sustainability

MDPI

Article

Designing Public Soundscapes through Social Architecture and Soundscape Approaches: Reflective Review of Architectural Design Studio

Joo-Young Hong [1,*] and Keng Hua Chong [2]

[1] Department of Architectural Engineering, Chungnam National University, Daejeon 34134, Republic of Korea
[2] Architecture and Sustainable Design, Singapore University of Technology and Design, Singapore 487372, Singapore; chongkenghua@sutd.edu.sg
* Correspondence: jyhong@cnu.ac.kr; Tel.: +82-42-821-5619

Abstract: This paper provides a reflective review of an architectural design studio that utilized both social architecture and soundscape approaches to create human-centered and context-based designs for urban public spaces. During field research, students in the studio analyzed four different public spaces in Marina Central BID, Singapore, employing a combination of social architecture (behavioral trace and activity mapping) and soundscape (acoustic measurement and soundwalk) methods. Through this process, the students identified issues related to social architecture and soundscapes and developed soundscape design strategies to improve the quality of the public spaces. The soundscape design strategies were categorized into three groups: the introduction of desirable sounds, the reinforcement of desired sounds, and the reduction in unwanted sounds. This paper shows that the integration of social architecture into soundscape design education enables students to better comprehend the social–behavioral aspects of the environment and create more comprehensive and enjoyable public soundscapes.

Keywords: soundscape; social architecture; design studio; public spaces; soundscape education

Citation: Hong, J.-Y.; Chong, K.H. Designing Public Soundscapes through Social Architecture and Soundscape Approaches: Reflective Review of Architectural Design Studio. *Sustainability* **2023**, *15*, 12399. https://doi.org/10.3390/su151612399

Academic Editor: Jian Kang

Received: 29 April 2023
Revised: 8 August 2023
Accepted: 11 August 2023
Published: 15 August 2023

1. Introduction

Over the last decades, the importance of soundscapes for enhancing overall environmental quality has been becoming increasingly recognized in the field of architecture and urban design [1–3]. According to ISO 12913-1 [4], a soundscape is defined as "an acoustic environment as perceived or experienced and/or understood by a person or people, in context". Unlike a conventional noise control approach mainly aiming at reducing or eliminating noise levels, the soundscape approach prioritizes improving the perceived acoustic environment by considering the interdependence between humans and sounds within a specific context [2,5]. Sound pressure levels alone do not adequately determine the acoustic quality of urban public spaces as they do not correlate well with human perception. Additionally, solely characterizing sounds based on their intensity poses a problem [2]. The soundscape approach emphasizes the importance of considering the types of sound sources within its context for a comprehensive evaluation of acoustic quality [6]. Therefore, the soundscape approach takes a more holistic view of sounds in the environment and focuses on creating perceptually pleasant and appropriate acoustic environments by incorporating the desired sounds and minimizing unwanted ones [5,7]. Recently, the increasing significance of soundscapes has led to the incorporation of the soundscape approach into the noise policies of several countries, such as the UK [8,9], Wales [10], and South Korea [11]. Despite this growing awareness, there is still a gap between soundscape research and design practices [3]. Particularly, current architectural design programs in many universities still do not provide comprehensive training and teaching in soundscape design. This is because conventional architectural design education focuses mainly on the visual aspects

of design, with less attention given to other sensory experiences such as sound, texture, and smell.

To address this gap, several attempts have been made to incorporate the soundscape approach into design education programs [12–14]. Kandemir and Özçevik Bilen [12] conducted a review of an architectural design studio with a theme of soundscapes that was held during the academic year of 2015–2016 at the Department of Architecture at Anadolu University, Turkey. They presented a comprehensive approach to the soundscape design studio that involved various phases, such as binaural sound recordings, acoustic analyses, identification of context and issues, and final design outcomes. Winne et al. [12] presented an overview of the 2019 soundscape hackathon event held during the Urban Sound Symposium in Ghent, Belgium, where participants were tasked with designing urban soundscape interventions using virtual reality visualization and auralization technologies and presenting their solutions to a professional jury. In their paper, they analyzed the process, results, benefits, and shortcomings of the hackathon. Xiao et al. [14] used a reflective practice approach to compare the educational processes of sound engineering and architectural design students across four projects conducted in different UK higher education institutions between 2015 and 2020. They examined how the soundscape approaches such as soundwalks, acoustic measurements, and computational simulations could be integrated into teaching building acoustics and design studios, while also discussing potential future directions for soundscape design education.

The previous studies on soundscape design education have largely emphasized the integration of soundscape approaches such as data collection methods, acoustic measurement, and simulations into the design process, but have been limited in their consideration of how to incorporate social and behavioral aspects into soundscape design. Soundscapes are not only about the physical characteristics of sound, but also about how those sounds impact individuals and communities in spaces. By considering social and behavioral contexts, designers can create soundscapes that are tailored to the specific needs and preferences of the people who reside in or use a particular space.

To address the limitations of soundscape design education, the integration of the social architecture approach into soundscape design education could be valuable as it helps to analyze the social and behavioral aspects of specific locations that shape the soundscapes. Social architecture is a design philosophy that places people at the center of the design process [15]. It involves researching and understanding people's needs, behaviors, and social interactions in a specific environment to develop design strategies that encourage and support those social behaviors toward public interests and the common good. Social architecture approaches primarily focus on understanding the connections between people, activities, and places [16,17]. These three aspects are also central to the soundscape approach, making social architecture an ideal approach to incorporate into soundscape design education.

In this sense, by incorporating the social architecture approach into soundscape design education, students can gain a better understanding of the social and behavioral aspects of the acoustic environment and develop more inclusive and enjoyable public spaces. This paper focuses on a reflective review of an architectural design studio that adopted both social architecture and soundscape approaches to design urban public spaces. The design studio was conducted for third-year undergraduate students of the Architecture and Sustainable Design (ASD) Pillar at the Singapore University of Technology and Design (SUTD). The aim of this paper is not only to provide a reflective review of the design process and outcomes of the design studio, but also to identify limitations and challenges that could provide valuable information for educators who teach soundscape design in undergraduate architectural education.

The structure of this paper is as follows: Section 2 provides a detailed description of the soundscape design studio, including the theme, project sites, and the design studio process. Section 3 provides a summary of the students' soundscape design strategies and

the resulting outcomes. Section 4 includes a critical discussion of the soundscape design strategies employed by the students in their design proposals.

2. Public Soundscape Design Studio

2.1. Overview and Theme

The Sustainable Design Option Studio (SDOS) 2 builds upon and continues the Architectural Core Studio sequence provided by the ASD, SUTD. The SDOS explores the multi-dimensional issues of sustainable design through a variety of lenses and at diverse temporal and spatial scales. Under SDOS 2, the soundscape design studio entitled "Public Soundscape: reimagining Public Life in Post-COVID World" was held in 2020.

The soundscape design studio aimed to explore sustainable design in urban public spaces with a particular focus on soundscapes in the context of the COVID-19 pandemic. Since 2019, the COVID-19 pandemic has led to great interruptions to our urban public spaces and public life, as our social structures and routines were forced to adapt overnight. For example, friends no longer hugged or shook hands when they met, strangers were required to maintain a safe distance from one another, and large public gatherings were strictly prohibited.

In addition, during the COVID-19 pandemic, there was an increase in mental health issues such as anxiety, depression, post-traumatic stress disorder, psychological distress, and stress among the general population [18]. Soundscapes have emerged as a crucial factor in promoting the psychological and physiological recovery of individuals after COVID-19. Numerous studies have demonstrated the positive impact of exposure to natural and pleasant sounds in terms of reducing stress, enhancing mood, and improving overall comfort [19–22]. Moreover, soundscapes have been found to influence physiological responses, including heart rate, blood pressure, and skin conductance levels [23,24]. Recent research has specifically highlighted the restorative effect of natural soundscapes such as water sounds, birdsongs, and gentle breezes on individuals recovering from post-COVID-19 experiences [25]. These findings emphasize the significance of designing urban public spaces with soundscapes that incorporate soothing and natural sounds, offering opportunities for psychological and physiological restoration in the post-COVID era.

In this context, the soundscape design studio sought to answer the following questions on future urban public spaces in a post-COVID World: (1) Could balanced proximity be the key to formulating a more sustainable solution for future urban public spaces? (2) Could we engage the sense of sound to help create a new form of urban conviviality? Specifically, the objectives of the studio were to transform public spaces in Singapore into soulful and lively places that can be enjoyable by both the working population and visitors alike through innovative soundscape design with re-configurable public furniture.

2.2. Project Site

Marina Central Business Improvement District (BID), which is close to the waterfront of Marina Bay, was selected as the project site due to its unique characteristics and significance in the urban context. Marina Central BID is known for its diverse mix of commercial, residential, and recreational spaces, attracting a large number of visitors and residents. The dynamic nature of the district and its central location make it an ideal setting to study and propose innovative design solutions for the purpose of enhancing the urban soundscape.

Figure 1 shows four public spaces (South Beach, Suntec City, Marina Square, and Millenia Walk) identified by the Urban Redevelopment Authority (URA)'s Marina Central BID program for enhancing the vibrancy of the precinct where business meets leisure.

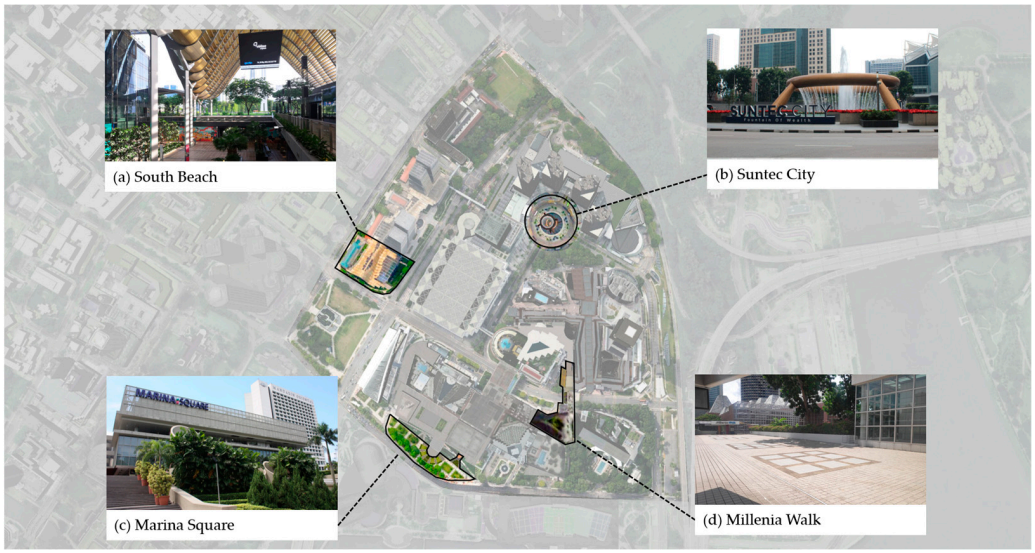


Figure 1. Four urban public spaces identified within Marina Central Business Improvement District: (**a**) South Beach, (**b**) Suntec City, (**c**) Marina Square, and (**d**) Millenia Walk.

South Beach is a mixed-use development that integrates four historical buildings with two new towers to comprise office space, luxury residences, F&B, and retail. As depicted in Figure 1a, the first public space located in South Beach is currently a transitory area, linking various parts of the South Beach area to the MRT entrance and traffic junctions.

Suntec City is a vast mixed-use complex that consists of shopping malls, office buildings, and a convention center. Suntec City consists of five buildings and the convention center. At the center of these buildings, the Fountain of Wealth, a ring-shaped water fountain made of bronze, is positioned. The second public space is located near Suntec Plaza between Towers 1 and 5 across the Fountain of Wealth, as shown in Figure 1b.

Marina Square is located in the heart of the shopping, dining, entertainment, and cultural hub of the vibrant Marina Center. Marina Square Mall serves as a hub linked to City Hall, Promenade, and Esplanade. As shown in Figure 1c, the third public space in Maria Square is an outdoor area facing the Esplanade Theatres on the Bay.

Millenia Walk is a commercial center featuring a sequence of 15 gigantic pyramid domes and a 41-story office tower with a mega-central dome. As shown in Figure 1d, the fourth public space is located between Marina Square and Millenia Walk.

In this studio, new urban programs that involve sounds could be considered while imagining how the selected sites could function as hangout spaces or playscapes during non-event hours, with careful consideration to avoid large congregations of people and yet offer a convivial atmosphere in the post-COVID world.

2.3. Methodology

The curriculum of SDOS 2 was 14 weeks long, with design studios twice per week. In total, 12 undergraduate students at the ASD SUTD participated in the soundscape design studio. The studio adopted a design approach with three phases, as illustrated in Figure 2:

- Phase 1: Lectures on theories of soundscape and social architecture;
- Phase 2: Field research for social architecture and soundscape analyses;
- Phase 3: Development of soundscape design proposals.

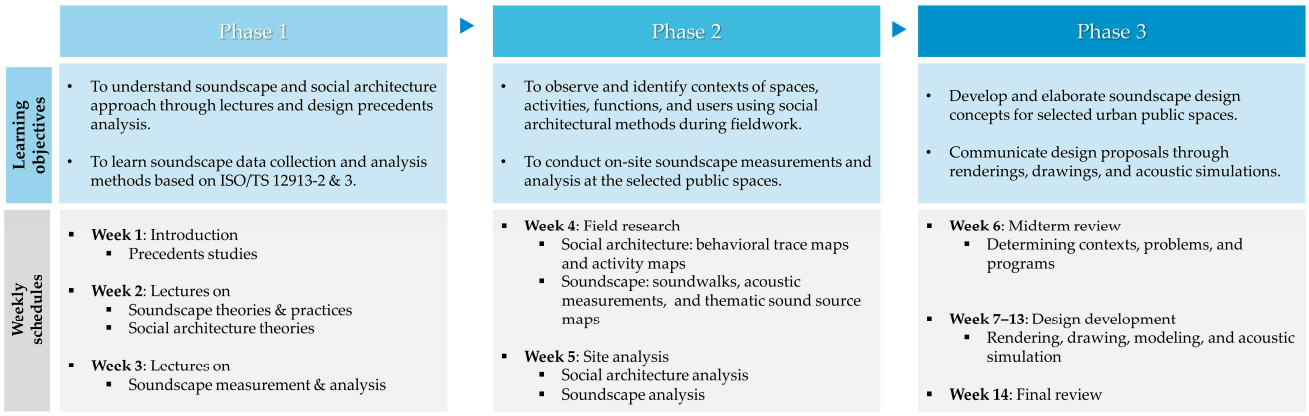


Figure 2. Course outlines from Phase 1 to Phase 3 for the SDOS 2.

During Phase 1 (Weeks 1–3), the students learned the principles of the soundscape approach and social architecture and conducted design precedent studies. Instructors gave lectures on soundscape theories and design practices. The students learned methods for soundscape data collection and analysis, such as soundwalks and acoustic measurements, based on ISO/TS 12913-2 [26] and ISO/TS 12913-3 [27]. The students studied the key concepts and design processes in social architecture theories and also learned various methods, such as counting, mapping, and tracing, to explore public life.

Throughout Phase 2 (Weeks 4–5), the students observed and analyzed the contexts of the selected spaces in terms of activities, space functions, and users by applying social architectural methods such as counting, behavioral tracing, and activity mapping during the fieldwork. The activity mapping method is a useful tool for identifying and understanding patterns of behavior within a specific place. It visually represents activities, people, and points of interest on a map of the study area, using symbols to indicate the type and frequency of activities and their specific locations. This method provides valuable insights into how the area is used and experienced by its users. The method of tracing human behaviors visualizes information on people's movements and choices of routes in the study area. It involves drawing lines on a map or plan to depict the paths and movements of individuals across the study area. This method captures valuable information about the spatial patterns of human activity and movement, shedding light on popular routes, areas of congestion, and preferred paths. The students visualized the behavioral and tracing maps by using Adobe Photoshop and Illustrator.

The students also conducted on-site soundscape measurements and analyses at the selected sites according to ISO/TS 12913-2 [26]. The students utilized the NoiseCapture (version 1.2.22 2021) smartphone application [28], an Android application available for free as open-source software, to measure the acoustic environments at the chosen sites. The application employs the smartphone's built-in microphone to measure real-time sound levels and noise indicators, including A-weighted equivalent sound levels, spectra, and percentile values. However, smartphone microphones are not always calibrated for precise sound measurements, resulting in potential uncertainties and inconsistencies in the measurement data. Furthermore, the quality of the built-in microphone can vary among different smartphone models, affecting the accuracy and reliability of the sound measurements. Thus, the acoustic measurement results were not presented in this paper due to concerns regarding the accuracy of the students' smartphone microphone calibration.

Meanwhile, a soundwalk, a method involving walking in an area and attentively listening to the acoustic environment, was conducted to assess the perceived acoustic environment of the sites using the questionnaire protocol Method A, outlined in ISO/TS 12913-2 [26]. The Method A questionnaire consists of three sections. The first section evaluates the dominance of the identified sound source types on a 5-point scale, ranging from "1: do not hear at all" to "5: dominates completely". The sound sources are categorized into six groups, including traffic noise, sounds from humans, water sounds, bird sounds,

wind sounds, and ventilation noises. An open-ended option is also provided to capture other sounds of interest to the participant. The second section assesses the perceived affective quality of the soundscape using eight adjective attributes (pleasant, annoying, vibrant, monotonous, calm, chaotic, eventful, and uneventful) on a 5-point scale, ranging from "1: Strongly disagree" to "5: Strongly agree". The adjective attributes include pleasant, chaotic, vibrant, uneventful, calm, annoying, eventful, and monotonous. The third section evaluates the overall soundscape quality on a 5-point scale, ranging from "1: Very bad" to "5: Very good". Based on the collected soundscape data, the students analyzed the soundscape characteristics of the sites using various visual representations, including sound source maps and soundscape quality maps [29,30].

Throughout the fieldwork, the students were divided into four groups, each consisting of three or four students, and each group was assigned a specific target site among the four public sites. During the soundwalks, each group of students selected evaluation locations within the assigned public space where they experienced distinct acoustic environments. The fieldwork, including the behavioral observations and soundwalks, took place from 08:00 in the morning until 18:00 in the evening. It is important to note that, due to social distancing measures during the COVID-19 pandemic, only the students in the design studio participated in the soundwalks.

During Phase 3 (Weeks 6–14), the students focused on developing and elaborating soundscape design concepts for selected urban public spaces. The students translated their soundscape design strategies into urban public space designs. Throughout the course, the students convincingly communicated their sustainable design solutions in the form of renderings, drawings, and acoustic simulations. Particularly, a workshop was conducted to teach students to use the Pachyderm acoustic simulation software [31], an open-source acoustic simulation plug-in for Rhinoceros 3D (version 6, Robert McNeel & Associates). The simulation software was primarily utilized as an educational tool to facilitate communication and articulation of design concepts and processes rather than presenting research findings. It should be noted that the simulation results cannot be considered as reliable research findings since not all students had prior experience or training in architectural acoustics before participating in the design studio. Therefore, the simulation results were not included in this paper.

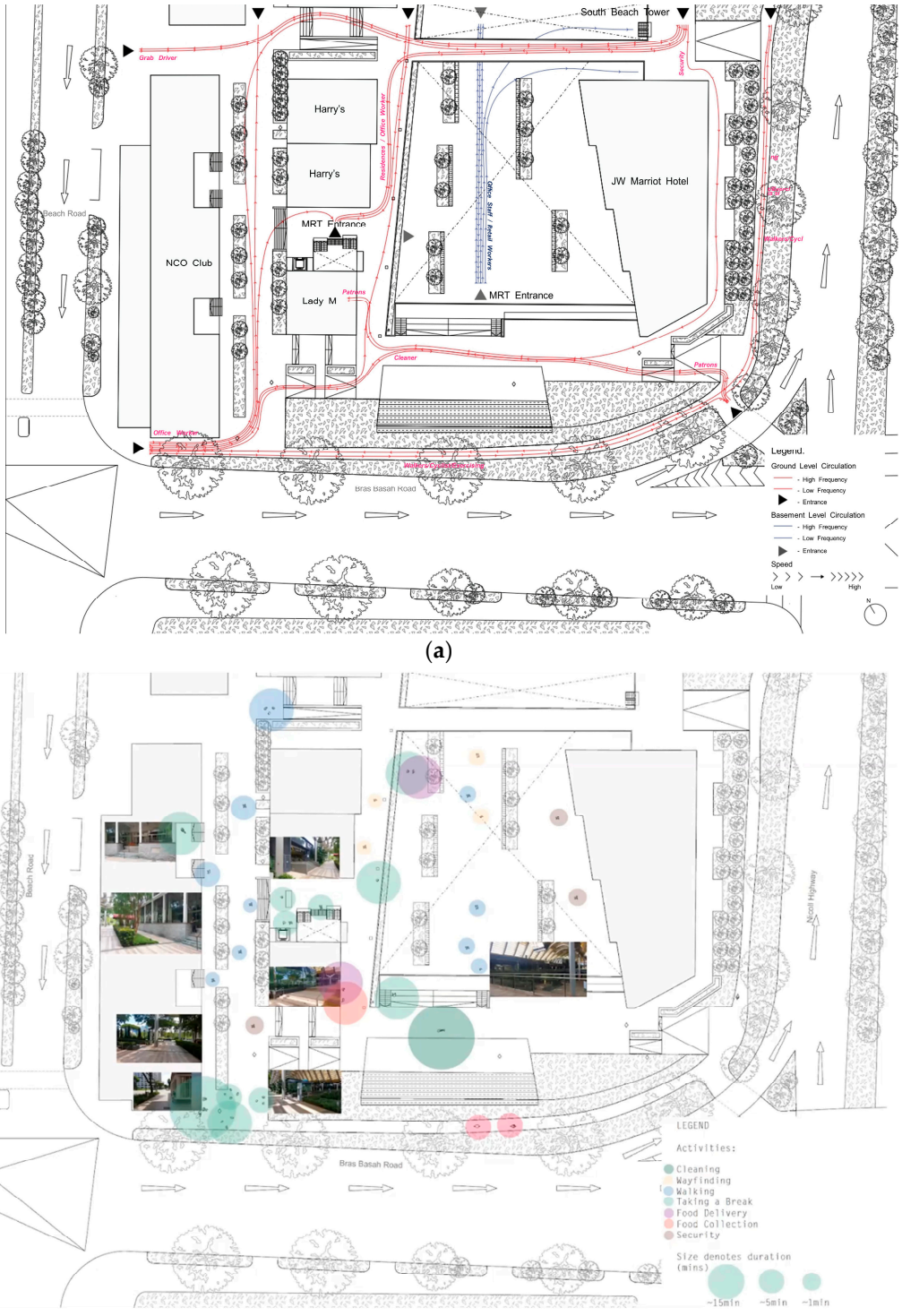
3. Results

3.1. Field Research on Social Architecture and Soundscape

During the field research, the students observed and analyzed how the selected sites were used by different demographics over time and how the sites are used differently by people at the same time using behavioral trace and activity mapping methods. Figure 3 shows some examples of behavioral trace and activity mapping obtained from the field research. As illustrated in Figure 3a, people's major or minor paths at South Beach are represented as lines of movement on a map, providing information regarding the crowd's movements, choice of routes, directions, entrances, etc. As shown in Figure 3b, an activity map of South Beach is drawn on a plan of an area with symbols indicating the number and type of activities and where they take place, providing information on the characteristics of users of the spaces and their activities over time.

The students also analyzed the soundscape data collected from the soundwalks to identify and characterize the existing soundscapes of the sites. Figure 4a shows some results of sound source mapping on the Suntec City site. Through sound source mapping, which visualizes the distribution and properties of sounds, including the types of sounds and their perceived loudness in a particular area, the students gained a comprehensive understanding of the existing soundscapes and identified potential acoustic problems within an area. Figure 4b illustrates the results of the perceived affective quality of the soundscape on the Millenia Walk site, which were obtained from the soundwalks. The students evaluated the affective qualities of the soundscape based on eight soundscape

attributes and were able to perceptually characterize the soundscape qualities across the sites.



(**a**)

(**b**)

Figure 3. Examples of social architecture analysis obtained from the field research at South Beach: (**a**) behavioral trace maps and (**b**) activity maps.

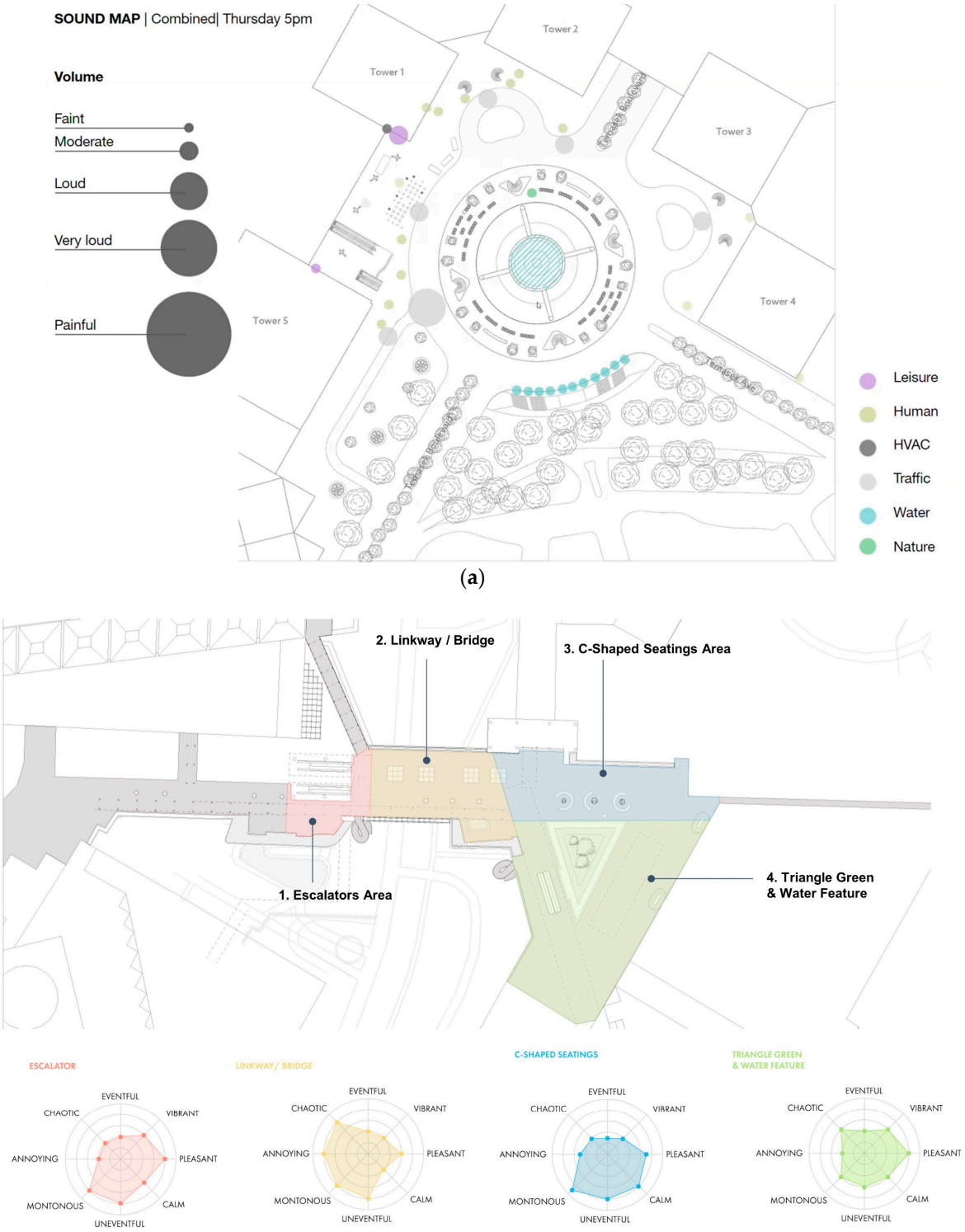


Figure 4. Examples of soundscape analysis from the field research: (**a**) thematic sound maps at Suntec City, where circle size indicates perceived intensity of sound source; (**b**) perceived affective quality of soundscapes using eight adjective attributes at Millenia Walk.

The following is a summary of the fieldwork in contexts regarding social architecture and soundscape across the four sites. It was observed that the South Beach site predominantly attracted white-collar and pink-collar workers, as South Beach is composed of offices, shopping centers, and residences. This junction was also used as a smoking and resting

area by the office and retail workers. The students found that it had huge potential to draw in passersby, although the site was underutilized. Regarding the acoustic environment, it was observed that road traffic and air conditioner units were the predominant noise sources, resulting in monotonous and unpleasant soundscapes.

The Suntec City site provided a significant amount of open public spaces, outdoor features, and street furniture for people to use. However, it was observed that these spaces were not being used most of the time. This might be due to the lack of shading, comfortable seating, and activities or events to attract people. Also, it was found that the majority of activities occurred at the entrance, and there were no indications of leisure strolling or relaxing around the area. Regarding perceived sound sources, traffic noise was one of the most dominant sounds due to the high volume of traffic at the junction, whereas birds and water fountains were the least dominant sound sources at the site.

The Millenia Walk site was mainly used by people for circulation between the Marina Square, Ritz Carlton, Pan Pacific, and Millenia Walk Buildings. It was also found that the majority of the people walked under the shelter from Marina Square to the Pan Pacific Hotel, while few people used the escalator. The main activities observed were smoking and resting. The main users who were observed were office workers and staff working at the surrounding buildings. Addressing undesirable soundscape features, it was observed that there were loud traffic noises on nearby roads and humming sounds from air conditioner condensers. As favorable soundscape features, soothing sounds from water fountains and occasional birds chirping were identified.

Due to the COVID situation, the public space outside the Marina Square site remained underutilized, with the absence of tourists and events. It was discovered that the site lacked shade and space programs. In addition, despite the close proximity to the Esplanade theatre, it was recognized that a stronger connection between the Marina Square site and the Esplanade was needed to attract both visitors and tourists from the Esplanade and workers from the neighboring offices and malls. Regarding soundscapes, it was observed that the sound of traffic was the most noticeable sound across the site, which led to a monotonous or chaotic perception in terms of soundscape qualities. Thus, the students focused on utilizing soundscape design strategies to enhance the undesirable monotonous soundscapes in the public sites by integrating diverse programs and street furniture that fostered human engagement, ultimately infusing the acoustic environment with liveliness and diversity.

3.2. Soundscape Design Outcomes

Based on the field research and analysis of social architecture and soundscapes, students in the studio developed their design proposals for the selected urban public spaces. The following sections summarize the soundscape design strategies and outcomes of each student for their respective project sites.

3.2.1. South Beach

Urban Stage

The Urban Stage design proposal aimed to revitalize the underutilized South Beach public plaza by creating a flexible and adaptable urban stage. The venue would accommodate various activities, including working, dining, performing, spectating, playing, resting, and congregating, promoting empathy and understanding among people, as depicted in Figure 5. In this proposal, two different soundscape approaches were applied. Firstly, water fountains were proposed in the open area adjacent to the roadway to mask traffic noise from the major roadway. A waterfall was also designed in the sunken courtyard area to enhance the vibrancy of the space. Secondly, an acoustic reflector was designed to support a variety of performances and events within the area. The general shape of the sound reflector was developed using raytracing to improve the acoustic conditions for events such as cultural performances, speeches, and film screenings.

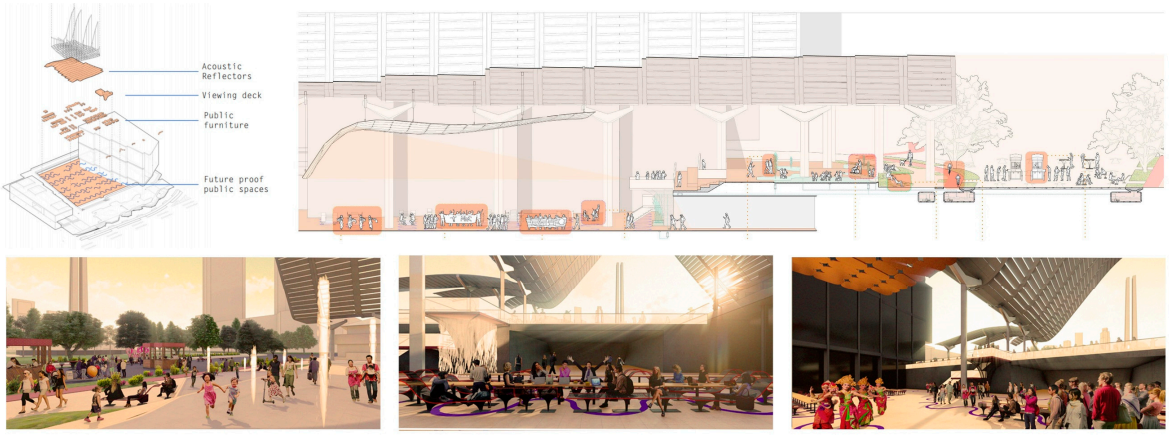


Figure 5. Urban Stage: social implications of the stage and soundscape strategies including water features and acoustic reflectors (Visual credits: Thet Naung Oo, 2020).

Alley

The aim of the proposal, Alley, was to reimagine the underutilized area of South Beach into a place where people can come together to interact. The objective of the soundscape design was to create a more pleasant and calm ambiance for users to gather, relax, and unwind during their monotonous work days. To achieve the project's goal, two primary soundscape design strategies were proposed, as shown in Figure 6. The first strategy was to augment pleasant sounds, amplifying them across the alley by designing bamboo wind chimes. Bamboo wind chimes in the shape of waves were proposed to be hung from the ceiling to generate soothing and pleasant sounds to enhance the soundscape quality of the alley. The second strategy was to reduce unpleasant noises using street furniture. Specifically, S-shaped wooden street benches were proposed to serve multiple purposes: offering visitors a sheltered seating area and effectively reducing the influence of traffic and machinery noises within the space. The wooden benches were intentionally designed with heights greater than the typical sitting height. This design feature serves as a low noise barrier when occupied, effectively minimizing the exposure to heavy traffic noise and enhancing the overall acoustic comfort of the environment.

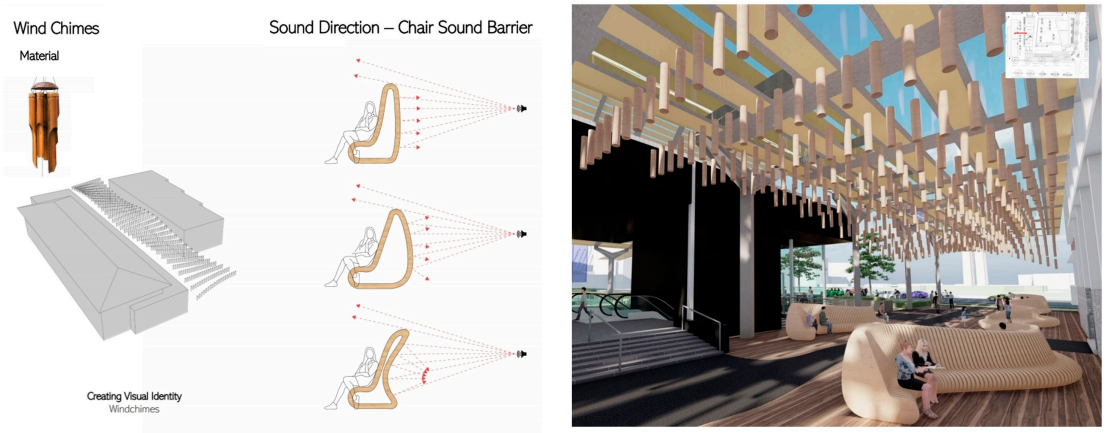


Figure 6. Alley: Bamboo wind chimes and street benches (Visual credits: Paris Lau Sherneese, 2020).

3.2.2. Suntec City

Suntec Party City

The project Suntec Party City aimed to transform the Sky Garden outside of Suntec City's shopping mall into a comprehensive sky club that would represent a collaborative effort among all the bars and restaurants operating there. During the planning phase, the students worked to ensure that the design of the sky club would prioritize social distancing

and privacy, while still offering an energetic and exciting atmosphere for visitors. One of the main features of the sky club was the colorful stepping stones, which were placed on the water feature to create a unique dancing floor, as seen in Figure 7. Additionally, curving terraces were designed to divide the space for social separation and offer visitors some privacy as they enjoyed the different activities offered at the sky club. To ensure optimal acoustic conditions in the sky club, the student utilized highly absorptive finishing materials for the floors (e.g., grass), walls, and roofs (e.g., perforated acoustic slatted panels). The use of these materials can help to reduce the reverberation time, resulting in a much more comfortable auditory experience for visitors. The student also incorporated a waterfall meditation garden with bamboo trees to create tranquil soundscapes for relaxation.

Figure 7. Suntec Party City: Stepping stones as individual dancefloors and waterfall meditation garden (visual credits: Wesley Koh Zhi Peng, 2020).

Luncheon with Benefit

The proposed design of Luncheon with Benefit aimed to provide a vibrant and pleasant outdoor public area in Suntec City where workers could enjoy their lunch while surrounded by nature. The modular system with adjustable green walls was designed to create various spaces for different uses, including seating areas, food stalls, and small social gatherings, as shown in Figure 8. Due to its proximity to a busy roadway, the site's soundscape was characterized by strong and constant traffic noise throughout the day, resulting in an unpleasant and monotonous soundscape. To address this issue, the design integrated two primary soundscape strategies to make the space more vibrant and attractive to workers. Firstly, modules were designed to incorporate additional sound insulation materials between the modular structure and the green wall to reduce the noise levels. Secondly, water features such as fountains and streams were strategically placed throughout the site to generate soothing sounds in order to mask the traffic noise and foster a relaxed environment.

Collation

The project Collation was designed to address the issue of food waste and food insecurity in Suntec City. The proposal aimed to create a public space where surplus food and ingredients from nearby restaurants could be distributed to individuals who had difficulty accessing food. The project consisted of three main components: the paver, the pavilion, and the urban furniture, as shown in Figure 9. To create a unique sound experience, the student utilized a combination of materials, including sand, gravel, and pebbles, to generate a variety of footstep sounds when walking through the space. The pavilion aimed to provide an enclosed gathering space with a terraced design. The pavilion's façade also acted as a noise barrier to mitigate road traffic noise. Flexible urban furniture was designed

for the pavilions, which could be configured in different ways depending on the situation. The grounds of the pavilions were designed with grass, which has a high sound absorption coefficient, to minimize sound reflections within the pavilions.

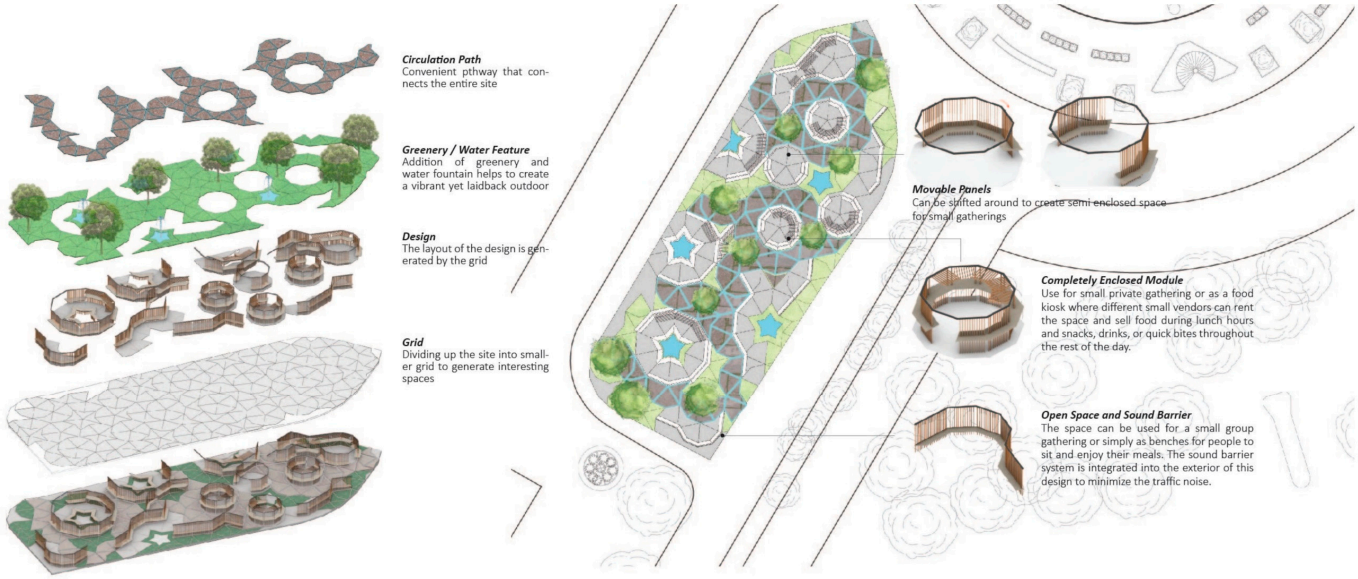


Figure 8. Luncheon with Benefit: Adjustable modular system with green walls and water features (visual credits: Arisa Teriyapirom, 2020).

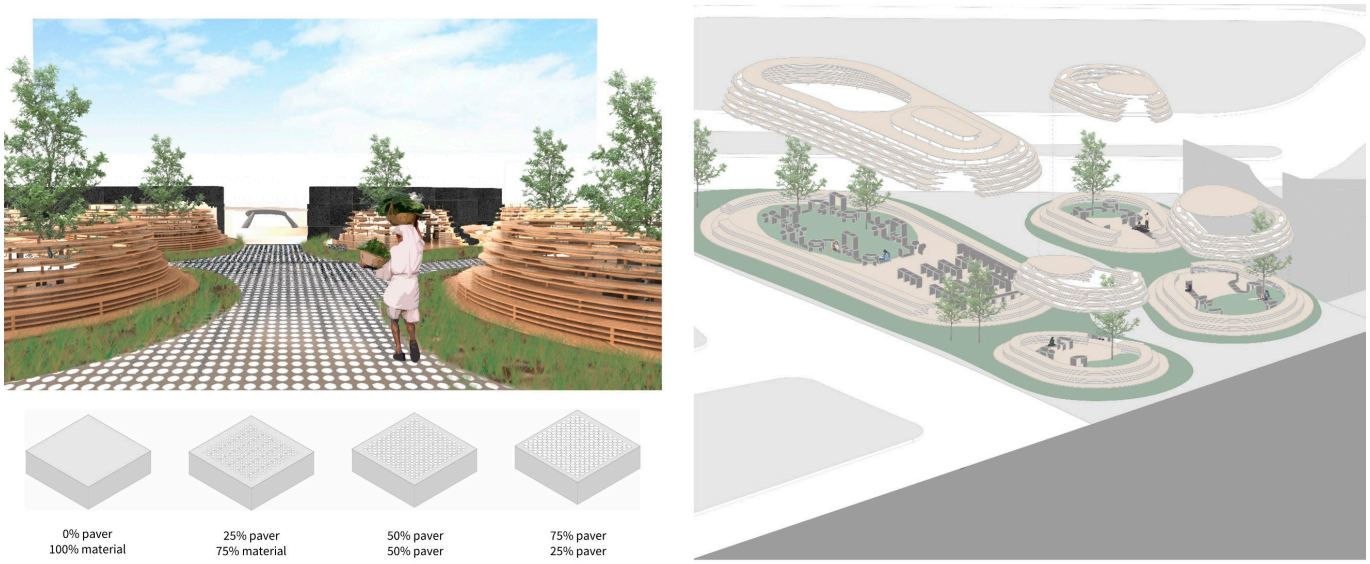


Figure 9. Collation: Paver design and adjustable urban furniture (visual credits: Clarissa Maharani Hartanto, 2020).

3.2.3. Millenia Walk

Millenia Art Walk

The design proposal, Millenia Art Walk, was envisioned to be a focal point that would encourage people to transit through and appreciate diverse types of art. Its bold canopy design was intended to stimulate the remaining unprogrammed spaces and included art programs to enhance the ambiance, as depicted in Figure 10. The molded canopy was designed not only to enhance the existing soundscape, but also to offer a suitable acoustic environment for various space programs. The soundscape design aimed to reduce the noise from road traffic by using noise barriers, which were integrated into the form of the

canopy. The objective was to amplify a positive sound source, including a performance stage as a central feature. The form of the canopy for the performance stage was developed through iterative acoustic simulations to achieve the desired acoustic circumstances. The canopy design also provided well-shaded and comfortable places for visitors to sit and enjoy the performances and visual art, such as sculptures and murals.

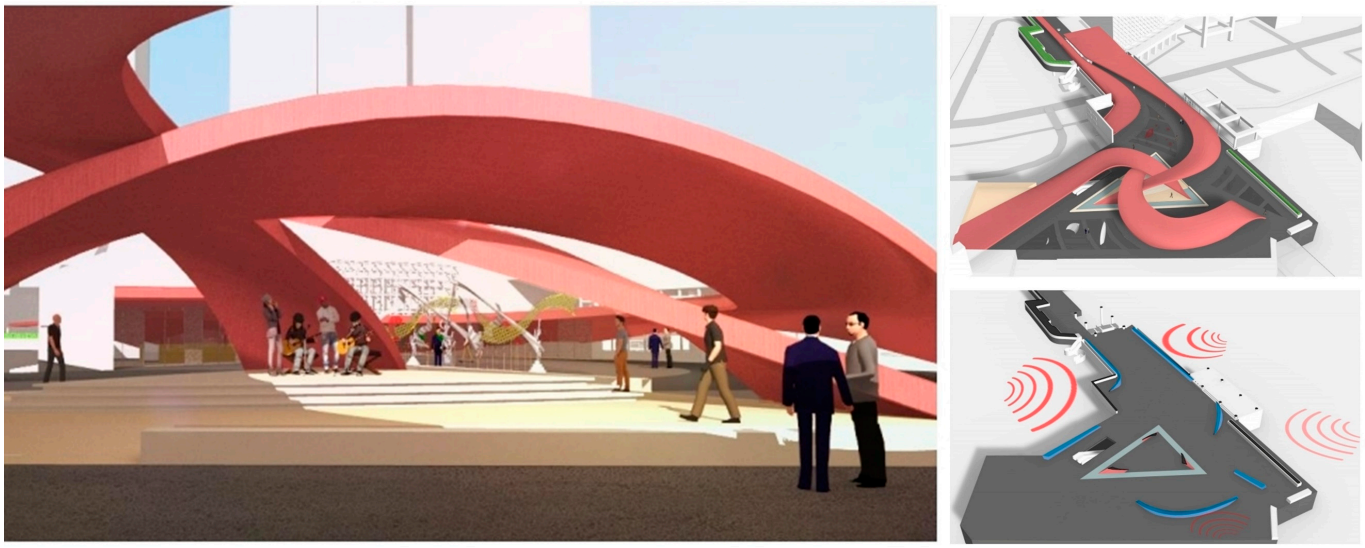


Figure 10. Millenia Art Walk: Canopy design as a noise barrier and a performance stage (visual credits: Yun Jie Pang, 2020).

Millenia Play Park

The design proposal of Millenia Play Park aimed to revitalize the underutilized and monotonous spaces on this site to attract workers from the Marina Center area to a gathering point for activities, performances, and collaborations. The main design idea was to craft a playscape that would use sound generation as the main aspect of play in the open space. In the proposal, musical street furniture and installations were strategically designed throughout the site, aimed at promoting interaction and engagement among colleagues and even strangers, thereby enhancing both social interaction and the overall soundscape experience. As shown in Figure 11, the space programs of Millenia Play Park were characterized in three zones: low-intensity, high-intensity, and stages. In the low-intensity zones, musical box installations inspired by lamellophone instruments encouraged passive to low-active engagement through simple gestures or movements, such as talking, slow pedaling, or turning handles. High-intensity zones involved step piano chairs and trampoline installations for more active participation, resembling keyboard and percussion instruments, respectively. Stage zones included acoustic shells of varying sizes for performances. The larger acoustic shell was designed to amplify performance sounds towards the audience, while the smaller acoustic shells were designed to effectively transmit the amplified sound to the audience.

Acculturation

Public spaces have the potential to promote social resilience by fostering social relationships and interactions across communities. The Acculturation project, which targeted disabled communities, aimed to challenge the negative connotations associated with disability by bringing disabled and non-disabled communities together in a productive system. The project sought to emancipate disabled communities from societal prejudice and discrimination by creating a welcoming and inclusive space. The Acculturation incorporated two distinct soundscape zones: a vibrant zone and a relaxation zone. The relaxation zones included small pocket gardens with water features to create a peaceful and serene atmosphere. Meanwhile, the vibrant zones were geared towards urban activities such

as restaurants, cafés, and galleries. As a soundscape intervention, whisper dishes were designed across the site to improve acoustic conditions for all communities, as shown in Figure 12. The whisper dishes aimed to increase the sound volume and enhance the speech clarity for verbal communication while maintaining social distancing measures.

Figure 11. Millenia Play Park: (**a**) Low-intensity zone, (**b**) high-intensity zone, and (**c**) stage zone (visual credits: Low Shawn, 2020).

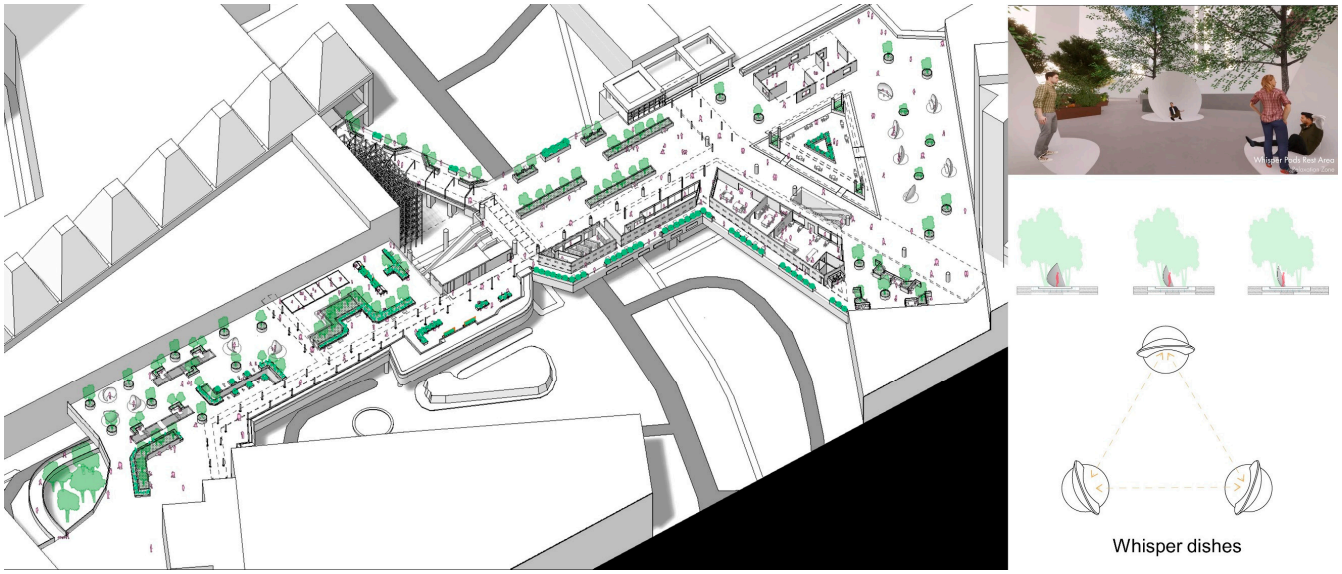


Figure 12. Acculturation: Soundscape design: relaxed zone and vibrant zone, with whispering dishes (visual credits: Lucas Ngiam, 2020).

3.2.4. Marina Square

Solace

The design proposal, Solace, aimed to revitalize this space and create a multifunctional area that would foster work–life balance. Using a soundscape approach, Solace aimed to provide conducive public spaces for work, relaxation, and entertainment. As shown in Figure 13, a wave-shaped fence made of wooden poles and wire mesh was designed to create spaces for work with adaptable furniture units. To provide a relaxing area for visitors, a semi-private space with a small pond was created. The fence facing the road was filled with rocks to block off traffic noise, while the rest were covered with green creepers

to provide a semi-private spot for visitors to rest. For entertainment, a plaza was designed for music performances or movie screenings to attract crowds, with an acoustic reflector and a stage. This entertainment space was designed to draw people from the surrounding offices and encourage them to linger after work, promoting a work–life balance.

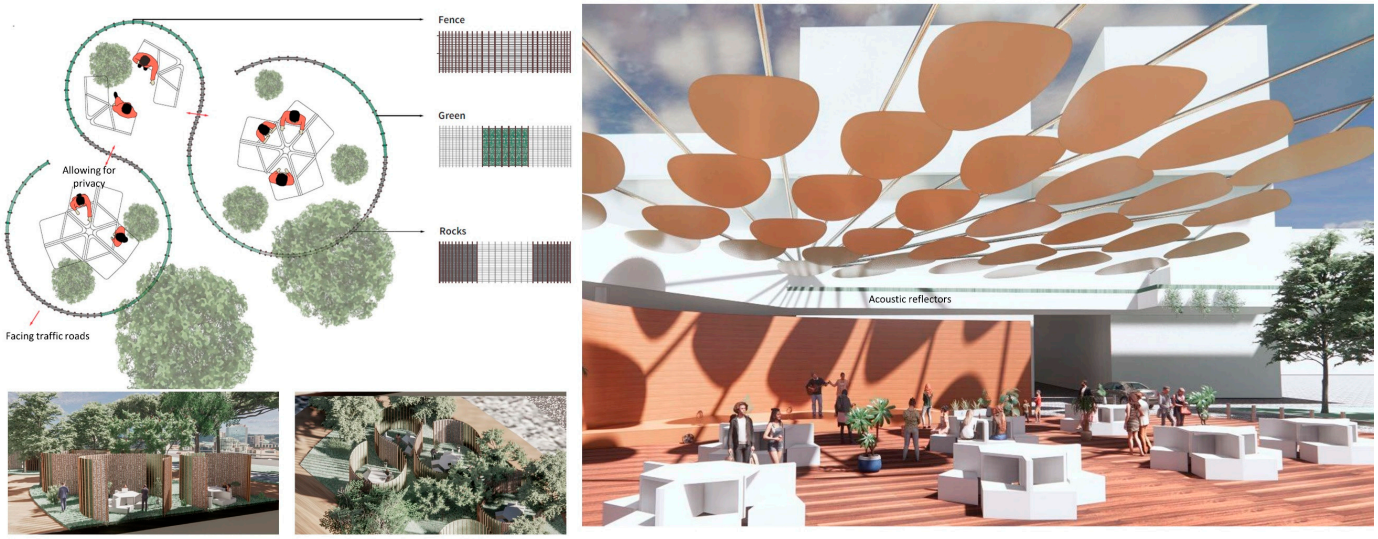


Figure 13. Solace: A wave-shaped fence and a plaza with acoustic reflectors (visual credits: Natalie Tsang Yan Ting, 2020).

Foreign Ground

The design proposal, Foreign Ground, aimed to create a versatile public space in Marina Square catering to migrant workers. It would serve as a venue for job fairs, providing opportunities for workers to find employment. When not used for job fairs, the space could be repurposed as a shelter for the homeless, offering them a place to rest and store their belongings. To enhance the soundscape, the design included three distinct zones (water-scape, green-scape, and hard-scape) to create vibrant and pleasant auditory environments, as shown in Figure 14. The water features were proposed across the area, not just to mask traffic noises from the adjacent road, but also to create pleasing soundscapes. Green spaces were intended to serve as recreation areas for migratory workers. As a soundscape design approach, a noise barrier was designed along the road to reduce noise levels and simultaneously function as street furniture, offering a range of seating options for visitors.

Marina Arts and Culture Walk

The Marina Arts and Culture Walk was a design proposal that aimed to improve the upper-level outdoor area of Marina Center. It sought to extend the existing space towards the food street, creating a direct connection to the waterfront that ended in a stage. By doing so, the design injected arts and culture into the conventional retail activities, providing a more enriching pedestrian experience for visitors. To enhance the soundscape quality, two sound interventions were proposed for the site, as shown in Figure 15. Water curtains were designed beneath the elevated pedestrian walkway to mask traffic noise and create a relaxing environment, while vibrant-colored lantern pods along the path blocked out noise and provided a tranquil setting for work and relaxation. The pods' LED-lined interior surfaces added visual appeal, and their raised height offered unique views of the surroundings.

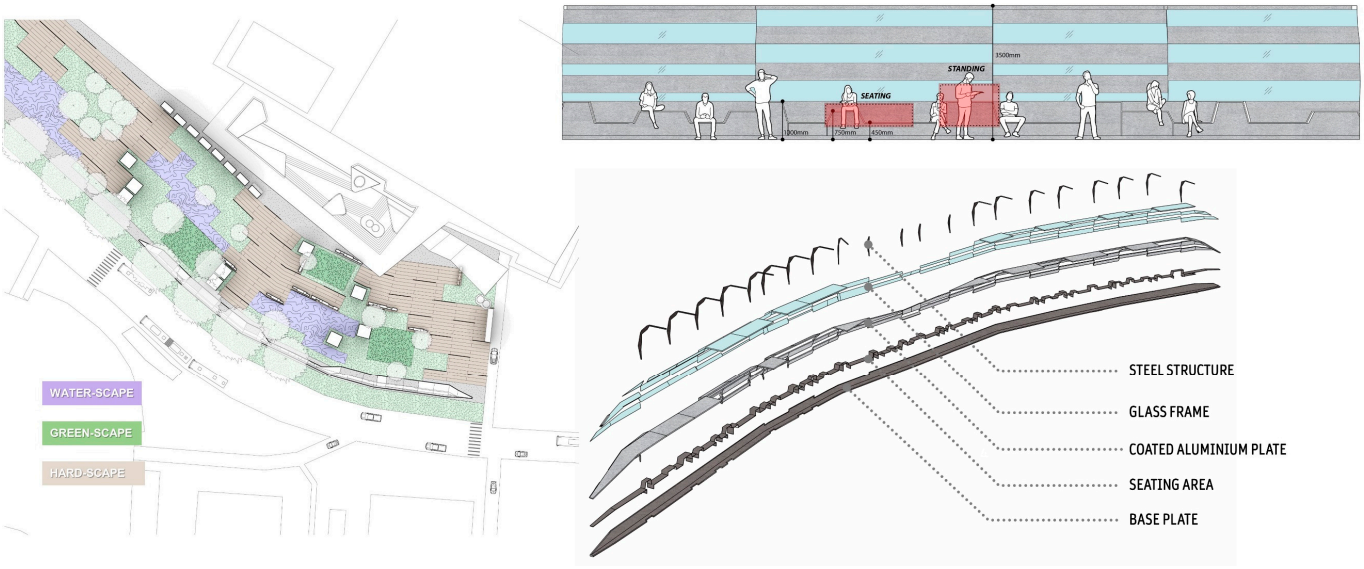


Figure 14. Foreign Ground: Zone planning (water-scape, green-scape, and hard-scape) and a noise barrier as street furniture (visual credits: Song Tingxuan, 2020).

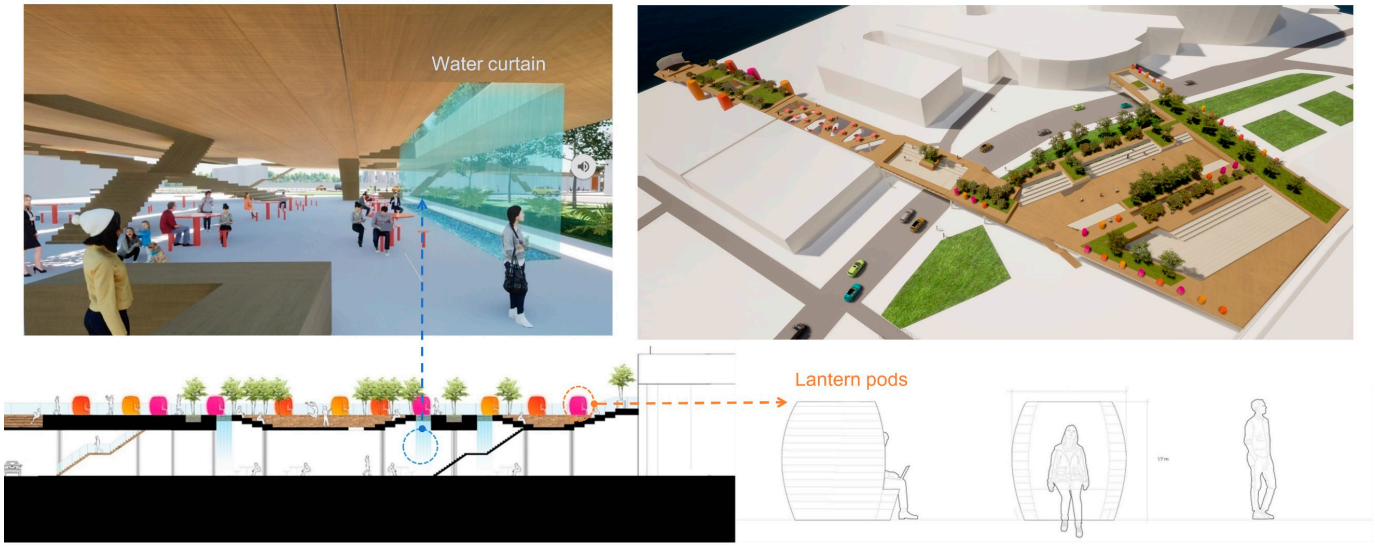


Figure 15. Marina Arts and Culture Walk: Water features under the elevated walkway and lantern pod design as a low noise barrier (visual credits: Samson Sim, 2020).

4. Discussion

4.1. Analysis of Contexts Based on Social Architecture and Soundscape Approaches

The main goal of the soundscape design studio was to explore sustainable design in urban public spaces by engaging a new sense of soundscape in the context of the COVID-19 pandemic. The students focused on four different urban public spaces located in Marina Central BID, Singapore, aiming to improve both urban vibrancy and soundscape quality. According to ISO/TS 12913-2 [26], soundscape design should take into account the key components of people, acoustic environment, and context. The first phase of the soundscape design process is, thus, to analyze the existing soundscapes and contexts to identify key design factors [32,33].

In this design studio, the students conducted field research to analyze the three key components based on social architecture and soundscape evaluation approaches. During the field research, the students used behavioral tracing and activity mapping methods to document people's paths and activities on maps, which provided information on the

characteristics of users of the spaces and their activities over time. The students also used thematic sound mapping and soundscape questionnaire methods to identify the existing soundscapes of the sites during their field research.

By analyzing the existing contexts of a place, the students were able to identify problems regarding social architecture and soundscape in the selected sites and develop design strategies that could enhance the quality of public life in urban public spaces. For instance, it was found that the four selected sites were underutilized, mainly being used as transitory areas due to a lack of shade and space programs, although the users' demographics varied over time. In terms of soundscape quality, the four sites were all situated in an urban environment where the predominant noise sources were road traffic or air conditioner units, resulting in monotonous and unpleasant soundscapes.

The field research demonstrates that the combination of methods in the fields of social architecture and soundscapes could provide valuable insights into how people use public spaces and their perceptions of soundscapes in urban environments, allowing us to design more inclusive and enjoyable public spaces that meet the needs of users.

4.2. Applied Soundscape Design Strategies

Classifying soundscape design strategies is important for both researchers and practitioners because it helps to identify and understand the different approaches which can be used to improve the soundscapes in various settings. Based on previous studies [32–35], when considering soundscape design, there are three main approaches: how to introduce desired sounds, how to reinforce desired sounds, and how to reduce or eliminate unwanted sounds in the target area. In this section, as presented in Table 1, we discuss the soundscape design strategies applied in the students' design proposals at four urban sites with three categories: (1) introduction of wanted sounds, (2) reinforcement of wanted sounds, and (3) reduction in unwanted sounds. Concerning the source–path–receiver model of noise control and management, the first category focuses on managing the sound sources, while the second and third categories concentrate on reinforcing and blocking the paths through which sound travels, respectively.

4.2.1. Introduction of Wanted Sounds

The first category refers to the intentional introduction of features that produce desired sounds. The primary aim of the techniques in the first group is to shift individuals' focus from undesired noises and eventually elicit positive perceptual responses to the desired sounds which are introduced. According to Cerwén et al.'s study [34], the first category was further divided into five sub-categories as shown in Table 1 (a): introducing water features, vegetation/biotope for birds, graveled walking paths, sound sculptures, and inducing human activities. Introducing pleasant water sounds by installing water features to mask unwanted noise is a critical soundscape design strategy for enhancing acoustic quality [20,36–38]. Many design proposals have applied various water features, such as fountains (e.g., Urban Stage), waterfalls (e.g., Suntec Party City), and water curtains (e.g., Marina Arts and Culture Walk), not only for sound-masking purposes, but also to provide positive multi-sensory experiences in urban public spaces.

Table 1. Summary of soundscape design strategies applied in the students' design proposals at four urban sites: South Beach (SB), Suntec City (SC), Millenia Walk (MW), and Marina Square (MS). Design strategies for attracting activities are denoted by PS (Performance Stage), SF (Street Furniture), CA (Community Activities), and PG (Playground).

Site	Project Title	Soundscape Design Ideas	(a) Introduction of Wanted Sounds					(b) Reinforcement of Wanted Sounds	(c) Reduction in Unwanted Sounds	
			Inducing Activities	Water Features	Vegetation/ Biotope	Walking (Pavement)	Sound Sculptures	Reflection	Barriers	Absorption
SB	Urban Stage	Water fountains and a waterfall mask traffic noise and enhance vibrancy, while an acoustic reflector supports performances.	PS, SF	•				•		
	Alley	Wind chimes amplify pleasant sounds, while street furniture reduces unpleasant noises.	SF				•		•	
SC	Suntec Party City	Applying absorptive materials reduces noise, while a waterfall garden adds tranquility.	PS, SF	•	•					•
	Luncheon with Benefit	Modules with green walls reduce noise. Water features mask traffic noise and create relaxation.	SF	•	•				•	
	Collation	Pavilion uses various paver materials for footstep sounds. Façade acts as a barrier against traffic. Grass reduces sound reflections.	SF, CA		•	•			•	•
MW	Millenia Art Walk	Canopy enhances soundscape, reduces traffic noise, and amplifies positive sound sources, including a performance stage.	PS, CA					•	•	
	Acculturation	Pocket gardens and water features create spaces for relaxation. Whisper dishes improve verbal communication.	CA	•	•			•		
	Millenia Play Park	Musical street furniture and an acoustic shell encourages interaction and enhances the overall soundscape experience.	PS, PG				•	•		

Table 1. *Cont.*

Site	Project Title	Soundscape Design Ideas	(a) Introduction of Wanted Sounds					(b) Reinforcement of Wanted Sounds	(c) Reduction in Unwanted Sounds	
			Inducing Activities	Water Features	Vegetation/ Biotope	Walking (Pavement)	Sound Sculptures	Reflection	Barriers	Absorption
MS	Solace	Wave-shaped fences with rocks reduce traffic noise, while an acoustic reflector supports performances.	SF	•	•			•	•	
	Foreign Ground	Water features mask traffic noise, while a noise barrier acts as a form of street furniture with seating options.	SF	•	•				•	
	Marina Arts and Culture Walk	Water curtains beneath the walkway mask traffic noise, while lantern pods provide a tranquil environment.	SF, CA	•					•	

Another common soundscape intervention which was applied was the use of vegetation or biotope design, since the sound of leaves rustling in the wind can be perceived as soothing and natural. Furthermore, the presence of vegetation and biotopes can attract birds [20,39,40] and insects [41,42], contributing to the creation of pleasant biophony that can enhance the soundscape. Indeed, some studies have revealed that views on vegetation can improve soundscape pleasantness [43] and reduce noise annoyance [44,45]. In this studio, the design proposals, namely, Luncheon with Benefit and Solace, utilized vegetated screens to mitigate noise levels and foster a sense of calmness. However, the students' design proposals paid relatively little attention to the types of water sounds and vegetation that would be incorporated. Previous studies have demonstrated that different spectro-temporal characteristics of water sounds can result in varying perceptions [37,42,46,47]. Also, some studies have shown that certain tree species (e.g., poplars, bamboo, beech, etc.) produce stronger sounds in the wind than others [34,48,49].

The sound of people walking is one of the most common sources of sound in urban public spaces. Thus, designing sounds of footsteps can be a potential soundscape design approach, as the sounds produced while walking vary depending on the pavement materials used, such as grass, wood, stone, and gravel [50]. Among the design proposals, The Collation adopted this approach by utilizing a combination of ground finishing materials such as paver, sand, gravel, and pebbles to produce different footstep sounds when people walk in the area, thereby creating specific soundscape experiences.

Installing sound sculptures which generate certain sounds or music or incorporating sound-producing elements can be used as a soundscape design strategy by creating a unique and engaging aural experience for people in urban public spaces. For instance, Millenia Play Park suggested a range of interactive musical furniture installations that visitors could play with, while Alley installed bamboo wind chimes that sway with the wind as sound-producing elements in their soundscape design. These intervention have the potential to improve soundscape quality [51,52] as well as social interactions [52,53].

Previous studies have revealed that the sounds of human activities can enhance the vibrancy of urban public spaces [6,54,55]. In this context, creating spaces or urban elements that encourage vibrant human activities can be an effective approach to enhance the soundscapes. In this studio, the majority of the design proposals included different types of urban furniture intended for visitors to utilize for either socializing or relaxation. For instance, Millenia Play Park proposed an urban playground with musical street furniture to encourage visitors to engage in playful activities, which in turn would generate the sounds of lively human interactions. Also, many proposals included open-air performance stages that could produce music and other performance sounds in urban public spaces. These design proposals, namely, Acculturation and Collation, included social spaces for daily activities, such as cafes, galleries, and community gardens, in order to create a livelier atmosphere in public spaces.

4.2.2. Reinforcement of Wanted Sounds

The second category of sound design strategies focused on enhancing the physical propagation of desired sounds to improve the soundscape quality. During the design studio, various proposals, such as Urban Stage, Solace, and Millenia Play Park, utilized acoustic reflectors and shells to reinforce sound projection towards listeners, as depicted in Table 1 (b). These proposals aimed to tackle the poor acoustics that open outdoor spaces often have due to the absence of reflective surfaces. The lack of such surfaces can negatively impact the audience's acoustic experience, making it crucial to include sound-reflecting structures.

The Acculturation proposal stood out in its approach to improving speech clarity during verbal communication while adhering to social distancing measures amidst the COVID-19 pandemic. The proposal included the use of acoustic dishes, a novel intervention to improve the sound quality in the designated area. These dishes were placed at strategic locations to increase the sound volume and enhance speech clarity while maintaining

social distance. This innovative intervention demonstrated how design solutions could address the issue of social distancing during the pandemic back then, while improving the soundscape quality of public spaces.

4.2.3. Reduction in Unwanted Sounds

The third category includes strategies for reducing the sound pressure levels of unwanted sounds. When the ambient noise level exceeds 65–70 dBA, it is crucial to reduce the noise level, because previous studies have shown that introducing pleasant sounds through soundscape design is ineffective when the noise levels are too high [20,56]. Therefore, noise reduction strategies should be implemented to lower the ambient noise levels to below around 65 dBA in order to apply other strategies classified in the first or second categories. As shown in Table 1 (c), the third category was subdivided into two strategies: barriers and absorption. Design strategies that aim to decrease the activity of sound sources, such as reducing traffic speed, narrowing roads, or diverting traffic, could fall under the third category of soundscape design according to Cerwén et al.'s study [34]. However, these strategies were not within the scope of the design studio.

To achieve efficient noise reduction, it is recommended to position noise barriers near the source of the noise or in a location where people will hear it [57]. The design proposals Luncheon with Benefit and Solace incorporated adaptable barrier structures that vary depending on the distance from traffic roads, placing additional sound insulation material in areas closer to roads. Additionally, street furniture served as noise barriers in the design proposals Marina Arts and Culture Walk and Alley to effectively reduce the noise levels at the listeners' positions.

Using sound-absorbing materials is a commonly proposed soundscape design strategy to reduce noise levels in urban public spaces. One effective approach is to use vegetation or soil on surfaces like walls or the ground, which have high absorption coefficients [58,59]. According to Kim et al. [35], the reverberation time of an urban public space can be reduced to approximately 1.2 s due to sound absorption by vegetation and soil. Among the design proposals, Suntec Party City and Collation incorporated vegetated walls and ground, respectively, not only to decrease noise levels, but also to reduce the reverberation time in the spaces.

5. Conclusions

This article was based on the outcomes of a design studio that explored sustainable design in urban public spaces by engaging with the sense of soundscapes. The concept of soundscape design focuses on the interrelationships among people, places, activities, and the perceived acoustic environments in context. In this studio, the students analyzed four different urban public spaces in Marina Central BID, Singapore, based on the key components of people, the acoustic environment, and context. Using a combination of social architecture and soundscape evaluation approaches, the students were able to identify problems related to social architecture and soundscapes in the selected sites. Based on their analyses, they developed design strategies that could enhance the quality of public life in urban public spaces. The soundscape design strategies implemented in the students' design proposals were formulated and discussed based on three categories: the introduction of wanted sounds, the reinforcement of wanted sounds, and the reduction in unwanted sounds.

During the design studio, the students in architectural design disciplines made successful attempts to apply soundscape design frameworks such as data collection methods, acoustic measurement, and simulations to their designs. Nevertheless, there are still limitations and challenges in teaching soundscape design in an urban design studio. Soundscape design requires technical knowledge of urban and architectural acoustics. In this course, lectures on basic theories of soundscape and urban acoustics were provided to the students in the first few weeks, but these might not be sufficient for the students to fully understand the results of acoustic measurement and simulations. Therefore, it is crucial to provide

education and training focused on architectural acoustics and simulations to equip students with the necessary skills to create practical and effective design proposals. Furthermore, the majority of students used the Pachyderm acoustical simulation software to evaluate their acoustic design solutions. However, it is important to note that the software is designed for simulating room acoustics and may not be as effective when applied to urban acoustic simulations. Thus, future urban design studios for soundscapes should provide training sessions for easy-to-use urban sound propagation simulation tools to enhance students' understanding and application of the principles of soundscape design. Lastly, since the soundscape design approach emphasizes the perceived qualities of the acoustic environment and the context of places, soundscape design education should also incorporate auralization tools that leverage virtual reality techniques to provide students with a more immersive and realistic experience when designing soundscapes in the future.

Author Contributions: Conceptualization, J.-Y.H. and K.H.C.; writing—original draft preparation, J.-Y.H.; writing—review and editing, J.-Y.H. and K.H.C.; visualization, J.-Y.H.; supervision, J.-Y.H. and K.H.C.; funding acquisition, J.-Y.H. All authors have read and agreed to the published version of the manuscript.

Funding: This work was supported by research fund of Chungnam National University, Daejeon, Republic of Korea (2022-0579-01).

Data Availability Statement: Not applicable.

Acknowledgments: The authors appreciate the students (Thet Naung Oo, Paris Lau Sherneese, Wesley Koh Zhi Peng, Arisa Teriyapirom, Clarissa Maharani Hartanto, Yun Jie Pang, Low Shawn, Lucas Ngiam, Natalie Tsang Yan Ting, Song Tingxuan, and Samson Sim) for their contributions of visual materials extracted from their projects, which have been incorporated into this paper.

Conflicts of Interest: The authors declare no conflict of interest. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript; or in the decision to publish the results.

References

1. Kang, J. Soundscape: Progress in the Past 50 Years and Challenges in the next 50 Years. In *INTER-NOISE and NOISE-CON Congress and Conference Proceedings*; Institute of Noise Control Engineering: Washington, DC, USA, 2021. [CrossRef]
2. Kang, J.; Aletta, F.; Gjestland, T.T.; Brown, L.A.; Botteldooren, D.; Schulte-Fortkamp, B.; Lercher, P.; Van Kamp, I.; Genuit, K.; Luis, J.; et al. Ten Questions on the Soundscapes of the Built Environment. *Build. Environ.* **2016**, *108*, 284–294. [CrossRef]
3. Aletta, F.; Xiao, J. What Are the Current Priorities and Challenges for (Urban) Soundscape Research? *Challenges* **2018**, *9*, 16. [CrossRef]
4. *ISO 12913-1*; Acoustics—Soundscape—Part 1: Definition and Conceptual Framework. International Organization for Standardization: Geneva, Switzerland, 2014.
5. Brown, A.L.; Muhar, A. An Approach to the Acoustic Design of Outdoor Space. *J. Environ. Plan. Manag.* **2004**, *47*, 827–842. [CrossRef]
6. Hong, J.Y.; Jeon, J.Y. Influence of Urban Contexts on Soundscape Perceptions: A Structural Equation Modeling Approach. *Landsc. Urban Plan.* **2015**, *141*, 78–87. [CrossRef]
7. Kang, J. From DBA to Soundscape Indices: Managing Our Sound Environment. *Front. Eng. Manag.* **2017**, *4*, 184–192. [CrossRef]
8. Department for Environment. *Noise Policy Statement for England*; Department for Environment, Food and Rural Affairs: London, UK, 2010.
9. City of London, Noise Strategy 2016 to 2026. Available online: https://www.cityoflondon.gov.uk/services/environmental-health/noise-pollution/noise-strategy-and-policy (accessed on 28 April 2023).
10. Welsh Governemnt Noise and Soundscape Action Plan (2018–2023). 2018. Available online: https://www.gov.wales/sites/default/files/consultations/2018-07/180711-noise-and-soundscape-action-plan-2018-2023-consultation.pdf#:~:text=The%20noise%20and%20soundscape%20action%20plan%20is%20the,and%20soundscape%20management%20for%20the%20next%20five%20years (accessed on 28 April 2023).
11. Ministry of Environment of Korea. *Noise and Vibration Control Action Plans (2021–2025)*; Ministry of Environment of Korea: Sejong-si, Republic of Korea, 2021.
12. Milo, A. The Acoustic Designer: Joining Soundscape and Architectural Acoustics in Architectural Design Education. *Build. Acoust.* **2020**, *27*, 83–112. [CrossRef]
13. De Winne, J.; Filipan, K.; Moens, B.; Devos, P.; Leman, M.; Botteldooren, D.; De Coensel, B. The Soundscape Hackathon as a Methodology to Accelerate Co-Creation of the Urban Public Space. *Appl. Sci.* **2020**, *10*, 1932. [CrossRef]

14. Xiao, J.; Aletta, F.; Ali-Maclachlan, I. On the Opportunities of the Soundscape Approach to Revitalise Acoustics Training in Undergraduate Architectural Courses. *Sustainability* **2022**, *14*, 1957. [CrossRef]
15. Gatsby, C. Social Architecture: A New Approach to Designing Social Spaces. Available online: https://www.huffpost.com/entry/social-architecture-a-new_b_5448130 (accessed on 20 April 2023).
16. Chek, G. What Is Social Architecture? Available online: https://www.archlogbook.co/posts/social-architecture (accessed on 20 April 2023).
17. Keng Hua, C. Social Architecture: Theory and Practice. Available online: https://asd.sutd.edu.sg/programme/master-of-architecture/courses/20522-social-architecture-theory-and-practice (accessed on 20 April 2023).
18. Xiong, J.; Lipsitz, O.; Nasri, F.; Lui, L.M.W.; Gill, H.; Phan, L.; Chen, L.D.; Iacobucci, M.; Ho, R.; Majeed, A.; et al. Impact of COVID-19 Pandemic on Mental Health in the General Population: A Systematic Review. *J. Affect. Disord.* **2020**, *277*, 55–64. [CrossRef]
19. Hong, J.Y.; Jeon, J.Y. Designing Sound and Visual Components for Enhancement of Urban Soundscapes. *J. Acoust. Soc. Am.* **2013**, *134*, 2026–2036. [CrossRef]
20. Hong, J.Y.; Ong, Z.T.; Lam, B.; Ooi, K.; Gan, W.S.; Kang, J.; Feng, J.; Tan, S.T. Effects of Adding Natural Sounds to Urban Noises on the Perceived Loudness of Noise and Soundscape Quality. *Sci. Total Environ.* **2020**, *711*, 134571. [CrossRef] [PubMed]
21. Iyendo, T.O. Exploring the Effect of Sound and Music on Health in Hospital Settings: A Narrative Review. *Int. J. Nurs. Stud.* **2016**, *63*, 82–100. [CrossRef] [PubMed]
22. Jambrošić, K.; Horvat, M.; Domitrović, H. Assessment of Urban Soundscapes with the Focus on an Architectural Installation with Musical Features. *J. Acoust. Soc. Am.* **2013**, *134*, 869–879. [CrossRef] [PubMed]
23. Aletta, F.; Oberman, T.; Kang, J. Associations between Positive Health-Related Effects and Soundscapes Perceptual Constructs: A Systematic Review. *Int. J. Environ. Res. Public Health* **2018**, *15*, 2392. [CrossRef]
24. Erfanian, M.; Mitchell, A.J.; Kang, J.; Aletta, F. The Psychophysiological Implications of Soundscape: A Systematic Review of Empirical Literature and a Research Agenda. *Int. J. Environ. Res. Public Health* **2019**, *16*, 3533. [CrossRef] [PubMed]
25. Qiu, M.; Ji, S.; Utomo, S. Listening to Forests: Comparing the Perceived Restorative Characteristics of Natural Soundscapes before and after the COVID-19 Pandemic. *Sustainability* **2021**, *13*, 293. [CrossRef]
26. *ISO 12913-2*; Acoustics—Soundscape—Part 2: Data Collection and Reporting Requirements. International Organization for Standardization: Geneva, Switzerland, 2018.
27. *ISO 12913-3*; Acoustics—Soundscape—Part 3: Data Analysis. International Organization for Standardization: Geneva, Switzerland, 2019.
28. Guillaume, G.; Aumond, P.; Bocher, E.; Can, A.; Écotière, D.; Fortin, N.; Foy, C.; Gauvreau, B.; Petit, G.; Picaut, J. NoiseCapture Smartphone Application as Pedagogical Support for Education and Public Awareness. *J. Acoust. Soc. Am.* **2022**, *151*, 3255–3265. [CrossRef]
29. Puyana-Romero, V.; Ciaburro, G.; Brambilla, G.; Garzón, C.; Maffei, L. Representation of the Soundscape Quality in Urban Areas through Colours. *Noise Mapp.* **2019**, *6*, 8–21. [CrossRef]
30. Hong, J.Y.; Jeon, J.Y. Relationship between Spatiotemporal Variability of Soundscape and Urban Morphology in a Multifunctional Urban Area: A Case Study in Seoul, Korea. *Build. Environ.* **2017**, *126*, 382–395. [CrossRef]
31. Van Der Harten, A. Pachyderm Acoustical Simulation: Towards Open-Source Sound Analysis. *Archit. Des.* **2013**, *83*, 138–139. [CrossRef]
32. Hong, J.Y.; He, J.; Lam, B.; Gupta, R.; Gan, W.-S. Spatial Audio for Soundscape Design: Recording and Reproduction. *Appl. Sci.* **2017**, *7*, 627. [CrossRef]
33. Lex Brown, A. A Review of Progress in Soundscapes and an Approach to Soundscape Planning. *Int. J. Acoust. Vib.* **2012**, *17*, 73–81. [CrossRef]
34. Cerwén, G.; Kreutzfeldt, J.; Wingren, C. Soundscape Actions: A Tool for Noise Treatment Based on Three Workshops in Landscape Architecture. *Front. Archit. Res.* **2017**, *6*, 504–518. [CrossRef]
35. Cerwén, G.; Wingren, C.; Qviström, M. Evaluating Soundscape Intentions in Landscape Architecture: A Study of Competition Entries for a New Cemetery in Järva, Stockholm. *J. Environ. Plan. Manag.* **2016**, *60*, 1253–1275. [CrossRef]
36. Nilsson, M.E.; Alvarsson, J.; Rådsten-ekman, M.; Bolin, K. Auditory Masking of Wanted and Unwanted Sounds in a City Park. *Noise Control Eng. J.* **2010**, *58*, 524–531. [CrossRef]
37. Jeon, J.Y.; Lee, P.J.; You, J.; Kang, J. Acoustical Characteristics of Water Sounds for Soundscape Enhancement in Urban Open Spaces. *J. Acoust. Soc. Am.* **2012**, *131*, 2101–2109. [CrossRef] [PubMed]
38. Axelsson, Ö.; Nilsson, M.E.; Hellström, B.; Lundén, P. A Field Experiment on the Impact of Sounds from a Jet-and-Basin Fountain on Soundscape Quality in an Urban Park. *Landsc. Urban Plan.* **2014**, *123*, 49–60. [CrossRef]
39. Zhu, X.; Gao, M.; Zhao, W.; Ge, T. Does the Presence of Birdsongs Improve Perceived Levels of Mental Restoration from Park Use? Experiments on Parkways of Harbin Sun Island in China. *Int. J. Environ. Res. Public Health* **2020**, *17*, 2271. [CrossRef]
40. Hao, Y.; Kang, J.; Wörtche, H. Assessment of the Masking Effects of Birdsong on the Road Traffic Noise Environment. *J. Acoust. Soc. Am.* **2016**, *140*, 978–987. [CrossRef]
41. Farina, A. *Soundscape Ecology*; Springer: Dordrecht, The Netherlands, 2014; ISBN 978-94-007-7373-8.
42. Jeon, J.Y.; Lee, P.J.; You, J.; Kang, J. Perceptual Assessment of Quality of Urban Soundscapes with Combined Noise Sources and Water Sounds. *J. Acoust. Soc. Am.* **2010**, *127*, 1357–1366. [CrossRef]

43. Hasegawa, Y.; Lau, S.; Kwan, C. Potential Mutual Efforts of Landscape Factors to Improve Residential Soundscapes in Compact Urban Cities. *Landsc. Urban Plan.* **2022**, *227*, 104534. [CrossRef]
44. Van Renterghem, T.; Botteldooren, D. View on Outdoor Vegetation Reduces Noise Annoyance for Dwellers near Busy Roads. *Landsc. Urban Plan.* **2016**, *148*, 203–215. [CrossRef]
45. Hong, J.Y.; Jeon, J.Y. The Effects of Audio–Visual Factors on Perceptions of Environmental Noise Barrier Performance. *Landsc. Urban Plan.* **2014**, *125*, 28–37. [CrossRef]
46. Rådsten-Ekman, M.; Axelsson, Ö.; Nilsson, M.E. Effects of Sounds from Water on Perception of Acoustic Environments Dominated by Road-Traffic Noise. *Acta Acust. United Acust.* **2013**, *99*, 218–225. [CrossRef]
47. Galbrun, L.; Calarco, F.M. A Audio-Visual Interaction and Perceptual Assessment of Water Features Used over Road Traffic Noise. *J. Acoust. Soc. Am.* **2014**, *136*, 2609. [CrossRef]
48. Cerwén, G. Urban Soundscapes: A Quasi-Experiment in Landscape Architecture. *Landsc. Res.* **2016**, *41*, 481–494. [CrossRef]
49. Yang, S.; Xie, H.; Mao, H.; Xia, T.; Cheng, Y.; Li, H. A Summary of the Spatial Construction of Soundscape in Chinese Gardens. In Proceedings of the 22nd International Congress on Acoustics, Buenos Aires, Argentina, 5–9 September 2016.
50. Aletta, F.; Kang, J.; Astolfi, A.; Fuda, S. Differences in Soundscape Appreciation of Walking Sounds from Different Footpath Materials in Urban Parks. *Sustain. Cities Soc.* **2016**, *27*, 367–376. [CrossRef]
51. Oberman, T.; Jambrošić, K.; Horvat, M.; Šćitaroci, B.B.O. Using Virtual Soundwalk Approach for Assessing Sound Art Soundscape Interventions in Public Spaces. *Appl. Sci.* **2020**, *10*, 2102. [CrossRef]
52. Steele, D.; Bild, E.; Tarlao, C.; Guastavino, C. Soundtracking the Public Space: Outcomes of the Musikiosk Soundscape Intervention. *Int. J. Environ. Res. Public Health* **2019**, *16*, 1865. [CrossRef]
53. Klein, G. Site-Sounds: On Strategies of Sound Art in Public Space. *Organised Sound* **2009**, *14*, 101–108.
54. Hong, J.Y.; Jeon, J.Y. Comparing Associations among Sound Sources, Human Behaviors, and Soundscapes on Central Business and Commercial Streets in Seoul, Korea. *Build. Environ.* **2020**, *186*, 107327. [CrossRef]
55. Meng, Q.; Kang, J. Effect of Sound-Related Activities on Human Behaviours and Acoustic Comfort in Urban Open Spaces. *Sci. Total Environ.* **2016**, *573*, 481–493. [CrossRef] [PubMed]
56. Yang, W.; Kang, J. Acoustic Comfort Evaluation in Urban Open Public Spaces. *Appl. Acoust.* **2005**, *66*, 211–229. [CrossRef]
57. Kotzen, B.; English, C. *Environmental Noise Barriers: A Guide to Their Acoustic and Visual Design*, 2nd ed.; Taylor & Francis: New York, NY, USA, 2009; ISBN 0203931386.
58. Nilsson, M.E.; Bengtsson, J.; Klæboe, R. *Environmental Methods for Transport Noise Reduction*; Nilsson, M., Bengtsson, J., Klaeboe, R., Eds.; CRC Press: London, UK, 2014; ISBN 978-0-415-67523-9.
59. Van Renterghem, T.; Hornikx, M.; Forssen, J.; Botteldooren, D. The Potential of Building Envelope Greening to Achieve Quietness. *Build. Environ.* **2013**, *61*, 34–44. [CrossRef]