 16 representative samples on the campus is obtained through measurement. According to the requirements of "Soundscape Quality Standard (GB3096–2008)", the campus should meet the requirements of Class 1 Soundscape functional area, that is, the maximum limit of the average sound level of continuous A sound weight in the daytime should be 55 dB. It can be found from Table 2 that out of all 16 sampling points, only 3 have equivalent continuous A sound level that meets the national standard, namely S4, S10 and S13, accounting for 18.8% of all sampling points; Among the 6 measurement periods, only 7 exceeded the national standard once, namely, S2, S5, S6, S7, S14, S15, S16. The rest have exceeded the national standard requirements many times. Among them, S1 exceeded the standard in all periods, reaching 67.70dB at the highest.

It can be seen that the sound levels of teaching areas, teaching auxiliary facilities and green

areas basically meet the national standards, while areas such as dormitories, restaurants, and sports fields exceed the standards due to the large and relatively concentrated number of students. The sound level in the main gate continued to exceed the national standard due to the impact of traffic flow and external traffic.

2) Analysis of the Elements of Soundscape

As shown in Tables 3 and 4, the elements of the soundscape on the campus of Linyi University are relatively rich. Generally speaking, it can be divided into four categories: natural sound, human sound, traffic sound and mechanical sound.

Natural sounds include wind, water, animal sounds, etc. Among them, animal sounds include birds, insects, and frog calls. Human sounds include conversations, footsteps, reading, etc, and sports areas such as basketballs and other sports sounds. The traffic sound is dominated by the sound of electric bicycles, as well as bicycles and cars. Mechanical sounds are relatively diverse. In addition to electric bicycle alarms, there are also sounds of mowing, screen broadcasts, and campus broadcasts.

Table 3 Elements of soundscape during weekdays

Number	Natural sound	Artificial sound	Traffic sound	Mechanic sound
S1	Fountain, Wind, Birdsong	Footstep, Conversation	The sound of distant traffic, Electric bicycle, Car	No
S2	Wind, Fountain, Birdsong	Footstep, Rehearse, Conversation	Electric bicycle, Off-campus Car, Small truck	Mowing
S3	Fountain, Wind	Conversation	Car horn, Sprinkler, Electric bicycle, Car	Lawn sprinkler irrigation, Cleaning car
S4	Wind, Insect, Birdsong	Conversation, Footstep, Singing, Reading	The sound of distant traffic, Car, Sprinkler	Pedestrian cell phone
S5	Birdsong	Trumpet, Cheering, Frolic, Footstep, Conversation	Car, Electric bicycle	Electric bicycle alert
S6	Wind, Birdsong, Insect, Bird fan wings	Reading	The sound of distant traffic	Electric bicycle alert
S7	Birdsong, Fallen leaves, Wind	Conversation, Playing basketball	Tricycle reversing sound, Electric bicycle	Electric bicycle alert, Music
S8	Wind, Birdsong	Playing basketball, Run, Cheering, Conversation, Footstep	Bike, Electric bicycle, Car, Airplane	Electric bicycle alert
S9	Birdsong	Commercial broadcasting, Playing basketball, Conversation, Footstep	Electric bicycle, Bike, Airplane	Electric bicycle alert, Pedestrian cell phone
S10	Wind, Birdsong	Footstep, Conversation	Airplane, Bike, Electric bicycle, Rubbish truck, Bike	Campus radio, Electric bicycle alert
S11	Wind, Fallen leaves, Birdsong	Footstep, Conversation, Frolic, Clean up, Restaurant trolley	Electric bicycle, Airplane, Rubbish truck	Commercial big screen broadcasting, Electric bicycle alert, Restaurant Broadcast, Commercial Promotion, College Student Activity Center Broadcast

S12	Wind, The wind blows the banner, Birdsong, Fallen leaves	Conversation, Clean up, Footstep	Electric bicycle, Rubbish truck, Tricycle	Bicycle bell, Electric bicycle alert, The water heater roars, Construction sound outside school
S13	Fallen leaves, Birdsong, Wind, Insect	Instrument playing, Conversation, Footstep	Electric bicycle, Car, The sound of distant traffic	Opera play
S14	Fallen leaves, Birdsong, Wind	Conversation, Footstep, Playing table tennis, Cleaning car	Electric bicycle	Electric bicycle alert, Rubbish truck, Air conditioner
S15	Fallen leaves, Fallen leaves, Birdsong, Wind	Conversation, Footstep	Airplane, Electric bicycle, The sound of distant traffic, Tricycle	Electric bicycle alert, Mowing
S16	Birdsong, Wind, Fallen leaves	Footstep	Electric bicycle	Air conditioner

Table 4 Elements of soundscape during weekends

Number	Natural sound	Artificial sound	Traffic sound	Mechanic sound
S1	Fountain, Wind	Conversation, Footstep, The sound of luggage wheels	Car, Electric bicycle, Trailer, The sound of distant traffic	No
S2	Wind, Birdsong	Footstep, Conversation, Frolic, Run, Clean up	Bike, The sound of distant traffic	Electric bicycle alert
S3	Wind, Fountain	Reading, Conversation, Run, Footstep, Guard training	Bike, Electric bicycle, Car, The sound of distant traffic,	No
S4	Birdsong, Wind, Fallen leaves	Run, Footstep, Conversation, Skateboard, Reading	Electric bicycle, Bike, Rubbish truck	Pedestrian cell phone
S5	Birdsong, Fallen leaves	Run, Frolic, Footstep, Conversation, Call	Electric bicycle, Bike, Airplane, The sound of distant traffic,	Mowing
S6	Birdsong, Insect, Wind	Conversation, Footstep	Airplane, Electric bicycle, The sound of distant traffic	Electric bicycle alert
S7	Birdsong, Fallen leaves	Run, Conversation, Class sound, Whistle, Cheering, Clean up	Electric bicycle, Bike, The sound of distant traffic	No
S8	Fallen leaves	Playing basketball, Run, Conversation, Footstep, Cheering, Playing basketball, Frolic	Electric bicycle	Electric bicycle alert
S9	Fallen leaves	Conversation, Footstep, Run	Electric bicycle, Bike, The sound of distant traffic,	Broadcast
S10	Wind, Birdsong	Conversation, Footstep	Car, Electric bicycle	Construction sound outside school
S11	Birdsong	Conversation, Footstep, Frolic,	Electric bicycle, Car, Bike, Blood donation cart	College Student Activity Center Broadcast, Electric bicycle alert
S12	Birdsong, Wind	Run, Conversation, Footstep, Frolic	Electric bicycle, Tricycle, Bike	Electric bicycle alert
S13	Insect, Frog, Birdsong	Conversation, Footstep, Run	Electric bicycle, Tricycle	Car horn

S14	Wind, Birdsong, Fallen leaves,	Frolic, Playing table tennis	Electric bicycle, The sound of distant traffic, Car, Airplane	Electric bicycle alert
S15	Insect, Birdsong, Fallen leaves	Conversation, Footstep, Footstep	Electric bicycle, Car, Electric bicycle, The sound of distant traffic	Mowing
S16	Birdsong, Fallen leaves	Footstep, Conversation	Electric bicycle, Bike, The sound of distant traffic	Sound of equipment in the laboratory building, Walkie talkie, Air conditioner

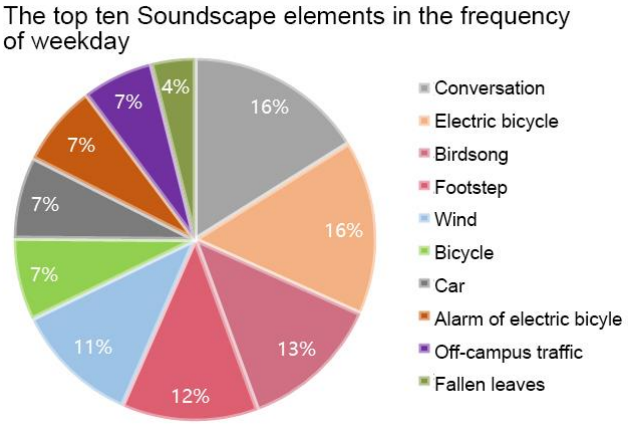
3)Perceived occurrences of individual sound analysis

As shown in Figure 2, the statistics of the number of occurrences of soundscape elements in the campus found that among the top ten soundscape elements, whether on weekdays or weekends, the four elements of conversation, footstep, electric bicycle and birdsong have a higher frequency, and the sum of the four items exceeds half of the total number of soundscape elements. Others include wind, bike, car, electric bicycle alarms, distant traffic sounds, etc. In addition, the sound of frolic is included on weekends, and the sound of falling leaves on weekdays. In general, the frequency of the sound elements at each point is in harmony with the environment, but some problems are also exposed.

1)There are a large number of electric bicycles on campus. The sound frequency of electric bicycles exceeds 16% and appears at almost every measurement point. The alarm sounds of electric bicycles also appear many times on weekdays and rest days. These are inconsistent with the quiet and comfortable environment that the campus should have, reflecting the proliferation of electric bicycles and the lack of public transportation on the campus.

2)The sound of bicycles outside the campus has a serious impact on the campus Soundscape. The sounds of off-campus traffic can be heard at multiple sampling points on the campus, especially at night. This is mainly due to the huge traffic volume on the Shuangling Elevated Road on the south side of the campus. The sound level exceeded the standard in all periods.

3)The sound level of the Dormitory Zone 2 exceeds the standard, which may have a certain impact on students' rest, and measures need to be taken to reduce noise.



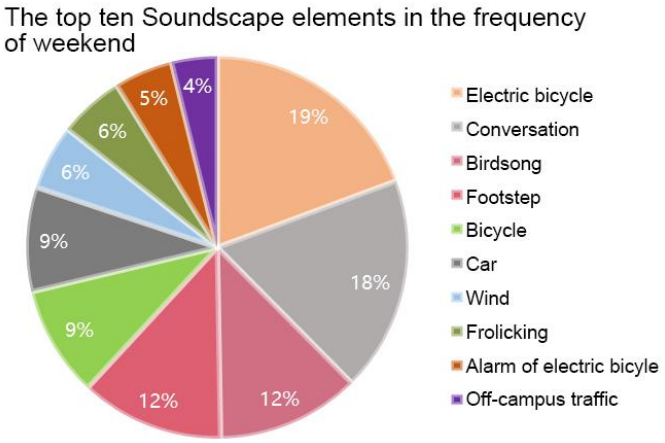


Figure 2 The top ten Soundscape elements in the frequency of weekday and weekend

4 Conclusion and Suggestion

4.1 Conclusion

This paper investigates the soundscape of Linyi University campus through the soundwalk approach and instrumental measurement, and obtains the sound level data and the components of the soundscape of representative samples on the campus, and further analyzes the frequency of these elements. The following conclusions can be drawn through research：

1) Among all 16 sampling points on the campus, only 3 have equivalent continuous A sound levels in all periods that meet the national standards. They are located near the library and the teaching area, accounting for 18.8% of all sampling points; Among the 6 measurement periods, 7 exceeded the national standard only once. The rest have exceeded the national standard requirements many times, and the gateway has exceeded the standard for all periods, with the highest reaching 67.70dB. The sound levels of teaching areas, teaching auxiliary facilities and green areas basically meet national standards, while areas such as dormitories, restaurants, and sports fields exceed the standards due to the large and relatively concentrated number of students. The sound level in the main gate always exceeds the standards due to the impact of traffic and external traffic.

2) Linyi University's campus Soundscape is relatively rich in components, which can generally be divided into four categories: natural sound, human sound, traffic sound and mechanical sound. Natural sounds are mainly animal sounds and weather sounds; human sounds are mainly students' various behavioural sounds including conversation, walking, reading and sports. The traffic sound is dominated by the electric bicycle sound, as well as the bike and car. Mechanical sounds are relatively diverse. In addition to the electric bicycle alert sound, there are also moving sounds, screen playback, Campus radio and other sounds.

3) In terms of the frequency of appearance of the components of the soundscape, whether on weekdays or weekends, the four sound sources of conversation sound, footstep sound, electric bicycle and birdsong sound have a higher frequency, and the sum of the four items exceeds

half of the total number of sound sources. There are a large number of electric bicycles on the campus. The sound frequency of electric bicycles exceeds 16% and appears at almost every measurement point. Electric bicycle alarm also appears many times on working days and rest days, which affects the overall image of the campus landscape. In addition, the sound of bicycles outside the campus has a serious impact on the campus Soundscape.

Through the investigation, it is possible to understand the sound level, constituent elements and frequency of the campus soundscape in detail, which is conducive to the optimization and improvement of the campus landscape, and further improves the comfort of the campus landscape, thereby serving various teaching activities and the lives of teachers and students. In response to the above results, the following improvement and transformation suggestions are proposed.

4.2 Suggestions

4) It is necessary to increase the number of public transportations on campus, and reduce the number of electric bicycles, thus creating a more harmonious campus soundscape. The electric bicycle on campus not only causes problems in parking but also affects the Soundscape to a certain extent, thereby affecting the overall quiet environment of the campus.

5) It is urgent to take measures to isolate the traffic flow outside the school on the south side to reduce the damage to the Soundscape inside the school, such as the use of centralized planting of tall green hedges or tall trees, sound insulation boards and other physical isolation measures.

6)For the dormitory areas, it is recommended that reduce the sound level of the dormitory area by planting plants and other methods to build a comfortable soundscape that meets national standards.

7)Overall, it needs to take further advantage of geographical conditions to protect and excavate natural sound elements. Linyi University has a large campus area and abundant plant arrangements, but the natural sound frequency is relatively low. Therefore, it is necessary to further protect the existing biological resources and create a more natural learning environment.

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