

INTERPRETING HOSPITAL SOUNDSCAPES THROUGH PARTICIPATORY DESIGN METHODS: A CASE OF A PEDIATRIC INPATIENT UNIT

A Ph.D. Dissertation

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Ankara
May 2025

To my dearest parents



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DESIGN METHODS: A CASE OF A PEDIATRIC INPATIENT UNIT

The Graduate School of Economics and Social Sciences
of
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İHSAN DOĞRAMACI BİLKENT UNIVERSITY
ANKARA

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By Cemre Orhan

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ABSTRACT

INTERPRETING HOSPITAL SOUNDSCAPES THROUGH PARTICIPATORY DESIGN METHODS: A CASE OF A PEDIATRIC INPATIENT UNIT

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Shared spaces in hospitals, such as inpatient units, serve users with diverse and sometimes conflicting needs, making it challenging to create inclusive and satisfying soundscapes. Standardized design approaches often fall short in addressing these complexities. This study explored how Participatory Design (PD) methods could help reinterpret hospital soundscapes by involving users and fostering cross-disciplinary collaboration. Conducted in six phases, the study aimed to identify the promises and pitfalls of integrating PD into hospital soundscape design.

In the first phase, spatial and behavioral observations were conducted in a Pediatric Inpatient Unit (PIU), supported by field notes, drawings, and photographs. In the second phase, semi-structured interviews with patients, families, and staff were analyzed using Grounded Theory. These findings informed the third phase, where users participated in a co-design workshop to create their ideal patient room. This design was then refined by architecture experts in phase four, resulting in detailed floor plans, 3D visuals, and animations. In phase five, acoustic experts evaluated user-identified pleasant sounds and selected them as tools for the final design game. In the sixth phase, a second co-design workshop was held where PIU users designed ideal soundscapes using game elements derived from previous phases.

This study contributes to the soundscape literature by demonstrating the potential of PD methods to support the creation of more inclusive and empathetic hospital sound environments. It highlights the value of user participation in complex healthcare settings and provides a framework for integrating PD into future hospital soundscape design.

Key words: Hospital Soundscapes, Participatory Design, Co-Design Workshops



ÖZET

KATILIMCI TASARIM YÖNTEMLERİYLE HASTANE SES MANZARALARININ YORUMLANMASI: BİR PEDIATRİK YATAN HASTA ÜNİTESİ ÖRNEĞİ

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Mayıs 2025

Ortak kullanım alanları olan yatan hasta birimleri, farklı ihtiyaçlara sahip kullanıcı gruplarına hizmet verdiği için kapsayıcı ve tatmin edici ses peyzajı çözümleri geliştirmek zordur. Standart yaklaşımlar bu karmaşıklıkları ele almakta genellikle yetersiz kalmaktadır. Bu çalışmada, Katılımcı Tasarım (KT) yöntemlerinin, kullanıcıların aktif katılımı ve disiplinlerarası iş birliği yoluyla bu zorluklara çözüm sunabileceği varsayılmıştır. Çalışma, hastane ses peyzajlarının KT yöntem, araç ve teknikleriyle nasıl yeniden yorumlanabileceğini araştırmış ve altı aşamada yürütülmüştür.

İlk aşamada, bir Pediatrik Yatılı Hasta Birimi'nde (PYHB) mekânsal ve davranışsal gözlemler yapılmıştır. İkinci aşamada, kullanıcılarla yarı yapılandırılmış görüşmeler gerçekleştirilmiş ve Gömülü Teori yöntemiyle analiz edilmiştir. Bu bulgular, üçüncü aşamada yapılan hasta odası tasarımına yönelik ortak tasarım atölyesine temel oluşturmuştur. Dördüncü aşamada mimarlık uzmanları, kullanıcıların tasarımını geliştirerek 3B görseller ve animasyonlar üretmiştir. Beşinci aşamada, kullanıcıların en hoş bulduğu sesleri içeren bir değerlendirme aracı geliştirilmiş; bu sesler akustik uzmanları tarafından analiz edilerek oyun aracı olarak seçilmiştir. Altıncı aşamada, kullanıcılarla gerçekleştirilen ikinci atölyede, bu araçlar kullanılarak ideal bir ses peyzajı oluşturulmuştur.

Çalışma, hastane ses peyzajı tasarımında KT yöntemlerinin potansiyelini ortaya koyarak literatüre katkı sağlamaktadır. Yöntem, daha duyarlı ve kullanıcı odaklı çözümler geliştirilmesine olanak sunmuştur.

Anahtar kelimeler: Hastane Ses Peyzajı, Katılımcı Tasarım, Ortak Tasarım Atölyeleri



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CHAPTER I

INTRODUCTION

1.1. Aim of the Study

This study aims to reinterpret the hospital soundscapes using Participatory Design (PD) methods. Healthcare facilities, specifically hospitals, are known for their complex structure. The high volume of medical devices and constant conversations contribute to noisy acoustic environments. Studies have shown that hospital noise impact patients, families, and staff both physiologically and psychologically. Although several adverse health outcomes caused by hospital noise have been recorded, yet very little is known about how an ideal hospital soundscape would be achieved for all stakeholders.

Hospitals generally include both outpatient and inpatient units. Each unit serves different users and their various needs. In outpatient services, the primary users are hospital staff while the patients and families have temporarily been there. However, inpatient units are shared spaces where staff members are assigned to, and patients and families may often stay from night to months. Therefore, one would make an inference that based on the varied contexts, the perceived and expected soundscapes would differ within the hospitals. Considering such differences, we cannot generalize a single finding over each hospital sub-space, user types, and acoustic environments.

Inpatient units are occupied by staff, families, and patients at the same time. Therefore, to address the issue of inadequate hospital soundscape solutions, there is a need to discover how different user groups perceive the existing soundscapes and what their specific needs are. Inpatient units can be divided into several subcategories by demographics and medical condition. We conducted this study in pediatric settings, given that those spaces serve the most vulnerable patient populations. First, we sought to identify users' perceptions of soundscapes and then integrate PD approaches to inform future hospital soundscape solutions. The preliminary study was conducted in a Neonatal Intensive Care Unit (NICU) associated with a Research Hospital in Turkey. As we observed several restrictions due to the context of the NICU, we conducted the primary study in a Pediatric Inpatient Unit (PIU) within the same hospital.

1.2. The General Structure of the Thesis

The methodology of the study consists of six phases. In the first phase, we conducted spatial and behavioral analyses in the PIU and its sub-spaces, identified by clinicians as places where daily and continuing activities occur. Architectural plans and detailed photographs of each subspace were analyzed to abstract salient design features. Initial conversations were conducted with chief clinicians to engage in institutional culture and learn about the daily routines. Spatial and behavioral observations were documented to understand better how users interact with the built and acoustic environments.

After the spatial analyses, we developed an interview tool based on ISO standards (ISO, 2018; ISO, 2019) and conducted semi-structured interviews with the volunteered clinicians, families, and patients in the second phase. The interviews were audio recorded and then analyzed using the Grounded Theory (GT). Using the rich data we gathered, we created design briefs called 'Implications for Practice' regarding the users' desired built and acoustic

environment features. Those design briefs were then used during the co-design workshops and expert evaluation sessions.

Before conducting the third phase, we developed a design game to be played in the co-design workshop. The game tools were designed based on the observation and interview findings. The aim of this workshop was to design an ideal pediatric patient room. The participants were volunteer staff, families and patients. The workshop included many conflicting discussions, in which users had to make decisions collaboratively. As a design outcome, users created a 2D mock-up of a patient room. We transferred this mock-up into an AutoCAD file to be used in the following session. The whole process was video recorded and thematically analyzed.

In the fourth phase, a panel of experts in healthcare architecture, design, and interior architecture evaluated the features of the user-designed floor plan. The aim was to evaluate the design and elevate it if necessary. We first introduced the study site and aim, then we shared our findings from the prior sessions. Experts had many questions regarding users' needs and the data collected helped us address such questions. After an overview, they decided to keep the main functions created by users and elevate the existing layout. They selected appropriate materials and color schemes to create 3D visuals and a short animation. These visual tools were then used during the acoustic experts' evaluation session and the acoustic environment co-design workshop.

The interview data revealed that PIU users expected to have a pleasant soundscape consisting of music, bird sounds, and water sounds. Therefore, based on the previous studies, we generated a sound source pool. Then, we combined the 3D visuals and sound sources and created an audio-visual task for the acoustic experts. Using these tools, we generated an evaluation tool to be used in the fifth phase. A panel of experts were given a questionnaire that

had a scenario to get familiar with the IPU context and a listening test. They completed this session individually, but their evaluations were combined to discover which sound sources would be the most pleasant. The sound source selection guided us to create design game tools for the upcoming and last co-design workshop.

The acoustic environment co-design workshop session, which was the last phase of this study, aimed to generate a pleasant soundscape. Participants were given 3D visuals of the patient room and sound cards. They were asked to define the soundscapes with soundscape adjectives and select the most relevant sound sources. With the selected sound sources, we conducted a co-listening test, where they discussed and evaluated the most proper options. Although this session involved many agreements and disagreements, the end design was satisfactory for each participant. At the end of this session, participants evaluated the end design and the overall participatory process. In conclusion, we analyzed the results and discussed the promises, pitfalls, and lessons learned to inform future hospital soundscape studies.

CHAPTER II

THEORETICAL BACKGROUND

2.1. The Soundscape Approach and Its Standardization

The soundscape is a developing concept applied to the methods used to evaluate acoustic environments. For years, noise control was solely based on objective measurements to reduce the adverse effect of noise but struggled to achieve intended aims regarding positive soundscapes (Schulte-Fortkamp & Fiebig, 2023). Such noise reduction efforts focused on reducing noise at a source level and through regulations, but as Schults (1978) stated, people were not satisfied with such actions as they still felt burdened after interventions.

The soundscape concept dates to the late 60's when the perceptual form of soundscape was analyzed to create a design criterion for cities (Southworth, 1967). A couple of year later, a Canadian musician R. Murray Schafer popularized the soundscape in his book titled 'the sonic environment and tuning of world' (Schafer, 1977). At that time, he was working at in one interdisciplinary department at Simon Fraser University with an innovative spark: to study all sounds, not solely unpleasant or dangerous (Schafer, 2013).

Schafer (2013) claims that the term soundscape was not recognized in the early 70's, or at least its definition was unknown to everyone. Eventually, the soundscape was used as an umbrella term for the study of diverse sounds (Fiebig, 2023). Up to that point, the soundscape was not fully understood by acousticians as they believed sound could be sufficiently identified by technical terms (e.g., decibels). After the term was developed, researchers started to describe acoustic environments from a more pragmatic perspective (Schafer, 2013).

At that time, the focus was on the noise reduction in which every sound source was regarded as a negative contribution (Fiebig, 2023). With that awareness, Schafer (1977) called for a positive approach towards the acoustic environments. Today, this shift in perspective is seen as one of the main reasons for the success of the concept of soundscape (Fiebig, 2023). There has been an increasing interest in this approach. Since the late 90's conferences and congresses on acoustics included dedicated sessions on soundscapes as a 'regular' feature for the first time (Fiebig, 2023). Furthermore, the COST Action 'Soundscape of European Cities and Landscapes' served as a platform to support collaboration and provide practical framework to advance studies in the field (Kang, Chourmouziadou, Sakantamis, Wang, & Hao, 2013). Based on these developments, the soundscape approach has attracted considerable interest particularly since the early 2000s among interdisciplinary areas including policymakers, researchers, and practitioners in acoustics (Kang et al., 2016).

Due to its growing popularity, researchers initiated a standardization process, which lead to the establishment of the ISO Working Group WG54 ISO/TC 43/SC1 in 2008. Up until today, the International Organization for Standardization (ISO) introduced three standards to guide soundscape studies, and one that has been working on (Figure 1). The first standard, ISO 12913-1, published the soundscape's definition and conceptual framework as "the

acoustic environment perceived or experienced and/or understood by a person or people, in context" (ISO, 2014). The framework shows the process of perceiving the acoustic environments in seven categories as context, sound sources, acoustic environment, auditory sensation, interpretation of auditory sensation, responses, and outcomes (Figure 2) (ISO, 2014). Context refers to "the interrelationships between person, activity, and place, in space and time, and it may influence soundscape through the auditory sensation" (ISO, 2014; Schulte-Fortkamp et al., 2023). Several soundscape studies demonstrated that the context is the most dominant factor on individuals' perceptions of soundscapes (Orhan & Yilmazer, 2021; Orhan & Yilmazer, 2024).

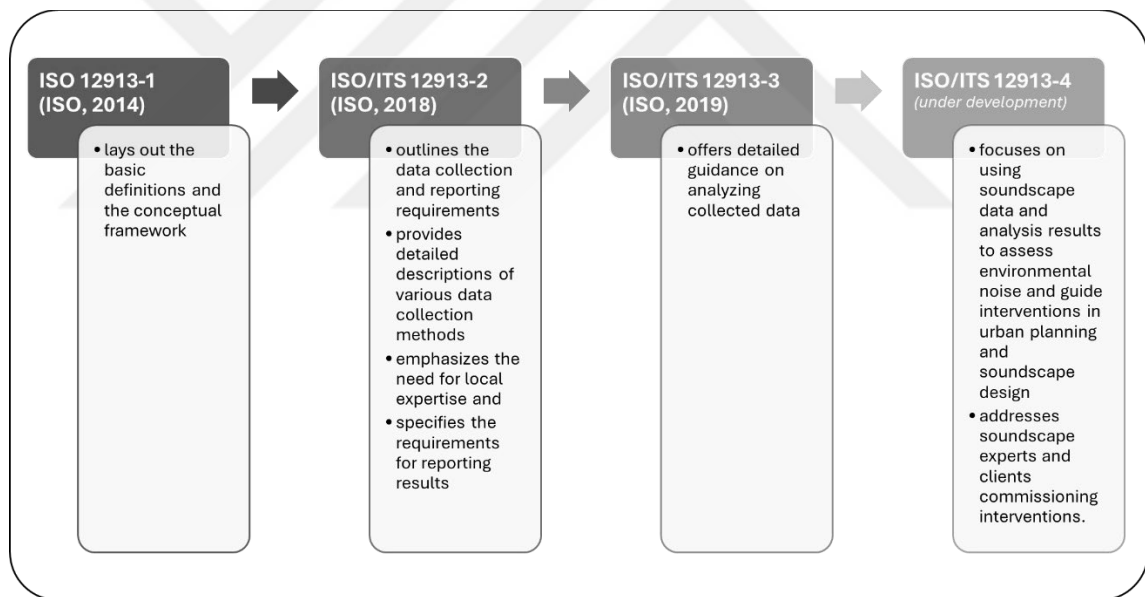


Figure 1. Overview of ISO 12913: Parts from 1 through 4 (ISO, 2014; ISO, 2018; ISO, 2019; Schulte-Fortkamp & Jordan, 2023).

The soundscape is clearly distinguished from the acoustic environment as it prioritizes perception (Orhan & Yilmazer, 2024); therefore, ongoing efforts aims to develop reliable methods that assess human perception (Schulte-Fortkamp & Fiebig, 2023). The second standard, ISO/TS 12913-2, revealed the Data Collecting and Reporting Requirements for soundscape studies (ISO, 2018).

The standard elaborates on soundscape methods; Method A (questionnaire), Method B (soundwalk), and Method C (interview) with sample data collection tools. Method A and B are not within our scope as we did not use soundwalk method in this study. However, we focused more on Method C, as interviews are common assessment methods to examine the acoustic environment (Engel, Fiebig, Pfaffenbach, & Fels, 2018) and to provide valid detailed soundscape data (Kang & Schulte-Fortkamp, 2018). Therefore, we have adapted the example interview questions in the standard and conducted semi-structured interviews based on this protocol.

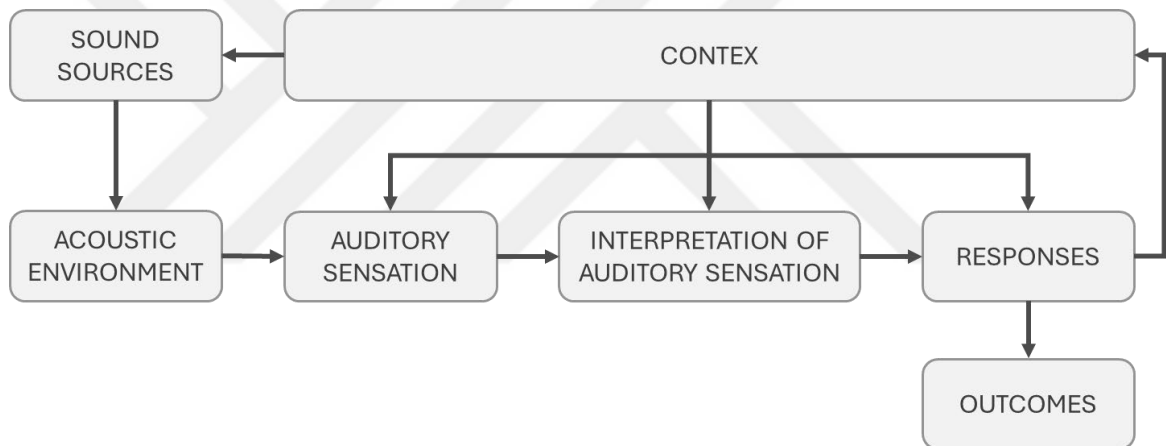


Figure 2. Conceptual framework of the soundscape approach. Adapted from ISO, 2014.

ISO/TS 12913-3 published a Data Analysis standard that extensively specifies the processes one would use to analyze the data collected through stated methods (ISO, 2019). Lastly, ISO/ITS 12913-4 will guide how soundscape data and analysis results can be used to assess environmental noise to identify interventions for urban planning and soundscape design (Schulte-Fortkamp & Jordan, 2023).

Although most studies have been focused on urban soundscapes for decades, many recent attempts have been made to explore indoor soundscapes of buildings, where people spend most of their time and are most affected by the acoustic environment (Torresin et al., 2020a). The indoor soundscape research aims to characterize the “indoor acoustic environment as perceived or experienced and/or understood by a person or people, in the context defined by the building” for designing spaces that support human activities and improve people’s well-being (Torresin et al., 2022). Building on this understanding, we aimed to deepen our knowledge of indoor soundscapes in hospital settings, which are known to be among the most complex and acoustically demanding environments due to the diversity of users, activities, and acoustic needs the encompass.

2.2. Hospital Soundscapes

Busch-Vishniac and Ryherd (2023) referred hospitals as ‘very interesting and challenging’ environments to consider soundscape.’ Hospitals are filled with people and sound sources. Auditory communication is usually critical and immediate in hospitals (Orhan & Yilmazer, 2024). Staff are sensitive to the noisy operations as they might affect the given care by interrupting sleep, mitigate speech communication, and make patients irritated and anxious (Busch-Vishniac & E. Ryherd, 2023). Researchers discussed the reasons why we should consider working on hospital soundscapes (Busch-Vishniac & E. Ryherd, 2023). These compelling reasons were listed from economic to health-related goals. However, efforts to improve hospital soundscapes face several challenges because of the strict infection control policies and rapidly growing medical technologies (Busch-Vishniac & Ryherd, 2023).

A key reason to consider hospital soundscape lies in the large number of people present in these environments all the time. The Organization for Economic Co-operation and Development (OECD) demonstrated hospital in-patient statistics

for 31 countries, including the total number of discharges and the average length of stay (OECD, 2019). Results revealed that the estimates of a country's population in hospital on a typical day ranged from as low as 0.04% in Mexico to 1% in Japan, with a median of 0.3%. The study also emphasized that hospital staff and visitors increase the total number of people present in hospitals, raising the density to a median of 0.6% of the population. Based on the results, it was seen that a large number of people in the world are in hospital any given day, staff on a reoccurring basis, and thus it encouraged researchers to investigate how the hospital environment, including soundscapes, affects its users (Busch-Vishniac & Ryherd, 2023).

The convenience of soundscape depends on the individuals occupying the space and its context (Orhan & Yilmazer, 2021). In hospitals, while staff tend to fall within the standard adult age ranges, patients span a wide demographic; from infants to the elderly (Eurostat Data, 2009). These differences come with varying auditory sensitivities, cognitive abilities, and sound preferences. As such, a one-size-fits-all approach to hospital soundscapes is unlikely to meet the needs of all users. It is, therefore, essential that soundscape researchers and designers develop a nuanced understanding of hospital environments to create soundscapes that support all stakeholders (Busch-Vishniac & Ryherd, 2023). However, the current applications of the hospital soundscapes, and indoor soundscapes in general, are limited to individual evaluations. Therefore, it is challenging to mention that a solution for a patient would necessarily be a solution for staff or any other users in the hospitals.

Another reason why hospital soundscapes should be considered is that the typical building features of the hospitals. Many studies have demonstrated that hospitals are full of hard surfaces and mechanical systems because of the infection control policies (Busch-Vishniac & Ryherd, 2023). Such surfaces offer minimal sound absorption (Deng, Xie, & Kang, 2023). Furthermore, the HVAC

solutions create mechanical noise (Hasegawa, Ryherd, Ryan, & Darcy-Mahoney, 2020). These features contribute to the complexity of hospital soundscapes.

Although noise has been considered among the top issues in hospitals, its importance became clearer with the introduction of patient satisfaction surveys. After the emergence of the term 'value-purchased care' the U.S. hospital fundings tied to HCAHPS (Hospital Consumer Assessment of Healthcare Providers and Systems) (Malone et al., 2008). The noise-related component of the survey has been getting the lowest average score (Jha, Orav, Zheng, & Epstein, 2008). Despite this growing concern, how soundscapes impact the users remained limited. For instance, the relationship between staff turnovers and hospital acoustics or physiological and psychological effects of sound on families and patients are insufficient. Moreover, evidence shows that new hospital buildings are not quieter than the existing ones (Madaras, 2017). This indicates that acoustics are still an overlooked aspect of the hospital design and that it needs to be investigated more.

Majority of the existing research on hospital noise has focused on describing the sound environment. Because of the ethical and logistical challenges of conducting research with vulnerable populations like patients, there is a limited number of rigorous studies exploring the direct impact of soundscapes on hospital staff and patients. Since the early 2000s, there have been more distinctive methods applied to study the complex interactions between sound and humans in hospitals (Busch-Vishniac & Ryherd, 2023). Compared to the existing research on patients, studies focusing on hospital staff are fewer. But the available findings indicate that the acoustic environment can influence staff stress levels, job performance, and occupational well-being (Ryherd, Okcu, Ackerman, Zimring, & Waye, 2012). Among these outcomes, stress has been the top concern. A study monitored pediatric ICU nurses' heart rate, cortisol

levels, self-reported stress, and sound exposures, and found a correlation between perceived noise annoyance and physiological stress makers (Morrison, Haas, Shaffner, Garrett, & Fackler, 2003). Another study reported that 91% of nurses in neurological ICU reported that noise had a negative impact on their work marking symptoms such as irritation, fatigue, concentration loss, and tension headaches (Ryherd, Waye, & Ljungkvist, 2008). All together, these studies suggest a significant relation between hospital noise and staff stress. However, little is known about which sound sources cause such adverse effects. Relatively, it is unknown how much stress could be mitigated through soundscape solutions. This gap in literature challenges us to design effective strategies to enhance the hospital work environment for staff.

Hospital soundscapes significantly influence patient outcomes, as patients are constantly present, vulnerable, and have little control over their acoustic environment (Hsu, Ryherd, Waye, & Ackerman, 2012). Hospitals noise can negatively impact sleep quality, physiological, and psychological well-being. Alarms, phones, and staff conversations cause sleep disruption and increase heart rate (Nguyen, MacDonald, Cignarella, & Miller, 2025; Yang et al., 2025). Psychologically, hospital noise can influence patients' mood, perception of safety, and overall well-being (Busch-Vishniac & Ryherd, 2023) and the exposure to a hospital noise has been demonstrated to reduce positive affect and increase anxiety (Iyendo, 2016).

The complex and dynamic nature of hospital environments make the development of soundscape solutions challenging, especially when relying on standardized approaches. While there have been intervention efforts to mitigate the negative effects of the hospital soundscapes. These interventions do not involve individual's perspectives; therefore, they do not specifically meet the phenomenon of soundscape approach.

2.2.1. Current Soundscape Interventions in Hospitals

Soundscape design refers to plans for changing the acoustic environment or planning a new area (Fiebig & Schulte-Fortkamp, 2023). Soundscape intervention, on the other hand, refers to implementing the design plan to protect or elevate an existing soundscape (Fiebig & Schulte-Fortkamp, 2023). Although soundscape design implementations are becoming popular, successful interventions remain scarce because practical guidelines for implementing soundscape design are rare (Fiebig & Schulte-Fortkamp, 2023). Based on that, Moshona et al. (2023) highlighted the need for documented examples of interventions and design of soundscapes. Previous studies on hospital soundscapes in healthcare used several methods to evaluate the psychoacoustic evaluations, post-occupancy evaluations, and subjective data collections (Orhan & Yilmazer, 2023; Orhan & Yilmazer, 2024) as outlined in previous sections, primarily focused on analyzing existing soundscapes rather than designing new ones. Busch-Vishniac and E. Ryherd (2023) documented current soundscape design strategies and hospital implementations in their study titled 'Hospital Soundscapes.' They categorized those interventions as source, path, and receiver.

Sound interventions focus on reducing alarms and human-based sounds determined by the most common sound sources and perceived as the most annoying for users (Kebapci & Guner, 2023; Orhan & Yilmazer, 2024). There have been several efforts to reduce the number of alarms or their impact. Cvach, Currie, Sapirstein, Doyle, and Pronovost (2013) discussed how to reduce the number of nuisance alarms without blocking safety and successfully achieved one in Johns Hopkins Hospital units. However, they found that even with reductions, alarms were perceived as annoying in ICUs. Reduction of alarms may cause patient safety risks. Therefore, as suggested, sending alarms to the staff devices or trying alternative alarm types like vibrating alarms could reduce noise exposure (Busch-Vishniac & E. Ryherd, 2023).

Conversations between staff, visitors, and patients have been noted as one of the most contributing sounds to the hospital soundscape. Interventions to mitigate the human-based sounds mainly focused on campaigns like 'quiet times' to produce lowered voices (Casey, Fucille, Flavin, & Dow, 2020; Weber et al., 2016). Although some studies highlighted that the staff members and patients appreciated the quiet times (Weber et al., 2016), applying quiet time did not affect average daily noise levels in the NICU (Casey et al., 2020).

Path interventions aim to control building noise by adding surface acoustic absorption (Busch-Vishniac & E. Ryherd, 2023). Since hospitals typically have hard surfaces for ease of cleaning and those materials do not exhibit much sound absorption, applying path interventions to reduce the noise levels has been investigated (Kinjo, Tomiku, Okamoto, & Otsuru, 2023). A study showed that speech intelligibility increased after placing sound-absorbing materials in cancer care units (Barnhill, West, Hsu, & Ryherd, 2010). Another study demonstrated that sound-absorbing curtains supported sound transmission reduction between patient bed spaces and promoted better speech privacy (Pope & Miller-Klein, 2006). Similarly, keeping the patient room doors closed significantly reduced sound transmission between the patient rooms and the corridor and improved the acoustic environment (Kaur, Rohlik, Nemergut, & Tripathi, 2016).

Receiver interventions include adding local sounds, such as sound masking or natural sounds, and using noise-canceling devices (Busch-Vishniac & E. Ryherd, 2023). In their review of the effects of natural sound exposure on health recovery, Zhu et al. (2024) highlighted that listening to natural sounds can reduce anxiety and pain while contributing to the patient's recovery. Another study showed that nature sounds caused improvements in tinnitus symptoms

(Lim et al., 2019). Mackrill et al. (2013) used natural and masking sounds in hospital waiting areas and found that natural sounds significantly improved relaxation. While no significant change was observed with the masking sounds, the study revealed that masking sounds had a more minor impact than the nature sounds.

The use of noise-canceling devices is one of the other receiver intervention types of growing interest lately. Wen, Yang, and Wang (2024) investigated the effect of noise reduction management on patients undergoing surgery. They compared two groups: one using conventional noise reduction management and the other using noise reduction earplugs. The patients using earplugs showed better sleep quality, lower blood pressure, and reduced anxiety scores. Another study found that patients using active noise-canceling (ANC) headphones during dental scaling showed reduced discomfort caused by noise and pain (Kim et al., 2023).

Interventions to alter the hospital soundscape have not been widely adopted. Although those interventions have demonstrated some positive results, there is a need for further research on effective soundscape design and interventions for broader application across hospitals. Implementing soundscape into practice requires a comprehensive approach considering key elements such as people, the acoustic environment, and the specific context (ISO, 2018). However, understanding specific contexts and their complex components during soundscape investigations is challenging (Orhan & Yilmazer, 2024). This complexity can hinder the practical application of a soundscape approach, highlighting the importance of guidelines, recommendations, and examples (Fiebig & Schulte-Fortkamp, 2023). To address these needs, standardization efforts are being made, such as ISO working group 54, "Perceptual assessment of soundscape quality" works on developing part 4 within the ISO 12913 series

to guide on how soundscape design and interventions should be implemented (Fiebig & Schulte-Fortkamp, 2023).

The most recent research presents the concept of co-creation as a central aspect of implementing soundscape into practice, but with the main focus on the urban contexts (Fiebig & Schulte-Fortkamp, 2023). There have yet to be indoor soundscape studies using participatory approaches to design an indoor soundscape that meet the users' needs. No soundscape study has been conducted in the hospitals involving all relevant stakeholders and experts in the research and design process. In order to engage the users and experts with the design process, this study suggests employing participatory approaches to design hospital soundscapes.

2.2.2. Hospital Soundscapes Case Study Examples

In recent years, there has been a growing body of research on soundscapes in healthcare environments. The patient waiting areas (Uğurlu & Yilmazer, 2021; Watts et al., 2016), nursing homes (Aletta et al., 2018), outpatient areas (Yilmazer & Ugurlu, 2022), inpatient units (Mackrill et al., 2013; Bliefnick, Ryherd, & Jackson, 2017), and ICUs (Okcu et al., 2011; Park, Kohlrausch, de Bruijn, de Jager, & Simons, 2014; Orhan & Yilmazer, 2023; Orhan & Yilmazer, 2024) are some of the healthcare environments studied in the scope of soundscape approach. Among the healthcare facilities, hospitals have the most complex soundscapes as they consist of various users, mechanical devices, and sub-systems (Busch-Vishniac & Ryherd, 2023). The following part expands the soundscape studies conducted within the hospital buildings.

Okcu and colleagues (2011) explored whether the objective measurements of noise and subjective responses of nurses differ. They compared old and new ICUs of a hospital. The objective measurement tool was LAeq, and the

subjective data were collected via a questionnaire. The questionnaire explored the noise annoyance, perceived loudness, and work performance of nurses. Results clarified that although the objective measurements slightly differed, the old ICU was perceived as louder, more annoying, and had a more significant negative impact of noise on work performance. The authors empathized that the objective measurements may need to be revised to capture the perception of individuals in terms of annoyance, loudness, and effects on performance.

Mackrill and colleagues (2013) studied in the cardiothoracic ward in a UK hospital. They aimed to explore patients' and nurses' perceptions of soundscapes. After interviewing 27 individuals and analyzing the data via Grounded Theory, results showed that soundscape perception depends not only on specific sound sources but mainly on the physical and social context in which the sound is heard. The study revealed that the sound environment evoked positive and negative feelings in participants. They developed coping methods like acceptance and habituation once they understood the meaning of the sounds. Therefore, results indicate that considering the only sound level to understand hospital soundscape would be inadequate.

Park et al. (2014) investigated the ICU soundscapes using 67-hour audio-recordings. They created an annotated 24-hour segment for source-specific analysis. They have categorized the ICU soundscapes and found that the most dominant sound sources were staff noises, followed by patient-related sounds, alarms, and life-supporting devices. The study demonstrated that the majority of ICU sound sources were modifiable as they were human based and suggested potential areas to improve hospital acoustic management.

Watts et al. (2016) introduced natural sounds and large images of the natural landscape into a patient waiting room in the student health center. They

measured the LAeq level and conducted a questionnaire to measure perceived tranquility before and after the implementations. The result showed that the perceived tranquility improved significantly after the natural sound and images were placed, reducing the patient's anxiety.

Bliefnick et al., (2017) investigated the relationship between inpatient units' soundscapes and patient satisfaction via objective measurements and HCAHPS (Hospital Consumer Assessment of Healthcare Providers and Systems) survey. They measured sound pressure levels in 15 patient rooms and 5 nursing stations over 24-hour periods in five hospital units. They have found that low frequency sound levels (below 35 dBA) were associated with higher patient satisfaction regarding quietness.

Yilmazer and Ugurlu (2022) conducted semi-structured interviews with patients on the waiting area of an oncology clinic to evaluate the soundscape. They have identified the audio-visual characteristics of the space and measured Laeq levels. The results revealed that patients expected to hear relaxing sound sources such as music and natural sounds together with the natural visual elements like water and greenery to enhance their experiences.

Orhan and Yilmazer (2023) conducted qualitative soundscape research in one pediatric ICU and analyzed nurses' perceptions of the soundscape. Following the ISO/TS 12913-2/3, they conducted semi-structured interviews and analyzed the data with the Grounded Theory approach. The study demonstrated that the most dominant sound sources were human-based and technology-based. Like previous soundscape studies, the context was the framework's main category. Participants responded neutrally to alarms and negatively to irrelevant sounds that caused concentration loss and disturbance.

Orhan and Yilmazer (2024) conducted qualitative soundscape research in one neonatal ICU. They aimed to analyze staff members' perceptions of the soundscape. They followed the ISO/ TS 12913-2/3 protocols, conducted semi-structured interviews with ten NICU staff members, and analyzed using the grounded theory. Eventually, they generated a conceptual framework. The study demonstrated that the task-related sounds, including false alarms, were neutrally responded to as they evoked acceptance and adaptation behaviors. The sound sources perceived as irrelevant were responded to negatively. NICU staff indicated that although they expect to hear alarms clearly, specific features of alarms caused several physiological and psychological problems. The study showed that staff members' perceptions and responses primarily depend on the context rather than sound levels.

Most soundscape studies are limited to reflecting how users perceive present soundscapes. However, it has been proved that soundscape design is as important and needed as physical environment (Orhan & Semiha, 2021). Furthermore, it is vital to investigate soundscapes in the context of hospitals to create further understanding to improve such complex acoustic environments (Orhan & Yilmazer, 2023; Orhan & Yilmazer, 2024).

2.3. Pediatric Settings and Acoustics

Pediatric healthcare environments are dedicated to infants, children, adolescents, and young adults (Casimir, 2019), who requiring sensitive care and have unique needs (Jian, 2020). Studies since the mid-1960s demonstrated that hospitalization can be psychologically traumatizing for children (Cartland et al., 2018) because they lack control of their environment (Lerwick, 2016). Many children's hospitals aim to reduce the traumatic experience of hospital stay by providing support services such as therapeutic play, schoolwork, and opportunities for parents to sleep in the patient room and be present during medical procedures (Cartland et al., 2018). Additively, studies aimed to discover

the relationship between the pediatric environments and patients' psychological responses towards it (Cartland et al., 2018; Daraiseh, Hoying, Vidonish, Lin, & Wagner, 2016; Denham, Bushehri, Lim, 2018; Gaminiesfahani, Lozanovska, & Tucker, 2020; Goel et al., 2024; Hasewaga & Ryherd, 2020; Jiang, 2020; Matic, Oh, Lim, & Zimring, 2022; McLaughlan, 2018; Nanda, Chanaud, Brawn, Hart, & Hathorn 2009; O'Hara et al., 2018; Park, 2009; Payam, Hossaini, Zashka, Friedmann, & Mall, 2023; Pearson et al., 2019; Sherman-Bien et al, Malcarne, Roesch, Varni, & Katz, 2011; Vollmer & Koppen, 2021; Yu, Wong, Gignac, Walker, & Ross, 2023).

The environmental factors affecting children, the facilities' most vulnerable patients, have gained significant importance in the past decades (Jian, 2020; Payam et al., 2023). A study has demonstrated that lack of natural light and loud noises can increase stress and anxiety and cause headaches and sleep disturbance (Schweitzer, Gilpin, & Frampton, 2004). Other studies have shown that having control over the environment, social support, and positive distractions, helps patients cope with stress during hospitalization (Andrade & Devlin, 2015; Ulrich, 1991). In their review study, Gaminiesfahani et al. (2020) have demonstrated that environmental factors such as nature, color, noise, lighting, spatial crowding, art, and physical environment affect the well-being and healing of the occupants.

Piaget's theory of children's development demonstrates that children think and process information from the physical environments differently than adults (Revenson & Singer, 1978). Furthermore, Birch, Curtis, and James (2007) claimed that we cannot translate findings from adult to pediatric settings; we cannot assume that children and young people will react similarly to the built environment (McLaughlan, 2018). Research also supported that desired design of healing spaces may differ as ill children would have different needs to adults and require different treatments (Coad & Coad, 2008). Pediatric patients often

feel anxious, stressed, and fearful of being exposed to healthcare settings (Eisen, Ulrich, Shepley, Varni, & Sherman, 2008). Relatively, pediatric patients suffer from health-related concerns and fears during their hospitalization as they are taken away from their familiar environment to fit into a hospital setting (Lawi, 2017; Verschoren, Annemans, Van Steenwinkel, & Heylighen, 2015). This fearful journey of a child being hospitalized in an unfamiliar setting, going through tests and treatments, and losing their self-determination can have both short-term and long-term impacts on their lives (Downing, Martson, & Fleming, 2014; McCormick, 2017).

Hospitals are complex environments where healthcare staff, environmental psychologists, consultants, and architects should confront while designing healthcare buildings (Gaminiesfahani et al., 2020; Hamilton & Shepley, 2010). Additively, Varni et al. (2004) claims that involving users in the design process of healthcare facilities would positively affect mood, health, and satisfaction of them. Designing a desired healthcare setting must expand to a comprehensive level; however, the vast majority of pediatric environment studies focused on the impact of visual aspects of the built environment on users, such as color, artwork, natural lighting and view, furniture, and layout (Coad & Coad, 2008; Nanda et al., 2009; Park, 2009; Pearson et al., 2019; Redshaw & Smithell, 2000; Tivorsak, Britto, Klostermann, Nebrig, & Slap, 2004; Varni et al., 2004). Although noise is known as one of the main stressors that affect the quality of user experience in healthcare facilities (Ulrich et al., 2008), research on acoustic environments is often limited to objective and quantitative measurements and solely focuses on sounds rather than a holistic approach which considers the built environment and context factors.

Studies have demonstrated that hospitalized children, their families, and staff members in PIUs often show several adverse psychological outcomes (e.g., posttraumatic stress disorder, heightened aggression, sleep disruption, burnout,

and anxiety) (Cartland et al., 2018; Latta, Dick, Parry, & Tamura, 2008; Sherman-Bien et al., 2011). Nightingale (1859) emphasized the impact of the healthcare environment on its users' well-being. However, these facilities are full of stressors that negatively impact the users' experiences and perceptions of their physical environments (Sundberg, Olausson, Fridh, & Lindahl, 2017).

Noise is one of those main stressors that affect the quality of user experience in healthcare facilities (Ulrich et al., 2008). The sound levels have progressively increased in hospitals since the 1960s (Busch-Vishniac et al., 2005) and exceeded the levels recommended by scientific organizations (Dawson et al., 2022). Increases in sound levels and constant exposure to them are found to be associated with significant increases in subjective measures of stress in facility users (Kebapçı & Güner, 2022; Kooshanfar et al., 2022; Morrison et al., 2003). Moreover, noisy pediatric environments are contributing factors to staff members' performance obstacles (Kooshanfar et al., 2022), medical errors, and patient safety problems (Kebapçı & Güner, 2022; Santos, Carvalhais, Xavier, & Silva, 2018), cause communication problems between users (Busch-Vishniac et al., 2005).

A growing body of literature addresses excessive sound levels in pediatric healthcare settings (Daraise, Hoying, & Vidonish, 2016; Hasegawa & Ryherd, 2020; Hernandez-Molina, et al., 2020; Jung et al., 2020; Khowaja, Ariff, Ladak, Manan, & Ali, 2022; Mayhew, Lawrence, Squires, & Harrison, 2022; Ramm, Mannix, Parry, & Gaffney, 2017; Vicencio, Ananthanarayana, Khudr, & Monson, 2023) and their adverse effects on patients, families, and staff members' perspectives on the acoustic environments (Beken et al., 2021; Cardoso, Kozłowski, de Lacerda, Marques, & Ribas, 2015; Chawla et al., 2017; Darcy, Hancock, & Ware, 2008; Gholami, Borimnejad, Jafari, Rasouli, & Ranjbar, 2023; Restin et al., 2021; Sabetsarvestani et al., 2022; Santos et al., 2018; Spagnol et al., 2022). However, these studies are limited with objective and subjective measurements and lack user involvement.

Hospitals need better-designed spaces that promote healing (Litwin et al., 2023). If spaces are not designed for their users' needs, the procedures may take longer, patient and staff safety may be impacted adversely, and users would have unsatisfactory experience (MacAllister, Zimring, & Ryherd, 2016). Moreover, evidence-based facility design studies show that well-designed built environments can encourage positive medical outcomes (DuBose, MacAllister, Hadi, & Sakallaris, 2018; McLaughlan, 2018; Mourshed & Zhao, 2012; Schweitzer et al., 2004; Ulrich et al., 2008).

In pediatric settings, child-friendly environments can enhance patient and family responses, including experiencing higher quality of service, increased satisfaction with care, less fear and anxiety for caregivers, reduction of pain perception, and use of pain and sedation medications (Malenbaum, Keefe, Williams, Ulrich, & Somers, 2008). Pediatric environments are unique in terms of fostering family and child-centered care (Casimir, 2019). Human-centered design methods can be applied in healthcare facilities to make spaces uniquely suited to users' needs (Lorusso, Lee, & Woorden, 2021). Involving patients, families, and staff members in designing an optimal pediatric environment may result in more efficient, comfortable, and safer solutions to meet the specific needs (Litwin et al., 2023), which would be a new era of healthcare spatial design that is multidisciplinary and collaborative (Pentecost, 2022).

PD aims to bridge the gap between users, communities, and designers and directly involve them in co-designing tools from the concept stage to the final design stage (Becker-Haimes et al., 2022; Shanthi Priya et al., 2020).

Participation in design encourages users to react for human rights, freedom, and the right to be part of decisions (Manahasa et al., 2021). Given that the pediatric environments accommodate various users, and they have various needs,

participatory processes would help create manageable and appropriate environments for each user type.

2.4. Participatory Design

The Handbook of Participatory Design (Simonsen & Robertson, 2013) defines Participatory Design (PD) as:

“a process of investigating, understanding, reflecting upon, establishing, developing, and supporting mutual learning between multiple participants in collective ‘reflection-in-action’ (Schön, 1992). The participants typically undertake the two principal roles of users and designers where the designers strive to learn the realities of the users’ situation while the users strive to articulate their desired aims and learn appropriate technological means to obtain them” (p.2).

PD is a main concern for designers who works with users, thinking together to achieve a shared goal, a mutual learning process, and ensuring that both the final design outcomes and participants’ learning experiences are treated as valid goals (Bødker, Dindler, Iversen, & Smith, 2022). PD is committed to democracy, empowerment through design process, emancipatory practices based on mutual learning among designers and users, and recognition of human beings as skillful and resourceful to develop future practices (Bødker et al., 2022).

PD bridges the gap between local participation and larger project issues instead of only aiming to satisfy a small group of users (Bødker et al., 2022).

Researchers highlighted the broad scope of PD and discussed how it is applied in various contexts including product development, organizational development, and consultancy (Grønbæk, Grudin, Bødker, & Bannon, 2017). Another study

emphasized that PD extends to political and public organizations, in which workers and citizens participate to represent their peers in large-scale projects (Bødker, Dindler, & Iversen, 2017). Therefore, it is important to consider the participant selection, which can be based on the representativeness of trust, skill, or organizational roles of the peers, while planning a PD project (Bødker and Grønbæk, 2020).

The term PD is used for both in research and practice, which makes it complicated to compare it with other design approaches. While one group sees PD as similar to Interaction Design practices which refers to any design process that involves non-designers, others see it as a political engagement that grounded in democratic values and empowerments (Bødker et al., 2022). To differentiate the design approaches, Sanders and Stappers (2008) developed two parameters: (1) the extent to which the process is led by design or by research and (2) the extent to which participants are seen as “subjects” or “partners” in the design process. Based on this differentiation, it was clear that PD is the only human-centered approach in which participants are seen as design partners in either design- or research-based projects. However, because of the emergence of new approaches, the scope of human-centered design rapidly evolved. Therefore, over the years, PD has exchanged ideas with other design approaches, integrated and shared tools and techniques (Bødker et al., 2022). Now, although it is challenging to distinguish clear boundaries between PD and related disciplines, the legacy of PD remains still.

The origins of PD can be traced back to the various social, political, and civil rights movements of the 1960s and 1970s when individuals in Scandinavian countries demanded to have a more excellent saying in decision-making on various aspects of their lives and to participate in collective action centered on shared interests and values (Malinverni, Mora-Guiard, & Pares, 2016; Simonsen & Robertson, 2013). An early example of emergence of PD example can be

seen in helping the white- and blue-collar workers to understand and discover alternatives to technologies imposed by their management (Bødker et al., 2022). Ehn and Sandberg (as cited in Bødker et al., 2022) explained that the main goal was to make the design process democratic and counterbalance management's control over technological developments, which created a core commitment to the workplace democracy.

Researchers emphasized that empowering workers require active collaboration throughout the design process and claimed that this evolution of PD could not be possible through conventional expert process alone (Nygaard & Bergo, 1975). This perspective generated the development of the mutual learning concept which indicates the need for designers, researchers, and users to collaborate and learn from each other's experiences (Bødker et al., 2022). These events made designers consider how users might relate to their practices (Simonsen & Robertson, 2013). For instance, in 1971, the Design Research Society conference theme was arranged as Design Participation (Cross, 1972). Relatively, architects and town planners began to try to find a way to include individuals in several aspects of their everyday built environments (Simonsen & Robertson, 2013).

Today, PD is used in a variety of fields (e.g., software design, information systems, consumer products, humanitarian solutions, geography, urban designing, architecture, planning, and workplace layout) (Pelliccia et al., 2021; Drain & Sanders, 2019; Shanthi Priya, Shabitha, & Radhakrishnan, 2020; Sanoff, 2022). Based on its foundations, it can be noted that the PD is a unique methodology with its overlaps and distinctions with other design approaches. The following sections highlight essential elements of PD including activities, methods, tools, and techniques, and its reflection on architectural field.

2.4.1. Activities and Methods of Participatory Design

Bødker et al. (2022) presented the overview of typical PD activities via field studies, workshops, collaborative prototyping, infrastructuring, and evaluation. Their work, although written in the scope of Human-Computer Interaction (HCI), highlights how PD methods can be applied across a wide variety of disciplines and industries. However, as PD occurs across these multiple contexts and has an increasingly broader aim, no single methodological approach to “participation” has emerged as a best practice in the field (Bowler, Wang, Lopatovska, & Rosin, 2021). Therefore, the focus should be not on the uniqueness of PD methods but on how they are applied to foster participation and collaboration (Hansen, Fourie, & Meyer, 2021).

In their work, Bødker et al. (2022) compares the traditional user-centered design activities with PD activities based on Preece, Sharp, and Roger (2019) and Hansen et al.’s (2019) model (Figure 3). Preece et al.’s (2019) model represents the analyses of existing approaches to establish requirements for understanding the future user needs, design alternatives for suggesting ideas to cover these requirements, prototyping for creating ideas available to users, and evaluating the quality of the design. The model developed to compare the main activities by Hansen et al. (2021) presents alternative activities to better capture PD activities. Although their model has strong similarities to the standard user-centered design model, it specifically emphasizes mutual learning, collaboration, and sustainability of the results via social, organizational, and technical infrastructures.

USER-CENTERED DESIGN		PARTICIPATORY DESIGN	
ACTIVITIES	PURPOSE	ACTIVITIES	PURPOSE
Establishing Requirements	• Understanding the needs of future users	Field Studies	• Understanding practice and initiating mutual learning
Designing Alternatives	• Suggesting ideas that meet requirements	Workshops	• Facilitating the meeting between diverse stakeholders
Prototyping	• Making tangible representations of design ideas for users to engage with	Collaborative Prototyping	• Collaboratively exploring and developing design alternatives
Evaluating	• Measuring the qualities (e.g., usefulness, usability, etc.) of the designed product	Infrastructuring	• Securing that social, organizational, and technical infrastructures are in place to support sustainability of results
		Evaluation	• Assessing the outcomes of design

Figure 3. Comparison of a general user-centered design model (left) and the participatory design model (right). Adapted from Bødker et al. (2022).

Field Studies

Field studies in general involve methods conducting in a setting where ongoing activities naturally occur (van de Ven & Poole, 2017). A variety of other terms are often used to describe the field research methods including qualitative research, case study, observation, and ethnography (van de Ven & Poole, 2017). Such studies generally use observation and interviews to collect data. On the other hand, field studies in the scope of PD does not focus solely on data gathering, but also on collaborative reflection and starting mutual engagement (Bødker et al., 2022). Therefore, the field studies in PD usually ground for following workshops, prototyping, infrastructuring, and evaluation steps (Bødker et al., 2022).

Field studies are usually used to familiarize PD researchers with the existing phenomena that need to be changed (Bødker et al., 2022). Therefore, concrete methods like interviews and observations evolved into active engagement with

users in their own contexts (Spinuzzi, 2005) for an informative involvement (Scariot, Heemann, and Padocani, 2012). Field studies typically highlight how users are skillful and resourceful in their everyday activities and aim to foster mutual learning between users and researchers, or designers (Bødker et al., 2022). While their primary focus is often on understanding present practices, field studies can also explore future possibilities when using collaborative approaches in the scope of PD (Smith et al., 2016).

Workshops

Workshops are considered as pivotal practice of PD as they facilitate direct and active collaboration among designers, researchers, and users (Bødker et al., 2022). Workshops are structured design events in which participants with diverse backgrounds engage in common goals, which are collaborative understanding, helping stakeholders explore and develop a shared vision (Bødker et al., 2022). Workshop methods can vary widely depending on the participant, content, and context. For instance, PD has delved into working with vulnerable populations and children in design, with specific workshop formats developed to engage young participants (Baek & Lee, 2008; Lozanovska & Xu, 2013).

Design workshops that are organized around co-design methods are often considered helpful enhance collaboration, securing stakeholder trust, and gain meaningful input from users and designers or researchers (Hanington & Martin, 2022). Such workshops encourage participants to actively contribute to ideation using techniques like mapping, diagramming, and card sorting to articulate their experiences; and may also involve sketching, mockups, or roleplay interactions (Hanington & Martin, 2022). These workshops are used for research and development, as well as for teaching non-designers the principles of creative collaboration (Hanington & Martin, 2022).

Collaborative Prototyping

Prototypes are considered as essential design resources within the user-centered PD process as they enable considering various design possibilities at a time and creation of specific design alternatives (Mackay & Beaudouin-Lafon, 2023). Collaborative prototyping in PD is a process-oriented, co-creative activity that aims mutual learning between designers and users (Bødker et al., 2022). During this activity, non-designers are supported with accessible materials to reflect their ideas. Interactivity of prototypes are distinguished under three types: (1) noninteractive prototypes that do not involve interaction directly, but support designers in considering various interaction possibilities; (2) fixed-type prototypes that involve limited interaction and pre-scripted models to guide users through a predetermined sequence of actions; (3) open prototypes that allow users to experiment with a several interaction options (Mackay & Beaudouin-Lafon, 2023). Designers can develop prototypes with varying degrees of interactivity to tackle specific design challenges throughout the PD process (Mackay & Beaudouin-Lafon, 2023). Beyond interaction, collaborative prototyping can evoke new thinking (Kannabiran & Bødker, 2020) and help users imagine future practices (Bødker et al., 2022).

Infrastructuring

The infrastructuring in PD refers to ongoing activities that designers and users engage in to generate required social, organizational, and technical infrastructures to reach sustainable outcomes (Dantec & DiSalvo, 2013). Although this activity is often conducted in technology-related (e.g., computer sciences) PD projects (Sanders, Brandt, & Binder, 2010; Simonsen, Karasti, & Hertzum, 2019), its conceptual foundation in the public formation around the shared issues (Dantec & DiSalvo, 2013) expands its applicability in non-technological contexts. The primary focus of this process is to ensure that the results and their influence are maintained in the long term (Bødker et al., 2022). Therefore, one can say that infrastructuring is important as it encourages

continuous participation and adaptability of communities in addressing shared problems (Dewey, 1954). Instead of treating design as an infinite process, infrastructuring in PD enhances long-term engagement for continuous collaboration and equality in communications (Kyng, 2015).

Evaluation

In PD, evaluation involves the assessment of both the process and the final product (Bødker et al., 2022). They are often informal and take place during or after the project, rarely documented in detail, and expectedly makes it difficult for outsiders to understand or evaluate them (Bødker et al., 2022). However, as Nguyen (2022) claimed, evaluation in PD is not yet well-established. Previous works suggested various approaches including evaluating both the process and product within organizational settings (Kensing, Simonsen, and Bødker, 1998), extending the scope of evaluation and including long-term impacts on populations (Merkel et al., 2004), and retrospective evaluations after the project has completed (Bødker et al., 2022). Nguyen (2022) suggests several reasons why structured and systematic evaluation has not become a common practice in PD. First, as evaluation requires significant effort and resources, it is often seen as unnecessary and overly demanding. Second, the complex structure of PD makes valuable and context-sensitive evaluations challenging. Lastly, the innovative and non-traditional approaches included in PD process can be different from the traditional evaluation methods. Despite such challenges, evaluation in PD is essential for improving PD practices. Therefore, any form of evaluation in PD must be aligned with its methodology to make the process and outcomes more visible and discussible both within and beyond the PD community (Nguyen, 2022).

The key activities of PD, including field notes, workshops, collaborative prototyping, infrastructuring, and evaluation are expanded as outlined by Bødker

et al. (2022). Previous studies revealed that PD shares tools and methods with other design approaches, but it is distinct in how these methods are employed. PD combines current and future designs through infrastructuring considering the evolving nature of human practices. Compared to standard user-centered models, the PD is one method that actively involves the intended audience (Arcia, Stonbraker, Mangal, & Lor, 2024) and the process involves less direct control over the design process by researchers, which emphasizes the necessity of equality, mutual learning, and collaboration among participants throughout the process.

2.4.2. Tools and Techniques of Participatory Design

Although PD practices have developed significantly over the last decades, the tools and techniques remain unstructured and often context specific. Therefore Sanders et al., (2010) developed a broader framework to organize the fragmented situation. This framework eased the tool and technique selection procedure for researchers and designers via three components: form, purpose, and context (Figure 4) (Sanders et al., 2010).

Form stands for the type of action that takes place between the participants during the activity. They identified the *Form* as making, telling, and enacting. *Purpose* refers to why the tools or techniques are being used. It was expanded with four components: (1) for probing participants, (2) for priming participants to engage them into domain of interest, (3) to better understand their current experience, or (4) the generation of ideas and design concepts for future (Sanders et al., 2010). Lastly, *Context* identifies where and how these tools and techniques are used and has additional four components as (1) group size and composition, (2) face-to-face vs online, (3) venue, and (4) stakeholder relationship.

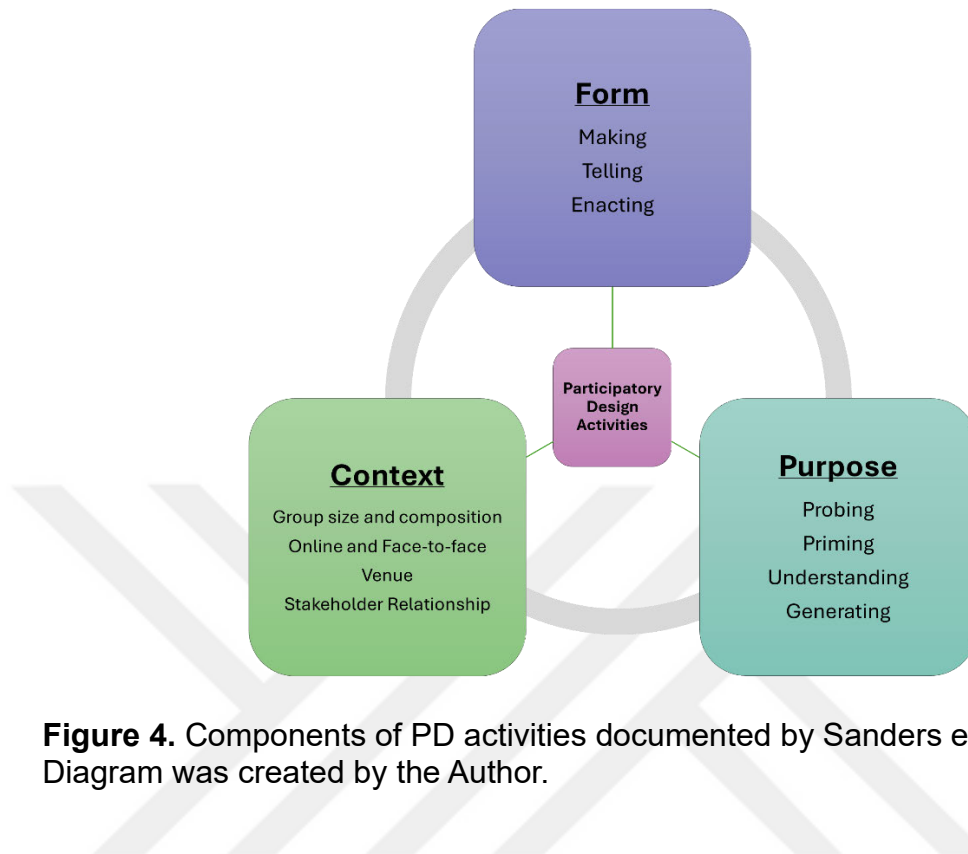


Figure 4. Components of PD activities documented by Sanders et al. (2010). Diagram was created by the Author.

The framework presents an overview of PD tools and techniques to engage in PD activities. Using each of the *forms* with any of the *purposes* is possible (Sanders et al., 2010). In PD, it is essential to understand the *purpose* and *context* of the tools and techniques to integrate them in specific projects (Sanders et al., 2010) as it can be applied in various different fields that require unique processes (Brandt, Binder, & Sanders, 2012). Researchers developed charts that were organized around the *form* component to represent the tools and techniques being used, where X's stand for the *forms'* relation to their *purpose* (Figure 5) (Sanders et al., 2010). This chart identifies three classes of activities: (1) making tangible things, (2) talking, telling, and explaining, and (3) acting, enacting, and playing (Ozkaynak, Sircar, Frye, & Valdez, 2021). When planning the PD research method, it is important to consider the *context* in which the tools and techniques have been used to provide relevant and sufficient approach (Brandt et al., 2012).

Sanders et al. (2010) have documented the context related variables indicating that they shape how people engage, collaborate, and contribute to the PD process. For instance, participants working in groups or individually may impact the depth and richness of insights will be gathered. Similarly, choosing online versus in-person formats affects the types of activities that are feasible. Moreover, the setting influences the participants' comfort, familiarity, and accessibility, which directly affects the relationship between users and designers or researchers in terms of trust, motivation, and engagement quality. Altogether, these components create the context of PD and identify how participatory efforts are implemented in actual design activities (Sanders et al., 2010).

Among these tools and techniques listed in the framework, design games have been one of the widely used tools as they are the most effective forms of collaboration. Brandt and Masseter (2004) identified the goal of using design games during the workshops as "to help facilitate a user-centered design process for cross-disciplinary design groups early in the design process." They claimed that design games would enhance ideas and communication among designers and stakeholders and improve collaboration. The notion of design games was first introduced by Habraken and Gross (1987) with direct reference to Wittgenstein's language games (Brandt, Binder, & Sanders, 2012). Habraken and Gross (1987) modeled design games as a dialogical engagement of design, guided by a set of rules and progressed sequentially between players. They used the concept of the design game to identify different aspects of the design process. However, over the years, this concept has been used to shape the design participation and participatory process (Brandt et al., 2012).

Design games are used in a variety of forms including research (Habraken & Gross, 1987), building design competence (Iversen & Buur, 2002), empowering users (Ehn & Sjörgen, 2020), and engaging multiple stakeholders (Buur & Sondergaard, 2000; Brandt & Messeter, 2004; Johansson, 2005). Design games

are developed as a tool to engage users and designers in the early stages of the design process as a common goal (Jessen, Mirkovic, & Ruland, 2018).

TOOLS AND TECHNIQUES	PROBE	PRIME	UNDERSTAND	GENERATE	INDIVIDUAL	GROUP	FACE-TO-FACE	ONLINE
MAKING TANGIBLE THINGS								
2D collages	X	X	X	X	X	X	X	X
2D mappings		X	X	X	X	X	X	
3D mock-ups			X	X	X	X	X	
TALKING, TELLING AND EXPLAINING								
Stories and Storyboarding	N/A	N/A	N/A	N/A	X	X	X	X
Diaries	X	X	X		X		X	X
Cards			X	X	X	X	X	
ACTING, ENACTING AND PLAYING								
Game boards, game pieces, and rules		X	X	X	X	X	X	
Props and black boxes			X	X	X	X	X	
Participatory envisioning and enactment				X	X	X	X	
Improvisation				X	X	X	X	
Acting out, skits and play acting			X	X	N/A	N/A	N/A	N/A



Figure 5. Framework shows PD tools and techniques that help enhance PD activities.

Design games enable participation and help to develop skills of telling, making, and enacting in any participatory practice (Brandt et al., 2012). Design games are conceptually very diverse, and they refer to any game (e.g., digital, board, card games, physical role-plays) used for design purposes (Harvianien & Melkko, 2022; Harvianien, Vaajakallio, & Sproedt, 2016). They are not competitive games, but there are rules for idea creation, turn-taking, and fostering for starting innovation and change (Harvianien & Melkko, 2022; Hannula, 2020; Vaajakallio, 2012). Design games aim to share participants' prior experiences and to plan new futures (Vaajakallio & Mattelmaki, 2014). There is a growing body of literature organizing co-design workshops to engage stakeholders in the design of products (Gennari, Matera, Melonio, & Roumelioti, 2019).

Today, determining the organization of PD processes in which users can be involved in many ways requires careful selection of methods, activities, tools, and techniques. PD requires structured organization instead of continuous direct collaboration between designers, researchers, and users (Bødker et al., 2022) because not all stakeholders are required to engaged at each phase of the process (Brandt et al., 2012). Therefore, participation have a fixed meaning across phases (Bødker et al., 2022).

Researchers have been developing frameworks for organizing PD methods and activities for decades, mostly focusing on HCI field. For instance, Kyng (1995) created a PD model for technological implementations, which highlights well-defined and less structured activities involving users and professionals. However, Kyng's model does not necessarily reflect the ongoing coordination work required to maintain PD process. After that, researchers expanded on these findings and differentiate the activities focusing on certain tasks, broader organizational practices, and cross-community interactions (Obendorf, Janneck, & Finck, 2009) Their approach highlights the importance of bridging user

organizations to enhance shared understanding and values. Lastly, a study elevated this notion by emphasizing how PD projects can connect communities beyond the boundaries of individual organizations (Bødker, Dindler, & Iversen, 2017). Although these contributions demonstrated that the successful PD depends both on iterative involvement of users and continuous development of organizational structures (Bødker et al., 2022), a comprehensive approach or framework for organizing PD process remains incomplete.

In PD, some researchers use methods such as field observation, interviews, group mappings, and focus groups (Becker-Haimes et al., 2022; Sanoff, 2022; Lynch et al., 2021), some use collective feedback on mockups or prototypes from stakeholders during the design phase (Robertson & Simonsen, 2012; Dopp, Parisi, Munson, & Lyon, 2019), and interactive decision-making techniques via workshops (Sanoff, 2022). PD method is a purposeful combination of tools and techniques to guide participants through a meaningful design process (Sanders et al., 2010). Each PD activity is developed to prepare the next based on making, telling, and enacting (Brandt et al., 2012). The foundation of project aims in PD have generated primarily for Information Technologies (IT). However, today the scope of PD expands upon various fields including space design, product design, industrial design, architecture, and service design (Sanders et al., 2012). As each field has its own unique requirements and contexts, it is crucial to decide which methods, tools, and techniques to use.

Among this wide range of methods and techniques available for designers, Nisha (2022) emphasizes the effect of exploring through design-by-doing and/or design-as-play to enable participation. Although there are standardized measurement instruments to assess patient, family, and staff perceptions of the hospital environment (Varni et al., 2004), those well-developed measurement instruments are primarily for evaluating the adult healthcare settings. Studies

stated that most research design methodologies in adult environments cannot be perfectly applied to pediatric environments as children's perceptions, needs, and behaviors differ from the adults' (Shepley, 2005; Shepley, 2014). The design practice can be seen as a collection of interconnected activities that bridge approaches, methodologies, methods, and tools, which enable practitioners to collaborate and shape design outcomes for various different field (Villa Alvarez, Auricchio, & Mortari, 2022). As we decided to carry out the study with children's participants, we focused more on the play and game integrated methodologies.

2.4.3. Overview of General Outcomes from Participatory Design Methods

PD is originated on the premise that "If we are to define the futures we wish to live, then we need those whose futures they will be to participate in their design actively" (Robertson & Simonsen, 2013, p. 1). In architecture and planning, PD is described as a process of "supporting mutual learning" between participants in "collective reflection-in-action" (Robertson & Simonsen, 2013, p. 2; Nisha, 2022).

Bringing stakeholders together and creating a space for discussion offers better outcomes, such as increasing efficiency and efficacy and reducing the risk of costly errors (Hall et al., 2021). Moreover, participatory approaches support individuals to be open to sharing knowledge, experience, expertise, and ideas while providing various perspectives on the topic (Hall et al., 2021). The positive outcomes of the PD process are also associated with the solutions that emerge from the users' knowledge (Spinuzzi, 2005) and the creation of collective intelligence (Fischer, Giaccardi, Eden, Sugimoto, & Ye, 2005; Sanoff, 2022).

The PD approach aims to involve all relevant stakeholders as active contributors to each phase of design process (Pelliccia, Bojko, Prielipp, & Riedel, 2021), which consists of planning, implementation, and evaluation of a given topic (Hall, Gaved, & Sargent, 2021; Slocum 2003). It originated as a collaborative product

design method to engage end-users while designing new products via various methodologies (Becker-Haimes et al., 2022; Robertson & Simonsen, 2012; Simonsen & Robertson, 2013). Nonexpert users who do not have professional education in design make active decisions about the future use of spaces, needing their feelings, ideas, and needs to be reflected in the design (Kwieciński & Słyk, 2023). Sanoff (2022) claims that PD is an attitude about a force for change in creating and managing environments for people. PD is “a process of investigating, understanding, reflecting upon, establishing, developing, and supporting mutual learning between multiple participants in collective ‘reflection-inaction.’” (Simonsen & Robertson, 2013). In this process, designers learn the realities of users, and users work to express their desired aims (Simonsen & Robertson, 2013).

Using PD allows different users to contribute to the design results, assess final solutions, and ensure the results meet their needs (Stappers & Visser, 2007; Bødker & Iversen, 2002). A growing body of literature also has shown that designers create more innovative conceptual approaches if they work within a co-design environment rather than independently (Pelliccia et al., 2021; Mitchell, Ross, May, Sims, & Parker, 2015; Trischler, Pervan, Kelly, & Scott, 2017). User involvement in the design process from initial concept to final assessment is low, and users’ needs are mostly considered functional, but their physiological and psychological needs are mostly neglected (Shanthi Priya et al., 2020). PD allows users to be involved and helps develop this process (Manahasa, Özsoy, & Manahasa, 2021).

2.4.4. Current Applications of Participatory Design in Built Environments

PD practices in architecture have been concerned with social engagement which focuses on user collaboration and meaningful cooperation between architects and stakeholders throughout the design process (Luck, 2007). It also emphasizes the direct involvement of users in design and decision-making

processes to elevate the design outcomes and maintain continuous learning (Luck, 2003). PD in architecture has been influenced by action research methods (Lewin, 1946) and demographic principles (Sanoff, 2000), which blurred the conventional boundaries between the architects and the user, as users became active participants who would shape their environments (Luck, 2003). Therefore, in years, PD has transformed architects' relationships with users and fostered collaboration, engagement, and empowerment (Luck, 2018b). Today, the current applications of PD in architecture include both facilitating user input and empowering users as co-designers of their built environments based on their unique needs.

Herriot (2017) explored the PD role in a hospital building design in Denmark. The researcher conducted interviews with architectural experts from three major design firms to understand how and to what extent real hospital users were involved in the design process. The study revealed that even though workshops, interviews, and mock-ups were used as consultation methods, the direct patient participation has been limited. Given that the complex and vulnerable nature of patient experiences in the hospitals, the study suggested that PD practices must be restructured to prioritize patient and other users' input for the hospital design.

Könings, Bovill, and Woolner (2017) analyzed stakeholder participation in the design process of educational buildings. The research was conducted in the UK and Netherlands with various stakeholders. Researchers suggested a new participation model that highlights various roles stakeholders can take at each stage of design process including informing, consulting, partnering, or decision-making. The student involvement in designing educational buildings was found to be essential.

Another architectural PD study in educational buildings was conducted with the involvement of secondary school students in Finland (Mäkelä, Helfenstein, Lerkkanen, & Poikkeus, 2017). Over 300 students involved in various PD activities including co-design workshop, feedback sessions, expert evaluation, and satisfaction surveys. Researchers emphasized that the students' active participation helped create more personalized and user-centered learning space design. As PD in school design positively impacted the design quality and students' well-being, the researchers concluded that involving users' perspectives can lead to more effective and adaptive built environments.

Costa (2024) examined how student experiences during the COVID-19 could inform the ideal learning environment through PD. They conducted focus group interviews and co-design workshops to (1) capture students' perceptions on home and school learning spaces and (2) design an ideal classroom. After these collaborative sessions, the findings revealed several built environment features to create flexible, comfortable, and adaptable educational spaces. The study concluded that PD integration was beneficial in architectural design as it fostered user engagement and helped create ideal, personalized, and conducive learning spaces.

Markkanen and Herneoja (2024) investigated the role of PD in shaping workplace environments with a specific focus on the effect of physical environment on work experience and satisfaction. Researchers engaged with the employees in three phases. In pre-design phase, they have conducted semi-structured interviews with employees to gather data on their daily tasks, needs, and coping strategies. Then, the co-design workshops were conducted and employees worked in groups to identify work related scenarios, spatial needs, and co-create potential design solutions. The workshops were supported through visual examples and guided discussions. During the design phase, the insights gathered through interviews and workshops were used to create

interventions in shared spaces. Lastly, in the post-design phase researchers gathered feedback, which showed that the changes increased employee satisfaction. The study demonstrated how PD approaches could effectively inform design decisions and enhance user experience.

PD process is considered as a site for learning and changing participants' understandings and appreciation toward their community (Luck, 2018a). Studies have shown changes in the mindset, knowledge, emotions, and social relations of individuals participating in the PD process, claiming that they become empowered and aware of their capacities in their living environments (Lam et al., 2018). There are a few studies applied PD methodologies in the built environment, and these are limited to the physical environment features. Therefore, there is a notable gap in the literature regarding the applications of PD in acoustic environments. The existing literature has primarily focused on sound design with co-listening activities to create more inclusive and accessible auditory experiences in object scale (Cullen & Metatla, 2019; Hardey & Rieger, 2021; Yoo et al., 2024), digital technologies (Moesgaard, Herneoja, & Bødker, 2020), or as a tool for urban planning support (Tarlao, Steele, Blanc, & Guastavino, 2023). There are a few studies that PD methods used in urban soundscape context.

A case study was conducted focusing on co-creation with residents to address noise issues from a local beer garden (Brooks, Schulte-Fortkamp, Voigt, & Case, 2014). They employed various community participation methods including sound surveys and stakeholder workshops. They found that the participatory process clarified an unexpected outcome: residents emphasized the importance of venue to the community identity and decided not to mitigate the beer garden's noise.

Another study explored the necessary elements for successful electronic public participation in the urban soundscapes (Fiebig, Schulte-Fortkamp, & Genuit, 2016). The elements included clear call, transparency, appreciation of participation, clear initiative targets, feedback, equal rights for participants, information about data use, professional digital platform, representations of all actors concerned, impartiality of stakeholders, transparent information processing, and data sharing and open access. The researchers highlighted that offering an electronic participation itself is not enough to achieve high engagement. They suggested designers and researchers carefully structuring the participation process to enhance meaningful public involvement.

Steele, Kerrigan, and Guastavino (2019) highlighted the need to bridge the gap between soundscape evaluations and PD models to improve the quality of urban soundscapes. Their work focused on two workshops conducted as part of Sounds in the City partnership with the City of Montreal, in which they compared various participation formats and provided recommendations for future works. They indicated empowering local experts to engage in urban sound planning through PD methods by making them to better represent their interests.

In 2018, researchers developed a model of flexible participatory urban soundscape planning process (Xiao, Lavis, & Kang, 2018). Their model suggested various participation and engagement methods for urban scales ranging from street level to city level. Researchers emphasized that different methods are needed to effectively engage stakeholders at each stage of urban soundscape planning and design processes. In addition, it was suggested that the design plans should be evaluated at every phase to sustain flexibility and maximize possibility to create the most pleasant and healthy urban developments (Renterghem, Dekoninck, & Botteldooren, 2020).

The soundscape approach considers people, acoustic environment, and context (ISO, 2018). Examining the specific context, inclusion of all relevant stakeholders, and effective communication across research disciplines in soundscape studies are complicated and challenging (Fiebig & Schulte-Fortkamp, 2023). This complexity encouraged the creation of new guidelines to address various needs. For instance, part four of ISO 12913 series is being prepared on “Perceptual assessment of soundscape quality” to provide standardized and detailed information about identifying the need for soundscape interventions and how they should be implemented (Fiebig & Schulte-Fortkamp, 2023). In that sense, co-creation and participation in soundscape studies are recognized as a necessary attribution.

In the scope of co-creation, Fiebig and Schulte-Fortkamp (2023) indicated that the knowledge of local experts is fundamental. They claimed that the move from passive role of residents to active participants and co-creators is a demanding perspective in urban contexts. Local experts are defined as ‘person who is familiar with the area under scrutiny either living in the area or having further daily routines related to the area’ (ISO, 2018) and therefore they can provide valuable information regarding necessary measures (Fiebig & Schulte-Fortkamp, 2023). The users of space are considered as the primary expert in any environment, and their contribution enables creative, innovative, and responsive solutions for the acoustic design (Fiebig & Schulte-Fortkamp, 2023; Lavia, Dixon, Witchel, & Goldsmith, 2016). Users’ participation would help the research and design teams better understand and analyze the soundscape data more sensitively (Schulte-Fortkamp & Jordan, 2016).

Current applications in soundscapes emphasize the necessity of further research on soundscape design to reduce the gap between theory and practice (Carvalho, Davies, & Fazenda, 2019). Considering the existing issues on achieving this, Fiebig & Schulte-Fortkamp (2023) documented goals for the

future soundscape studies including integration of stakeholders in all stages of urban soundscape planning. Soundscape plays a vital role in the quality of well-being and health (Orhan & Yilmazer, 2024). Although the most recent studies claimed that it is critical to engage local experts to achieve a good understanding of soundscape concepts, the initial work is only limited to the urban soundscapes. To our knowledge, there is yet another study focused on participatory approaches in hospital soundscapes.

Due to addressing this existing gap in the literature, including 1) the need to understand how different user groups perceive hospital soundscapes; 2) the identification of ideal hospital soundscapes for different user types; 4) the application of Participatory Design methods, tools, and techniques in hospital soundscape research, this study aimed to investigate the role of PD approach in designing the soundscape of a pediatric inpatient unit. The next section will provide a comprehensive overview of the research questions, hypotheses, and methodology of the study. The following chapter covers the six phases of the methodology, expanding on the study design, procedures, setting, participants, tools and techniques, and data analysis of each phase. Additional details are provided in each study phase.

CHAPTER III

METHODS

3.1. Research Questions and Hypotheses

In an attempt to address the aforementioned gaps our study addresses the following research questions:

RQ1: How can interpreting hospital soundscapes with PD methods inform the soundscape solutions?

RQ1a: How can built and acoustic environments in pediatric healthcare settings be co-created through PD methods, tools, and techniques?

RQ1b: What factors influence the effectiveness of PD methods in hospital soundscape development?

Based on the aim of the research and the literature, we prepared three research hypotheses as follows:

H1: Interpreting hospital soundscapes with PD methods can lead to more inclusive soundscape solutions.

H2: Co-design workshops can enhance stakeholder engagement, collaborative decision-making, and lead to empathic hospital soundscape solutions.

H3: PD methods may provide more in-depth insights of hospital soundscapes regarding cultural and contextual specificity; however, these findings may not be universally generalizable across all environments or populations.

3.2. Study Design

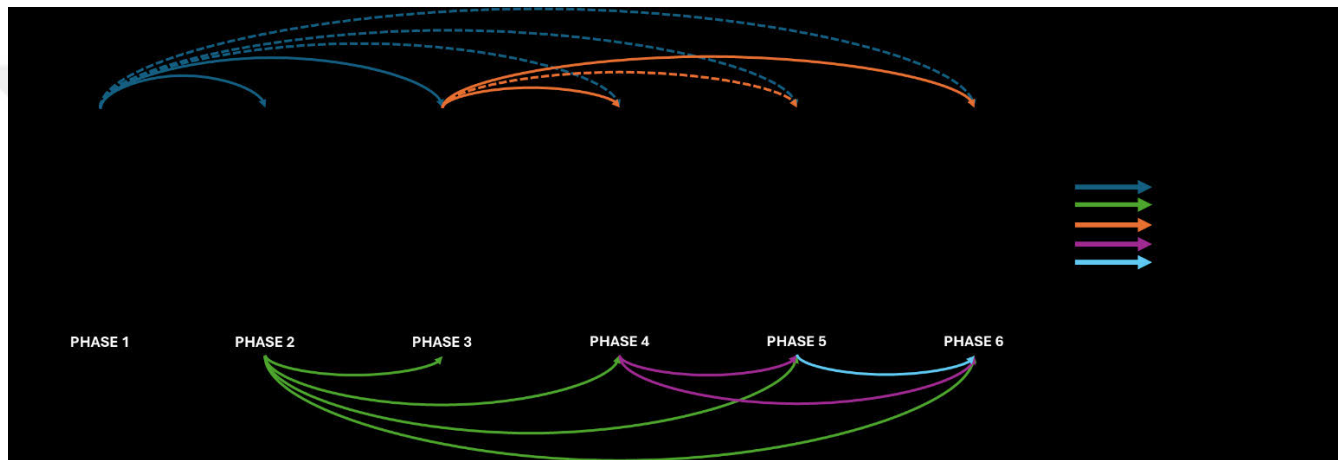


Figure 6. Overview of direct and indirect interactions across study phases.

The primary aim of this study is to interpret hospital soundscapes using PD methods to design user-centered soundscapes. Therefore, we investigated how users of pediatric settings perceived and responded to the existing soundscape through PD methods and how these insights would inform the design of more inclusive hospital soundscapes in six phases:

1. Spatial and behavioral observations
2. Semi-structured interviews and GT analysis
3. Built environment co-design workshop
4. Architecture Experts' Evaluation Session
5. Acoustic Experts' Evaluation Session
6. Acoustic environment co-design workshop

The research approach of the study involving six phases is shown in Figure 6. The arrows indicate whether the findings of one phase impact the generation, procedure, or tool development of another phase. A solid line indicated a direct impact, while a dashed line represents an indirect impact. For instance, the findings of the observations (Phase 1) directly informed the development of interview tools (Phase 2) and were used as a game tool in the first co-design workshop (Phase 3), hence the solid lines. In contrast, its relationships with the remaining three phases are represented with dashed lines, as the modified observation outcomes were used, rather than the original findings. The combination of these phases eventually created the creation of co-designed hospital soundscape.

3.3. The Preliminary Study

Prior to the main study, a preliminary study was conducted to assess the data collection procedures and participant engagement. Before conducting the study, we applied to the Ethics Committee of I.D. Bilkent University for approval (Ethics Committee Approval no: 2022_07_22_03, Appendix A). The study was conducted in a NICU associated with a Research Hospital in Turkey (Orhan & Yilmazer, 2024). We conducted the first two phases, spatial and behavioral observations and semi-structured interviews, with NICU staff members. The gathered data were analyzed using GT and the results were visually represented via conceptual framework (Orhan & Yilmazer, 2024). Although staff members' responses provided rich data about the current issues and desired solutions regarding the NICU soundscape, we observed that participation in NICU context would be limited only to the staff members, as families were not familiar with the context and as it was impossible to gather patient data. Another restriction was that NICUs have firm and dedicated protocols and guidelines about clinical alarms that made it almost impossible to design a new soundscape without causing any safety issues. Considering the collaborative nature of our intended methodology, those outcomes led us to focus on another

pediatric setting so that we could apply PD methods with all relevant stakeholders. After observing the existing settings and searching for the applicability of the PD methods, the decision was made to conduct the main study in PIU context, which provided major potential to involve both staff, families, and patients in the study. Reinterpretation of hospital soundscapes via PD methods required active involvement. Therefore, shifting the focus from NICU to PIU provided us with expanded opportunities for collaborative engagement and co-creation.

3.4. Integrating Participatory Design Method with Hospital Soundscapes

In order to apply a structured methodology in the main study, we identified PD activities (Hansen et al., 2021) that would be taken place in each phase consisting of varied forms, purposes, and contexts (Sanders et al., 2010) using several PD tools from existing literature (Table 1). Before conducting the main study, we applied to the Ethics Committee of I.D. Bilkent University with our elevated methodology and study scope for approval (Ethics Committee Approval no: 2023_07_10_01, Appendix B). The following sections cover the procedures, settings, participants, instruments and data analysis used in the six phases of the main study. Further details are provided under related heading.

3.4.1. Phase 1 – Spatial and Behavioral Observations

The primary purpose of conducting spatial and behavioral observations was to see how PIU users were interacting with their environments. We discussed the study objectives and methodologies with the Chief Nurse to decide on the appropriate data collection times and locations. During this meeting, the Chief Nurse also informed us about the specific timeframes of repeated events and daily routines. This helped us understand the PIU workflow and establish a more structured data collection plan. Based on the informal discussions with the Chief Nurse, in order not to prevent any medical error, the plan for conducting spatial

and behavioral observations was developed with a focus on key spaces where significant interactions happened between PIU users.

Table 1. PD methods, tools, and techniques used in this study.

Study Phase	PD activities (Hansen et al., 2021)	Tools and Techniques	Form (Sanders et al., 2010)	Context (Sanders et al., 2010)	Purpose (Sanders et al., 2010)
Phase I - Spatial and behavioral observations	- Field Study	- Architectural drawings - Photo-elicitation - Informal interviews (McLaughlan et al., 2019)	- Telling	- In PIU	- Understanding
Phase II - Semi-structured interviews and GT analysis	- Field Study	- Interview (ISO, 2018; Orhan & Yilmazer, 2024)	- Telling	- 38 PIU users - In PIU - Face-to-face	- Probing - Understanding
Phase III - Built environment co-design workshop	- Field Study - Workshop - Collaborative Prototyping	- Design Game (Hanington & Martin, 2022)	- Telling - Making - Enacting	- 11 PIU users - Face-to-Face	- Probing - Priming - Understanding - Generating
Phase IV - Architecture Experts' Evaluation Session	- Collaborative Prototyping - Evaluation	- User-Informed Design (Huber, 2021)	- Telling - Making - Enacting	- 6 Experts - Online	- Priming - Understanding - Generating
Phase V - Acoustic Experts' Evaluation Session	- Evaluation	- Scenario (Hanington & Martin, 2022) - Expert evaluation questionnaire (Ratcliffe et al., 2013)	- Telling	- 8 Experts - Quiet Lab at Bilkent University - Face-to-Face	- Probing - Understanding
Phase VI - Acoustic environment co-design workshop	- Field Study - Workshop - Collaborative Prototyping	- Design Game (Hanington & Martin, 2022)	- Telling - Making - Enacting	- 10 PIU users - Face-to-Face	- Probing - Priming - Understanding - Generating

The spatial observations were conducted in subspaces near and adjacent to PIU, identified by clinicians as places where routine activities typically occur. Architectural plans and detailed photographs of spaces were analyzed to

abstract salient design features. Privacy, accessibility, control over building elements (e.g., temperature, air quality, lighting), view, layout, ambience, size, capacity, proximity between subspaces, material selections, colors, furniture, available communication technologies, and sound sources were observed. Data was recorded using field notes, drawings, photographs, and floor plans.

Behavioral observation involved documenting the activities of individuals in their natural environment using nonparticipant observer method. We assessed how staff members, families, and patients interacted with each other and the space they occupied. Activities, communication patterns, interactions, and space use at different times of the day were documented. Spatial and behavioral observations were conducted with the aim of observing the existing sound sources and how the soundscape was connected to environmental and behavioral factors. This process was completed over three weeks at various times of the day and week, including daytime, nighttime, weekdays, and weekends, and extended throughout the data collection process. The researcher used observation results and materials to develop interview questions and game tools for the further steps of this study.

3.4.2. Phase 2 - Semi-Structured Interviews and GT Analysis

Recruitment and Participants

Participation was open to all staff members, families, and patients who experience the PIU. Based on the Chief Nurse's assistance, we created a recruitment plan and inclusion criterion to be able to reach out to the participants (Figure 7). All the participants were informed about the study protocol, and they volunteered to participate in the study.

The inclusion criteria for patients were as follows: (1) clinically stable with no critical care needs, (2) cognitively and mentally able to engage in the study, (3) not at risk of infection, and (4) accompanied by a parent or guardian. To determine the eligibility of patients, the Chief Nurse directed and accompanied us while reaching out to them. The inclusion criteria for family members were those who had been staying with the patient since admission, and for staff members, it was affiliation with the PIU. After we determined which patients we could reach out to, verbal consent from staff members, families, and patients; written informed consent from families were obtained before the semi-structured interviews. The inclusion criteria were that the staff members had to be affiliated with the unit to guarantee a deep understanding of the environment and users' needs, as they experienced and observed how users interact with each other.

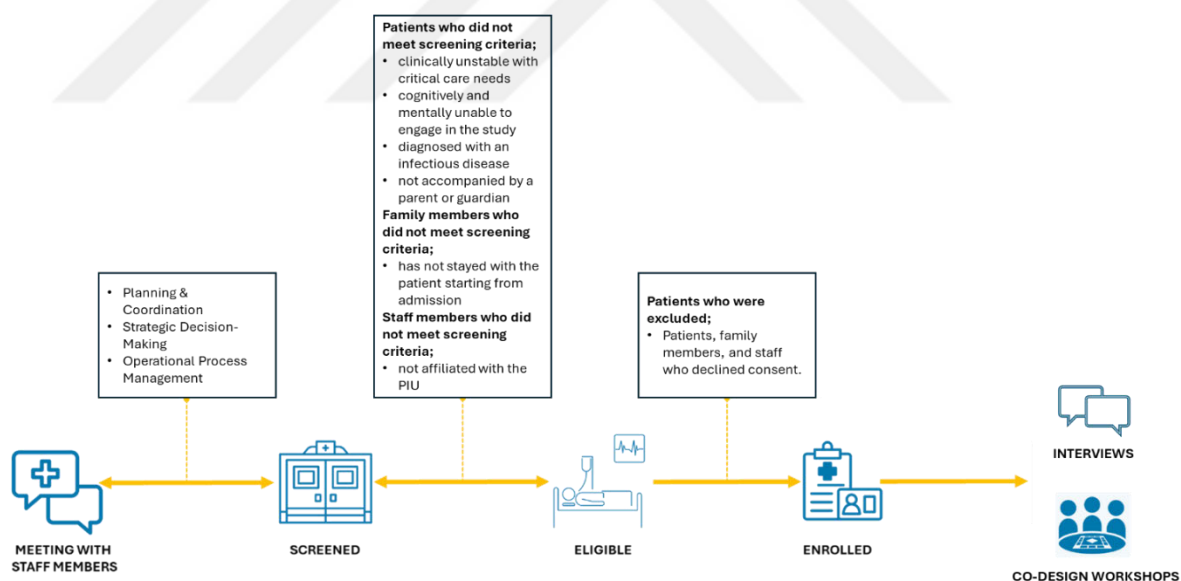


Figure 7. Participant recruitment process followed for the interview and co-design participation.

The interviews with staff members were conducted in the staff work rooms, while the interviews with families and patients were conducted in the patient rooms. A convenient sample of 21 staff members (four nurses, two cleaning personnel,

fourteen physicians, and one teacher), 13 female and 8 male (M age = 33.07 years, SD age = 8.14 years); 10 family members, 8 female and 2 male (M age = 36.8 years, SD age = 9.5 years); and 7 patients, 4 female and 3 male (M age = 13 years, SD age = 2.58 years) participated voluntarily in the interview (Table 2). Participant recruitment stopped when the gathered data reached theoretical saturation (Strauss & Corbin, 1998).

Table 2. Interview participants' demographic information.

Demographic/characteristic	Staff Members (N = 21)	Family (N = 10)	Patient (N = 7)	Total (N=38)
Age				
Age in years, mean (SD)	33.07 (8.14)	36.8 (9.5)	13 (2.58)	30.35 (11.46)
Age in years, median	31.0 (24, 50)	38.5 (18, 52)	13 (8, 16)	30.50 (8, 52)
Gender, n (%)				
Female	13 (61.9%)	8 (80%)	4 (57.1%)	25 (65.8%)
Male	8 (38.1%)	2 (20%)	3 (42.9%)	13 (34.2%)

Data Collection and Analysis

The interview questions were developed based on the existing literature and guidelines (see Appendix C) (ISO, 2018; Orhan & Yilmazer, 2024). Questions were aimed at prompting participants to reflect on what they perceived and expected regarding the built and acoustic environments of the PIU. We also asked spontaneous questions based on the conversation. Data was collected from July to November 2023. A semi-structured interview was conducted to obtain insights into the perceptions and expectations of different user groups toward the soundscape of PIU. The interview was conducted in Turkish and audio recorded. Each of the interviews took between 4 to 11 minutes. The data

collection process stopped when the data reached theoretical saturation (Strauss & Corbin, 1998).

Interview data were analyzed using the GT coding process. The interview transcriptions were analyzed sentence by sentence to extract key phrases, subcategories, and main categories. For instance, comments about the sounds of children crying, staff conversations, visitor conversations, and footsteps were coded as 'Sounds from Human Beings (SfHB).' The SfHB codes, along with other sound-related codes such as 'Other Noise,' 'Sounds of Traffic (SoT),' and 'Sounds of Nature (SoN)' were grouped under the 'Sound Source' subcategory. Combined with the other sound-related subcategory, 'Soundscape Assessment,' the subcategories created the category of 'Acoustic Environment.' Codes and categories were developed for each user type, and their relationships were analyzed to create a conceptual framework illustrating staff members', families', and patients' perceptions of PIU soundscape. Based on the findings, we created 'Implications for Practices' for both the built and acoustic environments to be used as a design brief during the co-design workshops and expert evaluation sessions. Additionally, this data was used to create game tools in further steps.

3.4.3. Phase 3 - Built Environment Co-Design Workshop

In the preparation phase, we developed the design game based on interview and observation results. While developing the game, we followed Schell (2020) to define the aim of the game, rules, and tools. The aim of the game is defined as the 'desired outcome that players aim to achieve' (Schell, 2020); therefore, we defined ours as 'the development of a desired built environment design' for this workshop. By setting a structured aim, we directed participants' perspectives to ensure that their 'moves' align with the overall goal (Schell, 2020). Game rules are the indicators of the game's structure and mechanics that guide players on how to engage with each other and the game materials (Schell, 2020). Therefore, the rules were designed to indicate how participants could

collaborate to achieve their goals during the co-design workshop. The game tools included 2D floor plans as game boards, furniture drawings as game cards, empty stickers, pens and pencils. These tools were provided to the participants to help them visualize and apply their own design decisions. As Schell (2020) suggested, we balanced the three elements to create a structured and creative environment where participants could collaborate effectively, following the PD principles. After creating the game aim, rules, and tools, we initially met with the Chief Nurse on how, when, and where to conduct the workshop session.

The recruitment process was sensitive and complicated given the context of PIU. After the operational meeting with the Chief Nurse, we screened patients to exclude the ones who did not meet eligibility criteria. We applied the same inclusion criteria that we used during the interview phase (Figure 7). Verbal consent from staff members was obtained before the workshop. We visited patients and their families in their rooms with a companion nurse to protect their privacy. We explained the purpose and details of the study verbally to both the patient and their families and asked if they wanted to participate. The ones agreed to participate also written consented. After we identified the eligible participants, the ones who declined consent were excluded. Eventually, we created a group of enrolled participants consisting of clinicians, families, and patients. In the meantime, the chief nurse informed us that the patients were only allowed to spend a maximum of 45 minutes in the shared areas. Eventually, a convenient sample of eleven participants: seven clinicians (four physicians, two nurses, one teacher), two family members, and two patients agreed to participate voluntarily in the built environment co-design workshop. We informed all voluntary participants about the time and place of the workshop.

Based on the hospital and unit policies, patients were not allowed to leave the unit. The classroom was the only space that this workshop could have been conducted within the unit. However, it was not designed for such activities. First,

the layout was narrow and designed regarding children ergonomics; second, the space was full of distractions such as books, board games, painting tools, and bookshelves. On the workshop day, we organized the class in a way that it could accommodate eleven participants at a time, removed all possible items that could cause visual or acoustic inaccessibility, and arranged seating area and table in a circular form to support communication. We placed the camera in the middle of the table using tripod for video recording and placed the game tools in a visible spot.

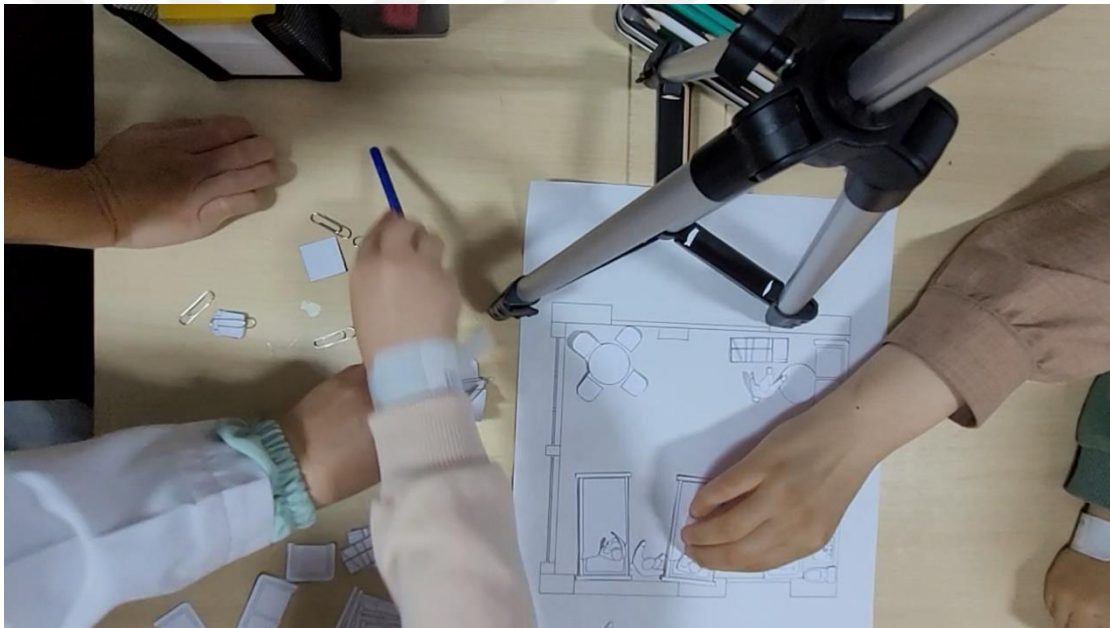


Figure 8. Game playing during the built environment co-design workshop.

The session started with an introduction. First, the aim of the study and this workshop were explained to the participants. Given that participants did not have any architectural background the researcher explained the architectural drawings using the game tools. After that, we introduced the game cards. We emphasized that we did not expect them to make a ‘perfect’ drawing or make a ‘correct’ decision to minimize the ‘failure stress’ on participants. After each

participant confirmed that they understood the rules and tools, we started the play phase (Figure 8).

During the play phase, the researcher only answered operational questions and did not make any comment about the design to prevent results from bias. When we needed more in-depth information about the design decisions, the researcher occasionally asked 'why' questions to be able to gather more insights about participants' design decisions. Participants were occasionally reminded to express their ideas before making any moves on the design board. The co-design workshop session took 42 minutes with several competing and collaborative discussions. The video recording was transcribed verbatim and analyzed.

3.4.4. Phase 4 - Architecture Experts' Evaluation Session

The purpose of this phase was to evaluate the patient room designed during the built environment co-design workshop. Before conducting this session, the researcher analyzed the gathered data from the workshop, combined the findings with the GT analysis and created a design brief for the architecture experts. This preparation phase also involved converting the PIU users' end-designs into an AutoCAD file and defining the goals for evaluation session.

The participants for the architects' evaluation session were selected using impressionistic modal instance sampling (Salkind, 2010). Specific disciplines were identified, and experts in those fields were invited to voluntarily participate. The target disciplines included architecture, interior architecture, visualization, and design professionals with experience in designing and evaluating indoor environments in both academic and professional settings. Experts were identified through existing collaborative networks known to the researchers. The participating architecture experts consisted of three architects, two interior

architects, and a visualization artist (4 females, 2 males), with professional experience ranging from 2 to 7 years. All participants completed a verbal consent form and a brief demographic survey to provide details about their expertise.

The session was conducted online. First, the attendees introduced themselves with an icebreaker and then the researcher presented the study objectives. The photos and plan layouts of the unit were shared to better engage with the PIU. Then, the design briefs were shared with the experts to better engage with the PIU users. After that we shared the designed patient room during the first co-design workshop, highlighting the reasons behind users' decision-making. Experts analyzed each document and discussed how to move forward. First, experts came up with a design plan and determined the design strategy. After collaboratively deciding on the end-design of the layout, they created a mood board to discuss material and color selections. At that point, the visualization artist asked more specific questions to complete 3D visualizations and animation. All together, we defined a strategy and content for visual representations. 3D visualizations of the space were created using Enscape Software and sent to the experts electronically for their feedback and approval. The expert evaluation session was completed fully-virtually.

3.4.5. Phase 5 - Acoustic Experts' Evaluation Session

The purpose of this phase was to select the most pleasant sound sources among the sound source pool created by the researcher based on GT analysis. Therefore, we developed a data collection tool consisting of brief demographic survey, scenario, and listening test (see Appendix D). The scenario was created based on the PIU users' experiences that we have learned through the interviews and reflected their needs. Experts were asked to read and understand the scenario and select the most appropriate sound sources accordingly. Similar to the first expert evaluation session, the participants were

selected using impressionistic modal instance sampling. We identified specific disciplines, and experts in acoustics and soundscapes with experience in designing and evaluating acoustic environments in both academic and professional settings. We identified the experts through our existing collaborative networks. The participating acoustic experts included an acoustic consultant/academician and seven graduate students specializing in soundscapes, consisting of seven females and one male, with experience ranging from a year to over 10 years. As this session was to be conducted in-person, we assigned each participants a specific time to meet.

The sound source pool consisted of three categories including 15 sound sources that were sourced from literature (see Appendix E). We extracted a 30 s sample from each sound source. This phase aimed to evaluate the sound type rather than the sound level, therefore, we normalized sound sources, as the use of a consistent level ensures compatibility. We used Audacity software to prepare the sound clips. After that, we combined sound clips and 3D visualizations of the patient room created by the architecture experts to create 15 different audio-visual data. The visual images were 3D still scenes of the patient room, and the audio signals were single dominant, easily identified sound sources. After creating the audio-visual data, we developed the data collection tool for expert evaluation.



Figure 9. An expert listening to and evaluating the audio-visual task during the acoustic experts' evaluation session.

Participants arrived at a well-insulated quiet laboratory room at Bilkent University (NC-34,5 dBA) (Yilmazer et al., 2023) (Figure 9) on their individual appointment times. We provided them with informed consent and explained the experiment process and use of data collection tools. First, they completed an audio calibration task to increase consistency of sound presentation. Then, we distributed the questionnaire for the listening task. The audio-visual stimuli were played back by a computer through headphones (Beyerdynamic 770 Pro) during the listening experiment. They listened to the stimuli in a random order as many times as needed. Participants were asked to indicate the extent to which each sound source would help create pleasant PIU soundscapes regarding the presented scenario, on a scale of 1 (not at all) to 5 (completely). Based on their assessments, we identified the most pleasant sound clips to be used as a game tool during the acoustic environment co-design workshop.

3.4.6. Phase 6 - Acoustic Environment Co-Design Workshop

Similar to the first co-design workshop, during the pre-recruitment phase, we developed the design game, its rules and its tools. This time the purpose of the game was to design a pleasant sound environment for the patient room considering users' needs. The game tools included game boards, soundscape adjective cards, and sound source cards. As a game board, we used the 3D visualizations created by the architecture experts. Soundscape adjective cards were created regarding the guidelines and previous literature (ISO, 2018; ISO, 2019; Yilmazer et al., 2023). Sound cards, on the other hand, were the ones selected by the acoustic experts and the semi-structured interviews.

The same recruitment process represented in Figure 7 was also repeated for the acoustic environment co-design workshop. A convenient sample of ten participants: seven clinicians (five physicians, a nurse, and a teacher), one family member, and two patients agreed to participate voluntarily in the acoustic environment co-design workshop. Before starting the workshop, the class was arranged appropriately for participants. We also placed a camera for video recording, a speaker for listening tasks, and game tools on the table. The speaker was positioned at the center of the space with the height of participants' head position (Guo et al., 2023). The speaker was compact and lightweight. It was calibrated before the listening experiment. Previous studies considered 55 dBA as the most appropriate sound level by participants because they could hear the sound clearly but not annoyed by it (Guo et al., 2023; Ma & Shu, 2018; Shu & Ma, 2018). We introduced the game tools and rules to the participants. After each participant confirmed that they understood the rules and tools, we started the game playing phase.

First, participants were asked to define the existing soundscape on the game boards and place the most relevant adjective cards on the game boards. After that, they started to discuss how they could make the sound environment pleasant. They selected sound sources that would make the space more

pleasant using the sound source cards. Participants then were asked to place the sound source cards on the game boards if they wanted to hear any. After they confirmed the desired sound source categories, the researcher started the listening phase of this workshop. Participants listened to the sound clips and collaboratively selected one 'most pleasant' from each category. Lastly, they agreed on combining the selected sound sources by manipulating their sound levels and create a pleasant soundscape for the patient room. Audacity Software was used to create a new soundscape under the researcher's control and with participants' directions. Eventually, the designed sound clip was combined with the short animation created by architecture experts. The co-design workshop session was completed in 36 minutes with several competing and collaborative discussions. The end-design and the overall participatory process were evaluated by the participants. The video recording was transcribed verbatim and analyzed.

CHAPTER IV

RESULTS

4.1. Spatial and Behavioral Observations

Spatial Observations

The hospital is located near the city center, airport, university campus, and residential zone. The PIU, located on the first floor of the hospital wing (Figure 10), features a rectangular layout with the nursing station centrally positioned and surrounded by patient rooms and various support spaces, including nurses' and physicians' rooms, treatment areas, storage, bathroom, a classroom, and an EEG room (Figure 11). The unit contains one single-patient room and eight two-patient rooms, which are typically used by one patient and a family member unless in an emergency. Each room had beds, chairs, cabinets, drawers, a television, and a restroom (Figure 12). The rooms had manually sliding doors. Six rooms (R-103 – R-109) had large windows overlooking the outside with a view of the parking lot and waste collection area (Figure 13). The other two rooms (R-101 & R-102) also had large windows overlooking the hospital atrium with limited daylight. The unit capacity was fifteen, but the number of patients varied between four and seven during the study. Relatively, patient rooms were only used by a single patient and their family member. The number of patient rooms, beds, patients, age ranges of patients, patient rooms, and overall square meters are represented in Table 3.

We also conducted observations of the acoustic environment. ISO/TS 12913-2 suggests classifying the sound sources under "sounds from human beings," "sounds of traffic," "sounds of nature," and "other noises" categories to report the existing acoustic environment (ISO, 2018). Given that the hospital is located close to the city center, hospital users were expected to be exposed to various sound sources. Throughout spatial observation, the sound sources reported were sounds from human beings (staff, family, visitor, and patient conversations, children crying/screaming, sneezing, footsteps, laughter, cleaning activities, and handwash), sounds of traffic (car, plane, helicopter, garbage trucks, ambulance siren), sounds of nature (birds flapping, birds chirping), and other noises (television, medical devices, phone ringing, doorbell, air conditioner, construction, sliding doors, trolleys, rattle, rustle).

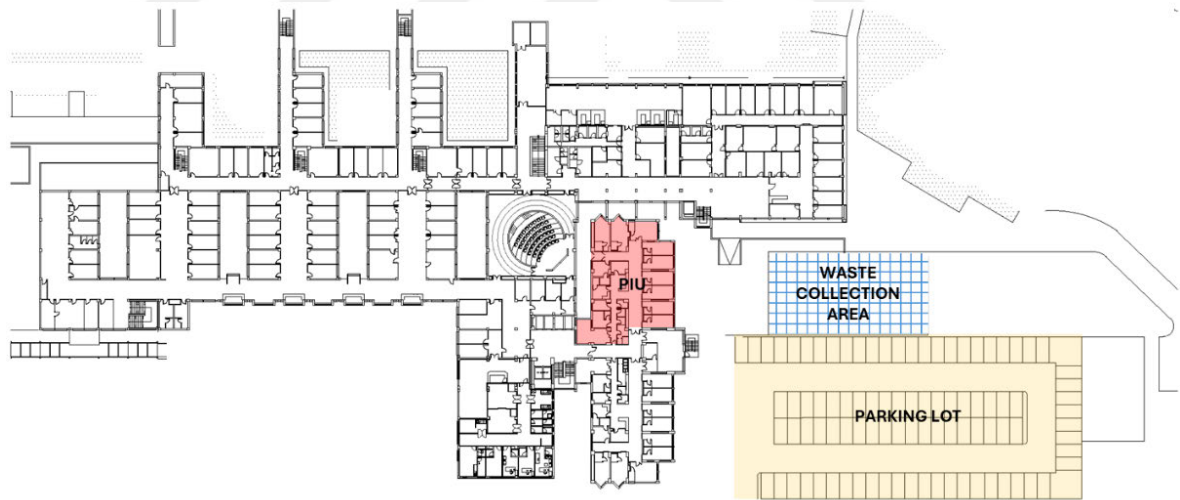


Figure 10. Hospital plan layout. Red indicates the location of the PIU, while blue indicates the waste collection area, and yellow indicated the location of the parking.



Figure 11. Plan layout of the PIU.



Figure 12. A typical patient room in PIU. Photographs were taken by the author from room 108.



Figure 13. The windows overlooking the outside with a view of the parking lot and waste collection area from room 103 (on the left) and room 108 (on the right).

Table 3. Spatial features of the Pediatric Inpatient Unit

	Pediatric Inpatient Unit
Number of patient rooms	8
Number of beds	15
Number of patients (during the study)	4 - 7
Age range of patients	4 – 18 years
Avg. patient room m ²	25
Approx. overall m ²	400

Behavioral Observations

To understand the organizational culture in the PIU, we observed users' interactions and found reoccurring events.

Morning Rounds

Various physicians and their teams conduct morning rounds every morning on weekdays. During these rounds, we observed the interactions from outside the patient rooms. When the clinical team had more than four clinicians, they could not simultaneously fit into the patient rooms. Therefore, physicians had to repeat procedures for the ones who stayed outside, or in some cases, physicians were loudly explaining the procedures or prognosis to ensure each clinician was informed. In such situations, as the doors in the room were open, conversations about patients and their prognosis could be heard from the outside. These interdisciplinary team rounds contributed to the highest noise levels in a typical PIU day. We observed that there was not enough space and furniture in the rooms for clinicians to sit down and discuss with families at an eye level. Moreover, after the rounds, clinicians had to complete the paperwork before leaving the unit, but most had to complete this task by standing as there was no adequate space for them.

Cleaning Routine

The patient rooms were cleaned each morning, but other cleaning activities happened at different times. When a new patient was admitted or discharged, the rooms were cleaned and filled with necessary supplements such as linens, pillows, tissues, etc. When cleaning the patient rooms, we observed that staff members had to move the furniture to reach any part of the flooring and had difficulty maneuvering in the rooms. Specifically, cleaning the under-bed parts was observed to be the most problematic. During the cleaning activities, we heard and documented specific sounds that occurred by cleaning supplies, furniture being moved, trolleys, and water from sinks, which were not frequently part of the usual soundscape of the PIU.

Lunch Time

We observed that a staff member arrived at the unit every noon to provide food for the patients and their families. The staff member left the trolley out of the rooms in the unit corridor as it did not fit into the rooms. If the doors were closed, the staff member knocked on the patient room doors and called out to the families to serve lunch from the corridor. The staff member called the families to see if the door was open. Therefore, one could tell that it was noon and lunchtime by hearing the food cart trolley, the staff member knocking and calling families out for lunch, non-clinical conversations, and the smells.

Visitors Arrival

The unit did not have a specific visiting time. However, visitors usually arrive at noon or in the afternoon. Some patients had more crowded visitors, and some had one person to visit. The crowded visitor groups often caused excessive crowding and higher noise levels, which sometimes clinicians had to ask to be quiet. We observed that the room size also influenced how noise disturbed users when visitors arrived. As there was not adequate space in the rooms for

visitors to sit or even stand, they had to wait in the corridor and have conversations with their loved ones from the corridor.

Clinicians, Family, and Patient Activities

Nurses and physicians were frequently moving between rooms for patient visits and paperwork. We observed that they spent most of their time either at nurses' desks or in nurses' rooms when they were not with the patients. There were two to three shifts in a day in the unit, and the shift times were busy with the handover of the patient reports and updates. Therefore, noise levels were higher during the shift changes. Compared to the mornings, afternoons were quieter, and the nighttime was the quietest. Although the same events occurred the whole day, we observed that the human traffic was reduced with fewer clinicians, no rounds, and no visitors. We observed that staff members did not have a designated space for daily activities such as eating, changing, and resting.

As the patients had to stay in their rooms during their care, families also spent most of their time with them in the patient room. We observed that families spent time watching TV with doors closed and the volume kept low. There were no designated family support areas for relaxing, so they had to leave the unit or even the hospital building to go outside. No vending machine or food service was nearby, so they constantly left the unit to get snacks for themselves or their children. On the other hand, patients had limited options to leave their rooms, including short corridor walks and attending classroom activities as their medical condition allowed. We observed that the teacher visited the available patients daily to give brief lectures in the patient rooms.

We observed that the built environment and the routine events affected the acoustic environment in the PIU. The unit was generally cramped, which restricted staff members' movement. Therefore, involving clinicians during the rounds and visitors when they arrived at the unit was hard. Staff members and families did not have a designated space for their respite needs, which eventually caused them to spend most of the time in a shared unit, causing increased noise levels and crowding. Patients mostly spend time in their rooms without any distractions to keep their minds away from the stressful nature of their hospital stay. Considering the various events on a typical day of the PIU, we observed that the noise levels and the sound sources heard varied all day. We noted that the mornings were the noisiest and the nights were the quietest. The afternoons and the weekends were usually calm, with less noise than the mornings, and more active than the nighttime. Both the spatial and behavioral observations contributed to our understanding of how the built and the acoustic environments affected PIU users' interactions, and that the unit did not serve each user's needs.

4.2. Semi-structured Interviews and GT Analysis

The interpretation of the PIU soundscape was based on the categories derived from the interview transcriptions. The analysis highlighted that both the built and acoustic environments affected individuals' perceptions and desires, and the PIU context. The built environment category directly influenced the acoustic environment category by affecting the perception of sound sources. Users developed coping behaviors based on their perceptions. Context, the interrelationships between person, activity, and place, is the most effective category that relates to all categories of this framework. The framework demonstrates that the PIU context influences how individuals respond to sound sources, categorizing them as pleasant, neutral, or unpleasant. Participants' responses, in turn, shaped the outcomes as positive, neutral, or negative.

The conceptual framework, derived from the GT analysis, revealed eight main categories and fourteen subcategories: built environment, acoustic environment, perception, desire, coping with unwanted sounds, context, response to sound sources, and outcomes (Figure 14). These categories were examined according to user profiles: staff members (S), family members (F), and patients (P). The framework demonstrates both the differences and similarities in perceptions among these user groups. Each category in the framework was developed based on statements from PIU user interviews.

Built Environment

The results demonstrated that the built environment category includes factors such as layout, proximity, building elements, acoustic insulation, technological advancements, unit's and hospital's location. The built environment directly impacted the acoustic environment, as the factors within the built environment category shaped the overall acoustic conditions within the PIU.

Acoustic Environment

Acoustic environment category was divided into subcategories as 'Sound Sources' and 'Soundscape Assessment.' Sound significantly influenced users' perceptions and desires by affecting their evaluation of the PIU. Sound sources were categorized into 'Sounds from Human Beings (SoHB),' 'Sounds of Traffic (SoT),' 'Sounds of Nature (SoN),' and 'Other Noise.' Human-based sounds included children crying, conversations, and footsteps. Traffic-related sounds comprised cars, garbage trucks, planes. Nature-based sounds were limited to birds singing. Other noises encompassed computer and tablet sounds, phone notifications, trolleys, HVAC systems, construction, and doorbells.

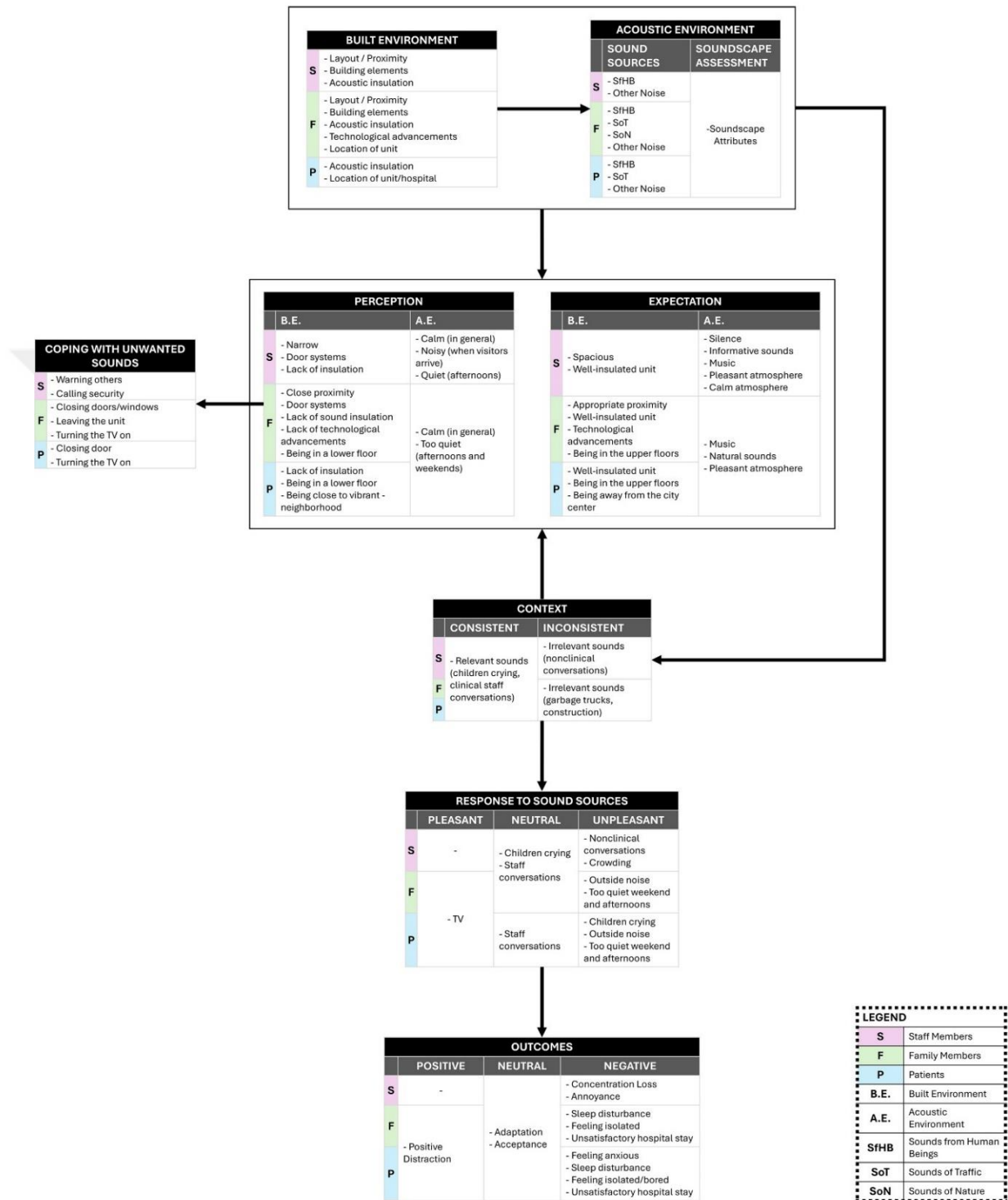


Figure 14. Conceptual framework derived from the GT analysis, depicting eight main categories and fourteen subcategories that illustrate how the PIU soundscape is perceived.

Perceptions and Expectations of the Built and Acoustic Environments

Individuals' prior knowledge shapes their expectations of places (Kang & Schule-Fortkamp, 2016). Perceiving the expected features within the place leads the person to a pleasurable experience (Kang & Schule-Fortkamp, 2016). The results demonstrated that both the built and acoustic environments affected users' perceptions and desires. The main concern was that patient rooms being too narrow, which affected the daily routines and quality of experience. This concern was reflected in the interview as:

CLINICIAN 12: Well, when we're examining the patient, the space can get pretty tight. Sometimes we're all trying to work side by side, and one person has to stretch over because it's so narrow. If there are more than 4 or 5 of us, it gets even more crowded, and we lose time with people shifting around or waiting for others to pass. On top of that, the patient has to stay in the same position for a long time, which makes them more uncomfortable and agitated. As they wait, their complaints just keep growing.

STAFF MEMBER 1: Well, it is good that having one patient per room because it is hard to clean rooms when there are two patients, two caregivers, and lots of equipment. It's a bit easier now... but the rooms are still small, and even relatives complain about the lack of space.

PATIENT 5: This room feels very narrow, there is not enough space for my daddy... beds are too close each other... It'd be better if the room is wider.

FAMILY MEMBER 10: I cannot imagine how it would be to share this room with another patient and their families. The room should be doubled the size, at least...

CLINICIAN 13: ...If we could combine two rooms and create a single-patient room, then it would be better for us to work more efficiently and would enhance a better patient care.

Users expected to have spacious, well-insulated patient rooms appropriately located close to nursing stations, incorporating technological advancements, situated on the upper floors, and away from the city center. Staff members described the unit, and the patient rooms as narrow with inadequate acoustic insulation, noting that sliding doors did not effectively absorb sound.

CLINICIAN 17: There's no room for more than one person to examine or visit at a time. The bed arrangement is awkward—some patients end up with their feet facing others' heads. Plus, it's hard to maintain privacy. When we discuss a patient's condition, the person in the next bed or their relative might overhear, which isn't ideal.

Participants indicated that the building was very old and required maintenance. They were unsatisfied with the poor acoustic insulation. Moreover, they thought that the furniture was not ergonomic and was old-looking. Families and patients expect to have the space to provide them with essential furniture and utilities such as refrigerator, TV, free Internet connection, adequate sofa, and shower in each room. Staff members were also dissatisfied with the lack of amenities and utilities for their patients and caregivers. Families expected to have bigger seating area to be able to host their guests comfortably.

CLINICIAN 4: ...For instance, families come to us and ask, 'do you have a refrigerator that I can put milk for my kid?' I mean...at least if there is a

refrigerator in their room, they can keep drinks and foods fresh which would be much better for them.

FAMILY MEMBER 10: ...there is no Wi-Fi connection, and there are a few very limited channels on television. We have limited opportunities to spend 'fun' time here.

PATIENT 1: I wish there is a refrigerator in the room... and I really wish having a private bathroom in my room.

Families and patients found the daylight sufficient in the patient rooms; however, they were not satisfied with the view. They highlighted their exposure to outside noises due to the location and the surrounding environment and emphasized concerns about the poor acoustic insulation.

FAMILY MEMBER 6: It is good to have a daylight, but the view could have been better...

PATIENT 4: ... Buildings, garbage...I don't want to see the trash cans. I had stayed in another hospital before, and the room had a view of the sea, was great.

FAMILY MEMBER 7: This is a pediatric setting, a unit for children...I mean...the view should be cheering for them...they have to see that ugly view...

PATIENT 4: I would not build an inpatient room on the lower floors of the building because there are always sounds of cars, garbage trucks, and construction noise coming from the ground level...for instance there was a time that I had a lot of pain, I would not want to stay here.

PATIENT 5: I think hospitals should be away from vibrant environments... Sometimes external sounds interrupt my sleep [...]

Majority of participants mentioned human based sound sources such as conversations and children crying. Families and patients also mentioned the traffic sounds such as cars, planes, and garbage trucks. Some also mentioned the natural sound of birds flapping. Each participant perceived some other noises such as television, medical devices, doorbells, air conditioner, construction, sliding doors, and trolleys.

There was a metal sheet in front of some of the patient rooms' windows, as is seen in the photos of room 103 (Figure 13). There were many birds and families and patients indicated that the sounds of birds flapping and movements on that metal surface disturbed them especially when it was unexpected. They did not mention any restorative effects of birds singing.

Users described the general acoustic environment of PIU as quiet. Staff members noted that the unit is quiet in the afternoons, but it becomes noisy when visitors arrive. They expected to hear informative clinical information regardless of the sound levels. Most of them preferred not to hear anything else but silence. Some expected to have controllable and calming music in the patient rooms as a positive distraction and in their respite areas. Families and patients found the afternoons and weekends too quiet and wished for a more pleasant acoustic environment featuring music and natural sounds.

CLINICIAN 13: [...] I would prefer to hear the necessary sounds only. However, it would be good for children if there may be soothing music in their rooms to make them feel comfortable [...]

FAMILY MEMBER 5: [...] There might be music that we can control... my daughter would also enjoy listening to music [...]

FAMILY MEMBER 10: Since this is a pediatric environment, there should be sounds that make children calm...such as music, birds singing [...]

PATIENT 5: I'd like some calm music playing. It would be great if I could choose and control the music in my own room. I'm getting bored and would love to have some fun while I'm here.

PATIENT 1: I would like to listen to relaxing sounds, like the sound of water.

Coping with Unwanted Sounds

Although users described the PIU acoustic environment as calm generally, they occasionally encountered unwanted sounds. Staff members managed this situation by warning individuals making non-clinical conversations, or calling security if they could not resolve the issue themselves. Families and patients reported coping by closing doors or windows depending on the source of noise. They also used the television to mask unwanted sounds or to mitigate silence in the afternoons and weekends. Additionally, some family members chose to leave the unit to avoid hearing unwanted sounds.

FAMILY MEMBER 4: [...] we turn on the television, thank God, we have it!

Context

Context is "the interrelationships between person and activity and place, in space and time" (ISO, 2014). In our study, similar to the previous studies, the context was found as the main category as it is linked directly to other categories of the framework (Çankaya Topak & Yilmazer, 2022; Orhan & Yilmazer, 2021; Orhan & Yilmazer, 2024). PIU participants responded neutrally, or negatively to

the soundscape depending on the consistency between the context, the built environment, and the auditory environment (Acun & Yilmazer, 2018; Acun, Yilmazer, & Orhan, 2018; Orhan & Yilmazer, 2021; Çankaya Topak & Yilmazer, 2022).

Staff members, families, and patients found the children crying and clinical conversations relevant and consistent with the PIU context. Even though clinical conversations about patients during the ward rounds generated a noisy environment, users expected to hear those conversations as they being informative.

CLINICIAN 4: [...] children crying... I cannot do anything to prevent children crying because a child may have pain...but that is just the way it is in the pediatric unit.

FAMILY MEMBER 9: Clinician conversations do not bother me. I mean, why would it? After all, they are doing their best for the patients. Those conversations are important for everyone...

On the other hand, PIU staff wanted to avoid hearing irrelevant sounds like nonclinical conversations. Families and patients did not want to hear irrelevant sounds outside the hospital, such as garbage trucks and construction sounds. They expected to implement soft music, birds, or water sounds that have pleasant effects to support patients' care process and distract them within PIU context.

FAMILY MEMBER 10: It could be nice to have calming music or maybe the sound of birds. Since this is a pediatric space, there could be sounds that make it a little more pleasant for them.

Responses and Outcomes

Users' interpretations of the PIU context formed the categories of response to the sound sources grouped as pleasant, neutral, and unpleasant, and outcomes grouped as positive, neutral, and negative. Families and patients found the television sound pleasant since it positively distracted them. Staff members and families found the children crying and staff conversations neutral in the PIU context; therefore, they accepted and adapted to these sounds. However, although patients found the children crying relevant to the context, they responded to children crying as unpleasant as it made them feel anxious.

PATIENT 2: I like watching television so much. I like this room because there is a television [...]

Users found nonclinical conversations, crowding, garbage trucks, and construction sounds unpleasant as they caused concentration loss, annoyance, and sleep disturbance. Families and patients defined too quiet afternoons and weekends unpleasant since it made them feel isolated and bored. Eventually, unwanted sound sources and poor acoustic quality caused family members and patients to experience unsatisfactory hospital stay.

FAMILY MEMBER 7: There might be a calming background music because there is no sound in afternoons and weekends...sometimes it gets extremely quiet and I think like “where are we, in prison?”

After completing the GT analysis, lists of 'implications for practice' with actionable items were developed to guide co-design workshops and expert evaluation sessions. Each item is listed as 'desirable outcomes' with the main objectives related to it regarding PIU users' input from the interview. Implications

of practice lists helped us to generate design game tools for co-design workshop and expert evaluation sessions.

Table 4. Implications of practices that reflect the desired outcomes and objectives.

Desirable Outcome	Objective
• Spacious patient rooms • An infection-free, comfortable area for families and patients • Easy access and circulation for clinicians • Adequate space for staff members	To create spacious, hygienic, and efficiently organized patient rooms, ensuring physical comfort, ease of movement, timely and effective care, and minimized infection risks.
• Enhanced hospital stays • Kitchen utilities in the room • Refrigerator for food preservation • Larger bathrooms with showers • Sufficient storage space • Comfortable seating/bedding area for family and visitors • Well-insulated rooms • Removing manual sliding doors	To create a comfortable, supportive environment that enhances patients' and families' hospital stay by enabling storage of their belongings and foods, offering larger bathrooms for convenience, minimizing stress, and fostering rest and relaxation, while also promoting quiet, peaceful space that aid healing through effective design.
• Positive distractions • Larger TV with internet access • Natural view from windows • A pleasant soundscape with music and natural sounds	To enhance the hospital experience by offering engaging activities and entertainment, calming natural views, and soothing sounds, such as music and nature sounds, to create a positive, stress-reducing atmosphere that promotes emotional well-being, especially during 'boring' afternoons and weekends.

PIU users' initial desires regarding the patient rooms were mostly related to the room size and layout, amenities that would help support hospital stay, and positive distractions. Therefore, we created the implications of practices as shown in Table 4. This table summarizes what PIU users desired and why. We have found that a patient room must support the patient's and family comfort while enabling effective healthcare delivery. First, each user desired to have a bigger room. Patients wanted it to have extra space within the room so that they could be physically active and infection-free. Families would experience more

comfortable hospital stays instead of having to sit on a wooden chair or on a patient bed. Clinicians would have easy access to the patient for physical examination for timely care. Moreover, a bigger room could support their medical education, especially during the morning rounds. The staff members, on the other hand, could reach any point in the room while cleaning, which would eventually create a more hygienic environment. The other essential point of the findings is that PIU users needed items that would improve their emotional and physical well-being during the extended hospital stays. Those items included storage units, kitchen appliances, bigger and comfortable seating and sleeping areas, and a restroom with a shower. Users also emphasized the desire to minimize the noise disruptions by replacing the manual sliding doors with a solid sound-proof door. To support patients and reduce stress and boredom, users indicated that they desired some technological advancements and having a pleasant view from the windows. Moreover, they desired to have a pleasant sound environment created with music and nature sounds as a positive distraction especially during too quiet times such as afternoons and weekends.

4.3. Built Environment Co-Design Workshop

Based on the GT outcomes and following Schell's (2020) game design methodology, the researcher generated the design game, its rules, and tools for the built environment co-design workshop. Based on the desired outcomes and the objectives listed in Table 4, the aim of the design game was generated as follows:

“The design game aims to collaboratively create the desired patient room that meets the diverse needs of patients, families, and clinicians.

Participants will work together to develop a spacious, functional, and comfortable room that enhances families' and patients' hospital stays and clinicians' work experiences by addressing infection control, accessibility, and overall well-being. Through the game, participants will co-design a

patient room that integrates practical, ergonomic, and aesthetic considerations."

After that, the game tools were created. GT analysis revealed that PIU users mentioned in several interviews that "this patient room should be combined with the one next to it and should be at least twice the size." Therefore, the primary game tool, the gameboard, was designed as a combination of two existing rooms and repurposed as a single patient room. In order to better explain the architectural plan layouts to PIU users, given that they did not have prior architectural expertise, we also provided the furniture plans for the existing rooms together with the game board (Figure 15). In addition to the game board, we created game cards (Figure 16). These game cards are 2D drawings of furniture pieces, including chairs, single, double, and triple-seat sofa options, tables, beds, TVs, refrigerators, and bathroom amenities such as a sink, toilet, and shower cabin. These items were chosen among the standard representative drawings from AutoCAD libraries. We also provided them with blank stickers, pens, and pencils so they could draw and add them to the design if they came up with any additional desired items. Lastly, we prepared the top view of human figures to support a better understanding of scale, circulation, and ergonomics. All 2D drawings were prepared on a 1/20 scale to give adequate interior details.

After we finalized the game tools, we developed the game rules, which involved designing spacious, infection-free, functional, accessible, and comfortable patient rooms. The room should also have positive distractions and supportive amenities like a kitchenette, restroom, and a storage unit. Participants were required to place the given cards on the game board and explain their moves aloud. If there were any conflicting and supporting ideas, the other participants must discuss their opinions.

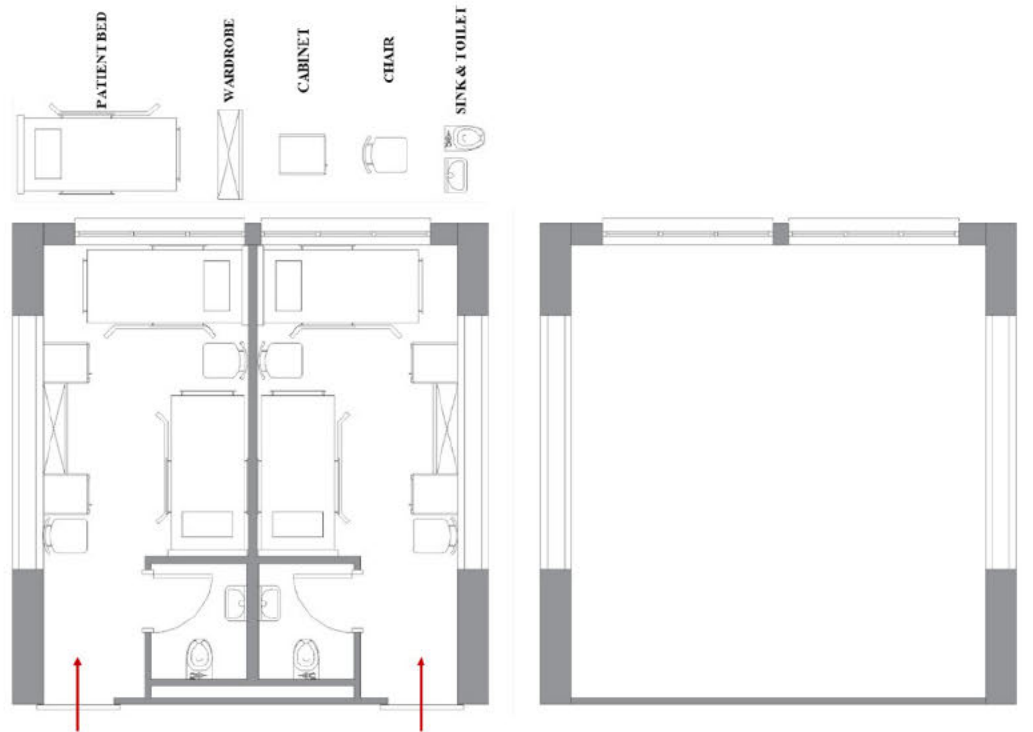


Figure 15. The one on the right represents the transformation into a game board setup, where the dividing wall has been removed, along with the entrances and furniture, creating an open space.

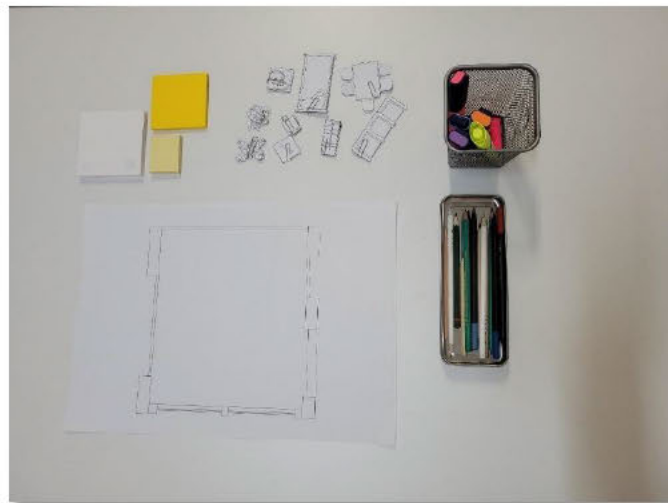


Figure 16. The built environment co-design workshop game tools, including a blank floor plan, 2D furniture, top-view human figures, various markers, and blank stickers for additional item design.

The findings revealed that the co-design workshop achieved its primary goal of collaboratively designing the desired patient room, with participants engaging actively throughout the process. Participants had conflicting ideas and disagreements from time to time. Still, as the rules of the game required, with open discussion and shared decision-making, they could reach a consensus that everyone agreed upon. Participants were asked to explain the reason behind their moves, and it helped them to have discussions on their varied needs. We observed that such discussions fostered empathy among users and encouraged them to contribute. The game aimed to design a room that considered users' needs; therefore, participants focused on creating a room that would be both comfortable, functional, and safe. The end design reflected the collaborative decision-making process with a room layout and features that would serve each user's needs.

The video recording of the co-design workshop was analyzed and participants' conversations and 'moves' on the game boards were documented. The researcher observed that participants started to discuss where the entrance room should be. First, they decided to place the door in the middle of the wall and placed the bathroom on the left of the entrance. After they agreed on the circulation pattern, they decided to discuss where to place the patient's bed. Patients placed the bed next to the window because of the view. However, families disagreed, indicating that it might be cold, and clinicians disagreed, indicating placing the bed next to the walls makes the patient physical examination inaccessible and highlighted that may cause adverse patient care outcomes. Therefore, they collaboratively decided to place the patient bed away from the walls.

The discussion continued whether to have a bed or sofa or not for the family members. Family members and patients indicated a desire to have one more bed for the family members, chairs next to each bed, a drawer between beds,

and a sofa and coffee table for the visitors. They placed the visitor zone away from the patient bed and placed kitchen utilities (e.g., refrigerator) close to the visitor zone. Patients wanted to put a table and chairs in the room. The teacher also supported having table and chairs indicating that she goes to rooms to teach some children in rooms and there is no convenient place to study in existing rooms. Clinicians also supported the idea of having a table in the room highlighting that children like activities as painting and they do not have adequate space for that, all participants agreed to place the table close to the window.

While the families and patients seemed satisfied with this layout, clinicians indicated that that much of furniture would create hygiene and infection issues. They argued that the chairs and the drawer may get in the way during the physical examination and risky for patient care. Some also indicated that having a visitor zone with seating area and a coffee corner is not consistent with the PIU context, instead, it was a luxury. Therefore, everyone agreed to minimize the furniture.

The participants started to think from the beginning. They had placed the door in the middle of the wall; however, then considering that this placement would cause them to waste a lot of space, they replaced it on the left side of the wall. Considering the accessibility and circulation, they decided on mirroring the location of the bathroom and placed it on the right side of the entrance. They decided to move the family bed and put in a foldable, multifunctional sofa instead. Therefore, it would work sleeping and sitting purposes. They decided to have a two-seater and a single seat for various visitor variations. They emphasized a need for storage units to put their stuff in and placed a wardrobe leaning towards the wall. The TV was placed opposite the patient bed and placed the refrigerator close to it. Lastly, they agreed to keep the table and chairs next to the window.

One participant felt the room was "too empty," but patients pointed out that adding more furniture would make it harder for them to move around. Clinicians also highlighted that some patients, due to infection risks, were restricted to their rooms but still needed to be encouraged to move. To support this, having enough empty space in individual rooms could lead to healthier outcomes. Everyone agreed with this approach and intentionally left an empty space and called it a 'playground' (Figure 17). By the end of the session, participants agreed on the final design, acknowledging how challenging it was to create a room that would work for everyone's needs.

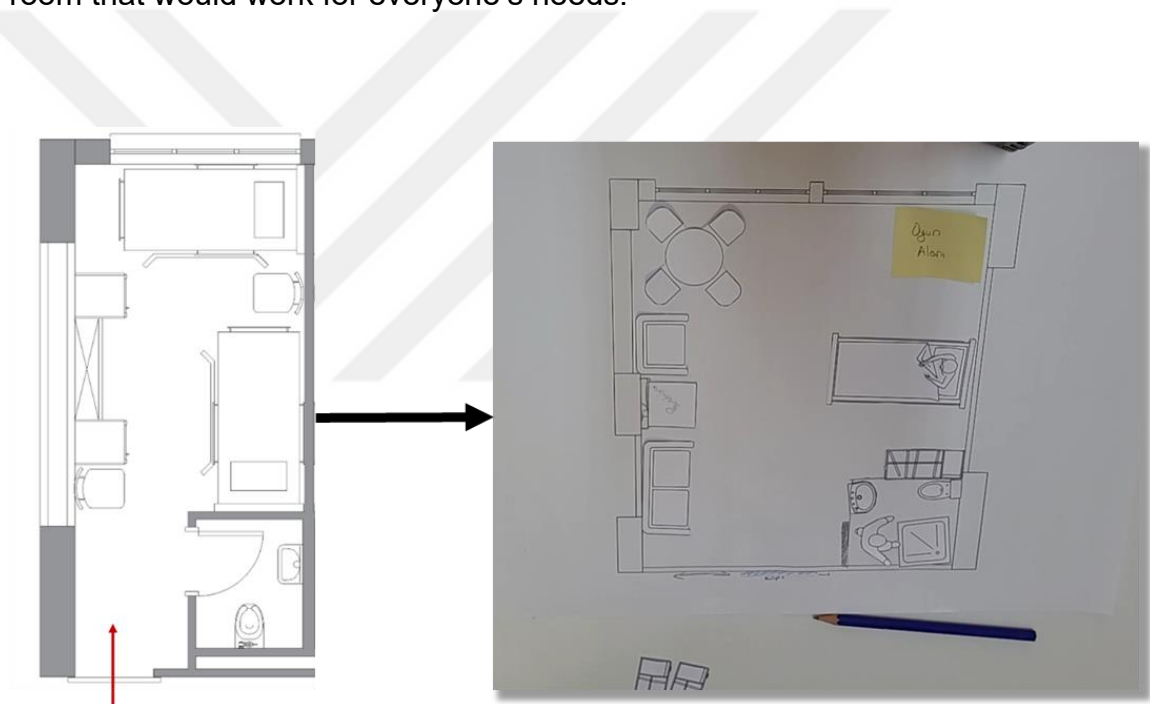


Figure 17. The original patient room (left) and the user-created version (right) with improved layout and added features.

The findings of this study revealed that PD helped PIU users engage with each other and the environment they experience and design. Users, especially clinicians and family members, frequently and actively participated in the co-design workshop sessions with several discussions. This behavior developed empathy among users and met common ground in conflicting situations. For

instance, when family members wanted to add more furniture to accommodate themselves and their visitors better:

FAMILY MEMBER: "There is no space for our guests when they arrive. They always wait standing... So, let us add a sofa and a coffee table in front of the room."

PATIENT: "Are you planning to sleep on the sofa?"

FAMILY MEMBER: "Oh, yeah, maybe we could put a bed for families here instead."

CLINICIAN: "This will not work... Too much stuff in the room."

TEACHER: "How about the dust? It would be hard to keep the room clean."

CLINICIAN: "I agree. First, when we enter a room for a procedure, we need to have a spacious environment. Second, too many people in the room can create noise and increase the risk of infection, so we would not want that."

(other clinicians agree)

FAMILY MEMBER: "Yes, you are right!"

This dialog highlighted the tensions between comfort and functionality, with family members prioritizing space for visitors, but clinicians emphasized the need for hygienic, quieter, and more controlled space. This discussion provided essential insights into the competing priorities of different users, how they engaged, and, eventually, how they shaped the final design of the inpatient room.

After 42 minutes of active discussions, the built environment co-design workshop was completed with each participant's agreement on the end design. The video recording was analyzed, combined with the GT analysis results, and a design brief was created for the architecture experts. Additionally, the researcher converted the end design of the layout into an AutoCAD file to be presented during the built environment-codesign session (Figure 18).



Figure 18. The original patient room layout (on the left), user-created version (in the middle), the researcher-refined version via AutoCAD (on the right).

4.4. Architecture Experts' Evaluation Session

The design brief for the architecture experts' evaluation included three parts: project overview, key design requirements, and visualization. In the project overview, we defined the objectives of this session as to understand and get familiar with the PIU setting and context, explore the current design of the patient rooms, how users perceived and reacted to the existing rooms and what they expected, understand users' design, and eventually elevate the patient room design considering the users' needs. We described what to include in the patient rooms based on users' desires in the key design requirements. The features included spaciousness, having adequate space for clinicians, staff members, families, and patients, safety (infection-free), accessible, comfortable, supportive amenities (kitchenette, restroom, storage), and private, positive

distractions (TV, pleasant soundscapes, scenic natural views). We aimed to use this session's output as game tools in the upcoming workshop and expert evaluation sessions. Therefore, we requested experts to create 3D visualizations and a short animation of the designed patient room, and the visuals' context details were discussed in the evaluation session.

Before beginning the session, the researcher shared a screen and showed the spatial analysis and the PIU users' design. After that, they analyzed and discussed the design brief generated based on PIU users' needs. This collaborative process involving users and architecture experts helped evolve the design of the patient room. The experts began the elevation process by focusing on zoning the space using the layout developed in the co-design workshop (Figure 19). Zones consisted of patient zones, family zones, and staff zones. First, they defined the purpose of each zone. Within the family-patient zone, items include storage for personal belongings, a sleeping and seating area for a family member, kitchen appliances (e.g., refrigerator, kettle), a bookshelf, and a table with chairs for studying and dining. A playground area is provided for the patient. To enhance clinician mobility, a spacious zone surrounds the hospital bed. The entrance and bathroom are part of the shared/transition zone.

Additionally, the entrance was widened for accessibility, and the bathroom's size and entrance were modified. The patient zone was designed to provide adequate medical care and support them emotionally. It was the central area of the room and designed to meet the patient's treatment needs; therefore, although the layout of the patient bed was not changed, experts ergonomically enhanced the surroundings to allow easy access to medical treatments and interventions. Experts kept the table and chairs to support patients' social activities but elevated the design to support well-being and circulation better. This area was designed as an eating and studying area by the window with a

natural view. Lastly, the patient zone prioritized infection control by offering an empty "playground" space to move in the room without leaving the room.



Figure 19. The zoning phase conducted by architecture experts, dividing the patient room into designated areas for patients, family members, and clinicians.

Experts wanted to design a family zone that could support patient care. Therefore, they aimed to create this zone in close proximity to the patient, but it was still an adequate space that could meet their respite needs. Experts discussed differing ideas on having a bed or seating unit for families in the room and decided to design a flexible option for various needs. As part of the layout revision, the bathroom design was adjusted to be more accessible for patients and families. Lastly, considering the extended hospital stay time, they decided to design a furniture unit that could accommodate the desired items, including storage and kitchen appliances.

On the other hand, the staff zone was purposed to ensure easy access to the patients and improve patient care and medical education of physician candidates. Experts worked on ensuring providing space that minimizes clutter and obstacles, prioritized accessibility, and infection control. Therefore, they decided to have as little furniture as possible.

After defining the zones and layout design, experts worked on elevating the users' design using AutoCAD software. Screen sharing and modifications were led by the researcher to ease the process. Following the experts' directions, the researcher created the elevated layout simultaneously. Experts discussed replacing the separate furniture pieces offered by PIU users with built-in options. All experts indicated this would make the patient's room more straightforward to clean and maintain. They kept the patient's bed in a pre-defined place. Still, they designed a built-in element such as a table, bookshelf, sitting and bedding areas, kitchen appliances, and storage were selected to reduce clutter while still providing a comfortable and functional environment. The end design met the users' needs discussed in the built environment co-design workshop, explicitly focusing on minimizing unnecessary furniture to maintain a spacious, functional, accessible, and safe room. The layout before (designed by PIU users) and after (elevated by architecture experts) can be seen in Figure 20.

After designing the room layout, experts created a mood board for selecting the materials and colors and discussed the 3D visualizations. To create a pleasant atmosphere, they preferred natural and soft colors to enhance the emotional comfort of space. A mood board was designed to capture the desired aesthetic, helping to ensure that the space felt pleasant (Figure 21).

EXISTING
PIU PATIENT ROOM
FLOOR PLAN

CO-DESIGNED
PIU PATIENT ROOM
FLOOR PLAN

EXPERT-ELEVATED
PIU PATIENT ROOM
FLOOR PLAN

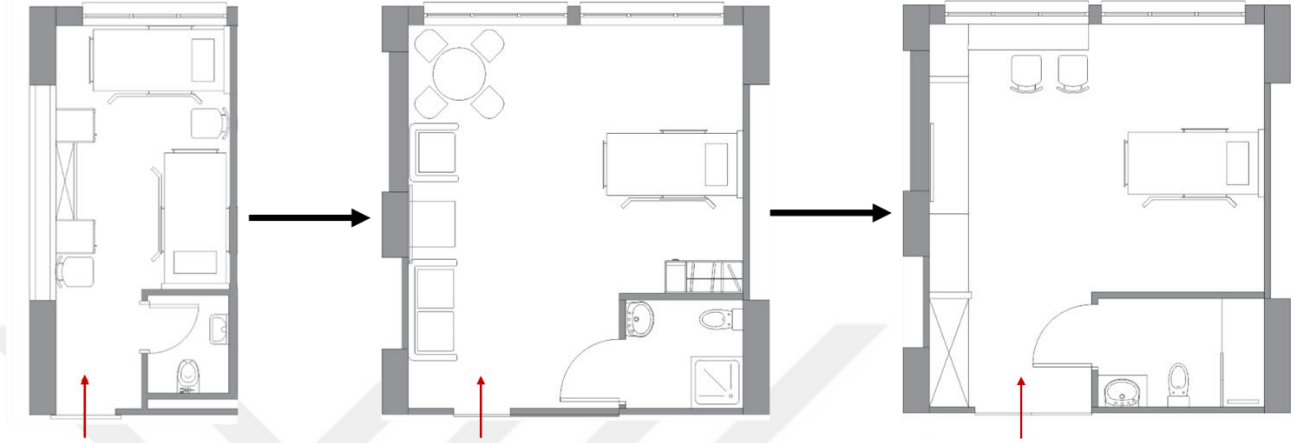


Figure 20. The evolution of the patient room design through three stages. The original patient room layout (on the left), co-designed version (in the middle), expert-elevated version (on the right).



Figure 21. Mood board that was created by the architecture experts to inspire the 3D visualization and a short animation of the room.

The visualization expert asked technical questions necessary for them to develop 3D drawings and animation. Based on the PIU users' needs, experts planned to create three scenes for morning, afternoon, and night scenarios. The morning scenario was decided to reflect a morning visit where the patient was on the bed, surrounded by clinicians, and the family member had a visual and auditory connection but not too close to the clinicians. The afternoon scenario comprised only the patient and family members in the room; everyone was in their zone. On the other hand, the nighttime scenario should have reflected the sleeping time with no active event. They decided to see a natural view from each visualization via varying lighting depending on the time of the day. Lastly, the experts discussed the scenes in the animation and decided to start with someone entering the room, seeing all over the room, and then going into the bathroom. In this way, the animation would efficiently reflect each 'elevated' part of the patient room.

Experts agreed on the end-design decisions and discussed further communication about the visualizations. They decided to evaluate the visualizations via feedback through email and have another Zoom meeting if necessary. After two weeks, visualizations and a short animation were electronically sent to everyone's approval. Experts indicated that they were satisfied with the results and approved of the visuals for further use in the upcoming phases of the study (Figure 22-25).



Figure 22. The morning scenario.



Figure 23. The afternoon scenario.



Figure 24. The nighttime scenario.



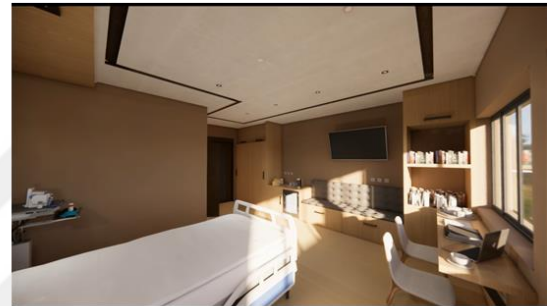
1



2



3



4



5



6

Figure 25. Scenes from the short animation that show an overview of the co-designed room.

The researcher observed how PD affected architecture experts' perceptions of the design process. It was observed that experts found the user-centered design solutions beneficial for anyone involved in the process. They noted that the design brief helped them understand user needs more comprehensively, which led to more informed design decisions and contributed to time efficiency.

EXPERT 4: Well. These requirements are definitely not written in the design guidelines.

(laughs)

EXPERT 1: Initially, I thought, 'Do we really need this much empty space in the room? Like...why?' However, after reading the brief, I realized that this is something patients, well, actually, all users need.

EXPERT 4: Yeah...Empty space would provide easy cleaning, better clinical examination and operation, and most importantly for patients to be able to move without infection risk...I mean...Sometimes, despite years of experience, we still learn something new..."

Then, another expert highlighted the importance of involving users in the design process:

EXPERT 3: ... Yeah, that is why it is essential to remain in touch with the end-users throughout the design process.

This dialogue illustrates how the design brief helped experts reflect on space's requirements more deeply, allowing them to consider factors they might not have initially prioritized. Their appreciation for the process demonstrated how the involvement of users in the design phase can lead to better-informed decisions that align with practical and emotional needs.

4.5. Acoustic Experts' Evaluation Session

The researcher generated a data collection tool for the acoustic experts' evaluation session. This tool consisted of three parts: demographics, scenario, and listening tests. Previous studies demonstrated that using scenarios for expert evaluation provided better understanding to experts about the study content (Ratcliffe et al., 2013). The scenario was created based on real user

experiences from the interviews by creating an imaginary character, Ali, to represent the PIU patients:

"Ali is 13 years old and has been hospitalized for two weeks. He and his mother are staying in a pediatric inpatient room together. On a casual day, they hear mainly nurses' conversations. They often get bored of the library-like stillness and expect to hear pleasant, calming, and relaxing sounds in their room. Now, as an expert, you are expected to select pleasant sounds that would best meet Ali and his mother's needs."

For the listening test, we created a sound source pool consisting of 15 sound sources. The selection was made based on users' expectations under the categories of music, bird sounds, and water sounds. Therefore, five different sound sources were assigned to each category. Bird sounds were gathered from open platforms and high-quality sound libraries, such as BBC and Xeno-canto.org (Ratcliffe, Gatersleben, & Sowden, 2016; Smalley et al., 2023; Tripyla et al., 2023), considering the most common bird species in Turkey (Kirwan, Guy, et al., 2010), while the selected five music genres and water sounds were compiled based on relevant literature (Figure 26).

We extracted a 30 s sample from each sound source. This phase aimed to evaluate the sound type rather than the sound level, therefore, we normalized sound sources, as the use of a consistent level ensures compatibility. We used Audacity software to prepare the sound clips. After that, we combined sound clips and 3D visualizations that were created by the architecture experts. Eventually, 15 different audio-visuals were prepared for acoustic experts to evaluate. The visual images were 3D still scenes of an unoccupied patient room to not cause any bias (Figure 27), and the audio signals were single dominant, easily identified sound sources.



Figure 26. Sound source pool created by the researcher (see Appendix E).



Figure 27. The still image of the unoccupied patient room, used to create audio-visual tools for the acoustic expert evaluation session.

Experts individually entered a sound-isolated room one by one to complete the listening test and rate the pleasantness of fifteen sound sources. The results revealed that the most pleasant sound sources were selected as Great Tit (Bird 4), Common Blackbird (Bird 5), Souvenirs D'EnfanceD'Enfance (Music 4), Sonata for Two Pianos in D major, K448 by Mozart (Music 5), rain (Water 3) and sea wash (Water 4) (Figure 28). The selected sound sources were then used as a game tool during the upcoming co-design workshop.



Figure 28. The most pleasant sound sources selected by acoustic experts, to be used as game tools in the further workshop session.

Using a scenario based on real user experiences helped experts stay goal-oriented and develop empathy when selecting sounds. Implementing participatory design (PD) approaches in the soundscape design process encouraged experts to prioritize users' perspectives over their own preferences. This alignment led to the selection of sound sources that matched users'

expectations for a pleasant soundscape. For example, experts sought clarification with questions such as:

EXPERT 3: “...Just to be sure, I should evaluate the sounds based on the scenario, not my own preferences, right?”

EXPERT 5: “... It really made me think from their perspective instead of just going with what I prefer.”

The user-focused approach in participatory soundscape design guided acoustic experts to prioritize understanding and addressing users' needs over personal biases.

4.6. Acoustic Environment Co-Design Workshop

Before the last phase of this study, we created the design game aim, tools, and rules. The design game and its tools were generated with the compilation of the previous phases. First, the GT analysis revealed that PIU users expected a pleasant soundscape in the patient rooms. Based on that, we generated the aim of the game. Second, users and experts designed the patient room. 3D visualizations and animation were completed to be used as game tools in the acoustic environment co-design workshop session. Lastly, acoustic experts selected pleasant sound sources, which then were used as another game tool. The aim of the design game was generated as follows:

“The aim of the design game is to co-design a pleasant sound environment for patient rooms at three different times of a day; morning, afternoon, and nighttime. The goal is to define expected sound environment and then create a soundscape using the given sound sources for each scenario. “

The design game aims to co-design a pleasant sound environment for patient rooms at three different times: morning, afternoon, and nighttime. The goal is to define the expected sound environment and then create a soundscape using the given sound sources for each scenario.

The game tools were game boards, soundscape adjective cards, and sound source cards. We created three game boards with 3D visualizations of patient rooms for the morning, afternoon, and nighttime scenarios (Figure 22-24). Then we made the soundscape adjective cards in Turkish regarding the literature and soundscape standards: rahatlatıcı (comfortable), sakin (calm), eğlenceli (enjoyable), tekdüze (uneventful), karmaşık (chaotic), dinamik (dynamic), rahatsız edici (annoying), and sıkıcı (monotonous) (Figure 29) (Yilmazer et al., 2023; ISO, 2018). Lastly, we created sound source cards based on experts' evaluations and interview results, as many clinicians preferred a quiet environment (Figure 30). After designing the game tools, we applied the same rules with the built environment co-design workshop session. The difference between these two design game rules is that participants were asked to place the selected cards on the relevant game board in this session after collaboratively discussing and deciding.

The design game aimed to collaboratively create a pleasant soundscape for patient rooms that meets the specific needs of morning, afternoon, and nighttime scenarios. As it is in the definition of soundscapes, although the space was the same, changing activities generated various contexts. Accordingly, as expected, users' perceptions and expectations varied regarding the changing contexts. We observed that open discussions helped users to engage with each other better and foster empathy. Participants had similar ideas when defining the expected sound environment for each scenario. When selecting the sound source, most of

the challenging ideas occurred during the listening part, which created in-depth discussions. Eventually, participants collaborated and designed a pleasant soundscape.



Figure 29. The soundscape adjective cards were created based on the literature (Yilmazer et al., 2023; ISO 2018).



Figure 30. The sound source cards were created based on the interview and acoustic experts' evaluations.

The participants' discussions in the video recording were analyzed, and their moves were documented. During the introduction, participants analyzed all the

game tools and understood the aim of the game and the rules. An enhanced communication process was one of the critical benefits observed during the co-design workshops, as it helped users engage with each other. Participants started to discuss the design goals. During these discussions, we observed that patients and families focused primarily on emotional needs, emphasizing that it could be emotionally supportive as too silent afternoons and weekends cause them to feel isolated and bored.

On the other hand, clinicians supported creating pleasant soundscapes with those sound clips; they highlighted the importance of functional needs with a more practical and clinical perspective. This results pattern was mainly observed when playing on the morning board, as the main focus was on the clinical teams' morning visits. However, when playing on the afternoon and nighttime boards, we did not observe any conflicting ideas on defining the expected sound environment with adjectives or selecting sound sources.

Participants first started playing with the morning board, which visualizes a scene of typical morning rounds in which the patient is lying on the bed and surrounded by clinicians. At the same time, the family member sits in the family zone (Figure 22). They often mentioned the morning sound environment as chaotic and vibrant. The common idea was to define the expected sound environment as *comfortable* and *calming*; therefore, they played with those cards. Eventually, clinicians and families said that the room should support communication during the morning ward rounds; therefore, there must not be additional sound sources that may cause interruption of communication or miscommunication, distraction, and medical error. Therefore, they decided not to add any sounds and played with a *quiet* sound source card (Figure 31). A related dialog was captured from the recordings as follows:

CLINICIAN: There should not be any sound during the rounds because it requires constant focus, we have many clinical and vital conversations that need to be heard clearly. Therefore, there should not be any distracting sound.

FAMILY MEMBER: Yeah, right. We are also listening what clinicians say about the patient.

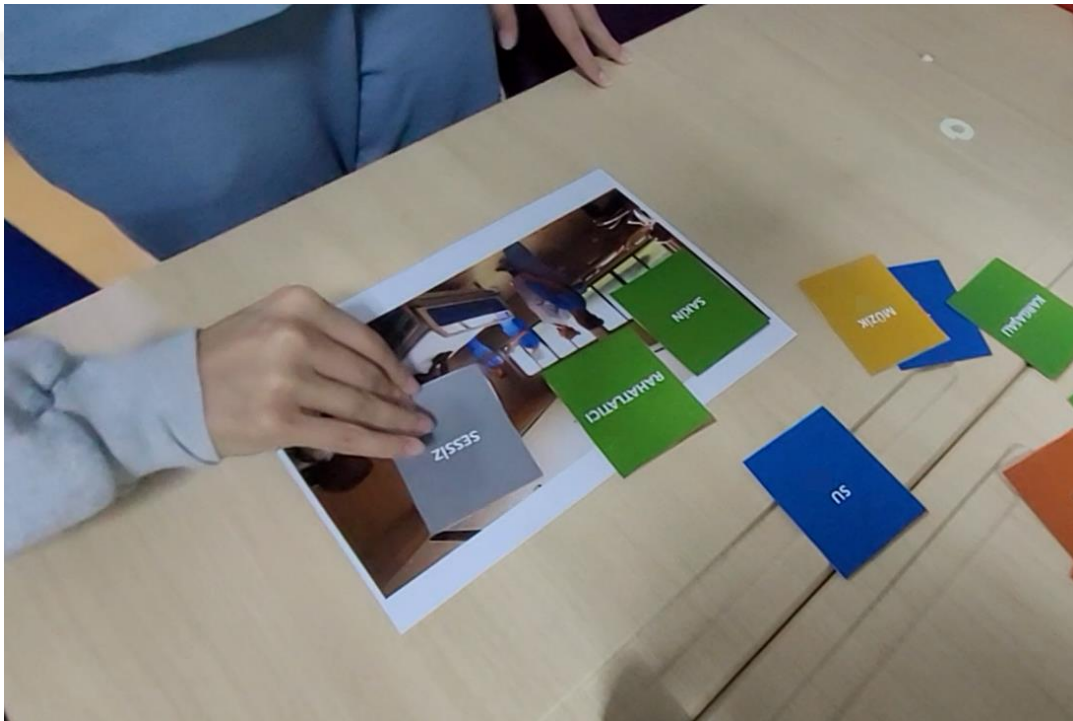


Figure 31. PIU users engage in the design game on the morning board.

After every participant agreed on the decisions made for the morning board, they moved on to the afternoon board. The afternoon game board illustrates a scene where a patient sits on the bed, and a family member is in the room (Figure 18). Families and patients described the afternoons as the time they felt the most isolated and bored in the GT analysis. This was also clear during the workshop when a patient immediately reacted upon seeing the afternoon board, "Ugh, I get so bored during the day." After that, every participant, including

clinicians, supported adding additional sounds that could enhance patients' well-being and work as a positive distraction. Therefore, they first define the expected sound environment with calm and comfortable adjectives. Considering that participants decided to have some additional sound sources in this scenario to create a pleasant soundscape. They moved with all the sound source cards, including music, birds, and water sounds (Figure 32).

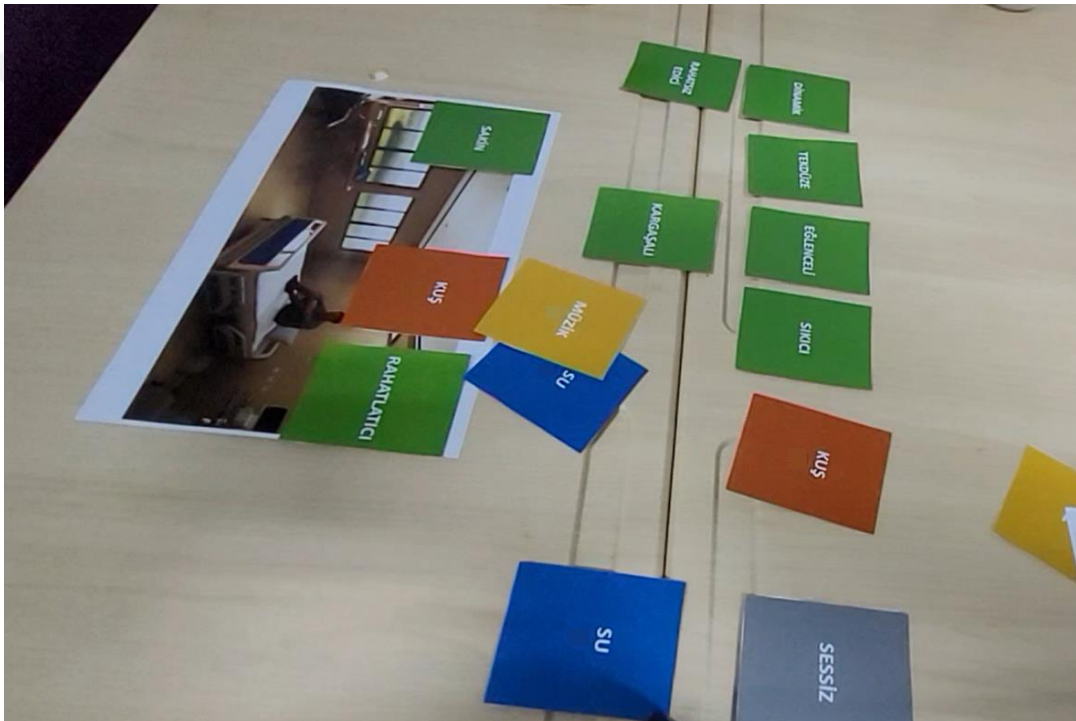


Figure 32. PIU users engage in the design game on the afternoon board.

Lastly, participants discussed the nighttime board, representing a scene from the sleeping time where the patient and family members are in the darker room and ready to sleep (Figure 24). Similar to the previous boards, participants expected to have a calm and comfortable sound environment. They decided to keep the sound environment silent for rest, minimizing sleep disturbance. Therefore, they played the quiet card and did not want additional sounds during

the nighttime (Figure 33). No disagreements were observed during playing with the nighttime board.

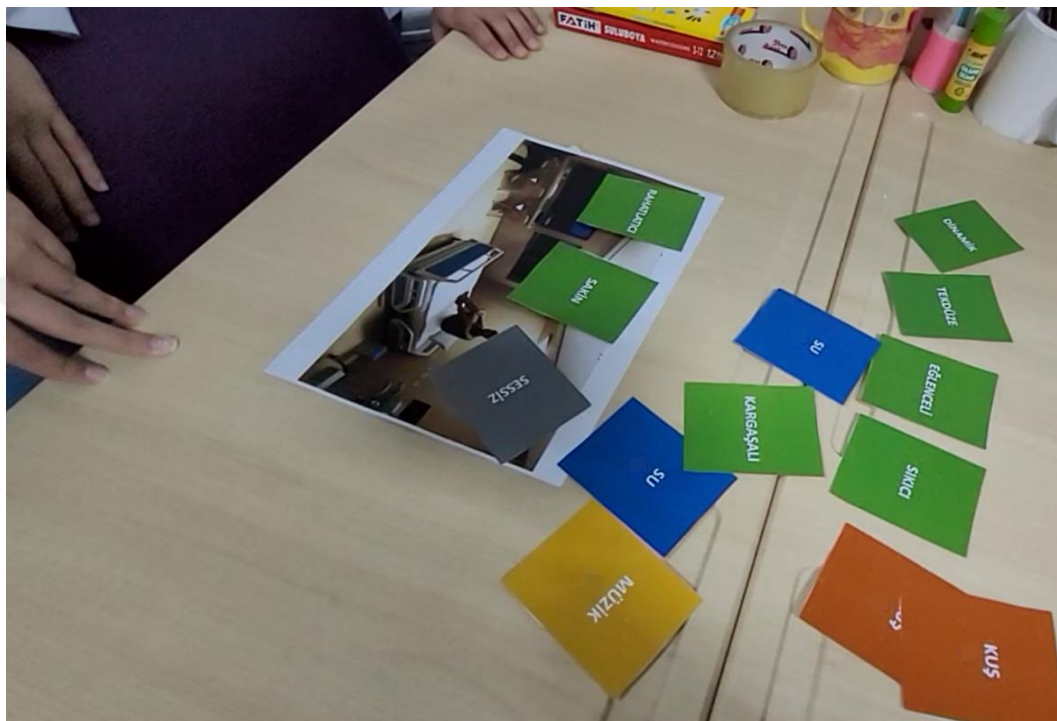


Figure 33. PIU users engage in the design game on the nighttime board.

The results revealed that PIU users expected to have a calming and comfortable soundscape any day, but their sound source selection differs regarding the related activity. For instance, in the morning, the primary focus was on the morning rounds when several clinician teams visited the patient and family in the patient rooms. Each participant thought the information shared during the morning rounds was critical and wanted to hear every detail. Therefore, they did not prefer to have any distracting sounds and preferred to have a quiet environment. However, families and patients perceived afternoons as one of the most 'boring' times of the day. Therefore, everyone agreed to have pleasant sound sources for an enhanced experience. They preferred to have both music, birds, and water sounds to create a pleasant soundscape. Lastly, the nighttime

was defined as one of the most critical times of the day, given that patients need quality sleep without disruptions. Therefore, participants preferred to have a quiet environment.

The next step was listening and designing. As participants preferred to have additional sound sources only during the afternoons, we moved on to playing the rest of the game on the afternoon board. Participants were asked to design a pleasant soundscape using their preferred sound sources. In this phase, we used acoustic experts' selections of sound sources for the listening test. From each category, we had two pleasant sound sources selected by experts (Figure 28), and participants were expected to select the most pleasant among them. The researcher controlled the listening part via a laptop connected to a Bluetooth speaker. Participants listened to the sound sources as much as needed and discussed which one to select as the most pleasant sound source.

The listening test started with bird sounds, and participants initially had conflicting ideas. Three participants preferred the first recording, while four preferred the second one more pleasant. At that moment, the researcher asked the participants for their reasons to choose a specific sound and started a discussion. Some participants found the first recording very high-pitched and energetic, which created an entertaining acoustic environment. The others found the second recording more relaxing, making them feel like they were in the woods. Then, they listened to both recordings repeatedly and had a discussion in which each group tried to convince each other about their selection. Eventually, a clinician emphasized the purpose of this game as designing a 'pleasant soundscape,' and they collaboratively decided to choose the second recording. A part of the related conversation was captured as follows:

CLINICIAN 3: The first one is a high-pitched and it is not pleasant, nor calming. It is more for entertaining purposes.

FAMILY MEMBER 1: But isn't it better?

PATIENT 1: I like the second one better, it is so relaxing.

CLINICIAN 4: I mean we should discuss which one is more pleasant rather than better, I guess...

FAMILY MEMBER 1: Yeah, you're right...we are designing a pleasant sound environment...

After participants selected the bird sound, they listened to the music pieces. Similarly, they found the first recording was entertaining and inappropriate for the intended purpose. All agreed to select the second recording because they thought it was pleasant. There were no conflicting ideas regarding the music piece selection. This may be because they had similar discussions while selecting the bird sounds when everyone was convinced to select the pleasant option over the entertaining one.

Lastly, participants listened to the water sounds. The selection of the most pleasant water sound was the most challenging part of this co-design workshop. They all agreed that both water sounds were pleasant. They requested to listen to the sound clips several times. During the listening test, conflicting ideas started to occur. It was challenging for participants to decide because they defined each water sound as pleasant and could not easily determine which one was more pleasant.

CLINICIAN 2: Actually, both of them are really relaxing sounds...

CLINICIAN 3: Yeah, can we listen to them again?

PATIENT 2: I like both of them. Sometimes my mom plays these sounds for me when I'm trying to sleep.

CLINICIAN 2: I think I'll go with the wave sound... or wait, no, maybe it's the rain sound...

FAMILY MEMBER 1: Okay, I guess I'll go with the sea wash...

CLINICIAN 4: To me, it's the rain, sorry...

(everyone laughs)

CLINICIAN 1: Okay, this one's tough. Let's listen again carefully, focusing on which one's more pleasant...

Eventually, a clinician's idea was directed in their decision-making, to which everyone agreed.

CLINICIAN 5: It is hard to choose because both sea waves and rain are pleasant. However, rain reminds me of walking in the streets when I need to clear my head. You know, this city is almost always rainy. Rain means grabbing my umbrella, stepping outside, and relieving stress. So, I am going to go with the 'rain' sound.

(everyone agrees)

At the end of the listening session, we observed that participants were sensitive about selecting the 'pleasant' sound source regarding the aim of the game. Moreover, we observed that when participants had different preferences in conflict, communication and empathy helped them make decisions easier. Therefore, collaborative decision-making helped them achieve the given task's goals.

We explained that participants should create a unique, pleasant soundscape using the afternoon board. They had to combine the sound sources they selected during the listening test to do that. The researcher operationalized the further process using Audacity Software. Following the participants' directions, the researcher created several sound combinations. At first, this phase was unclear to the participants, and they requested to hear what it would sound like if we combined all three sound sources. The first mix consisted of the three original sound sources, meaning no manipulation was made to the sounds.

This helped them better understand the process more concretely. The first dialog recorded after this sound combination was captured as:

CLINICIAN 3: It does not sound right to me...

FAMILY MEMBER 1: Yes, I guess the water sound is too dominant.

PATIENT 2: I'd like to hear the music more

After that, they began requesting adjustments to the volume, such as increasing or decreasing the sound levels:

CLINICIAN 2: Can we decrease the bird and water sounds' volume down?

Participants requested to change the sound levels of the sound sources only; they did not request any changes regarding the pitch, tone, or timbre. They directed us while manipulating the sound sources until each participant agreed on the final design. They decided to increase the music volume and lower the bird and rain sounds, as seen in Figures 34 and 35.

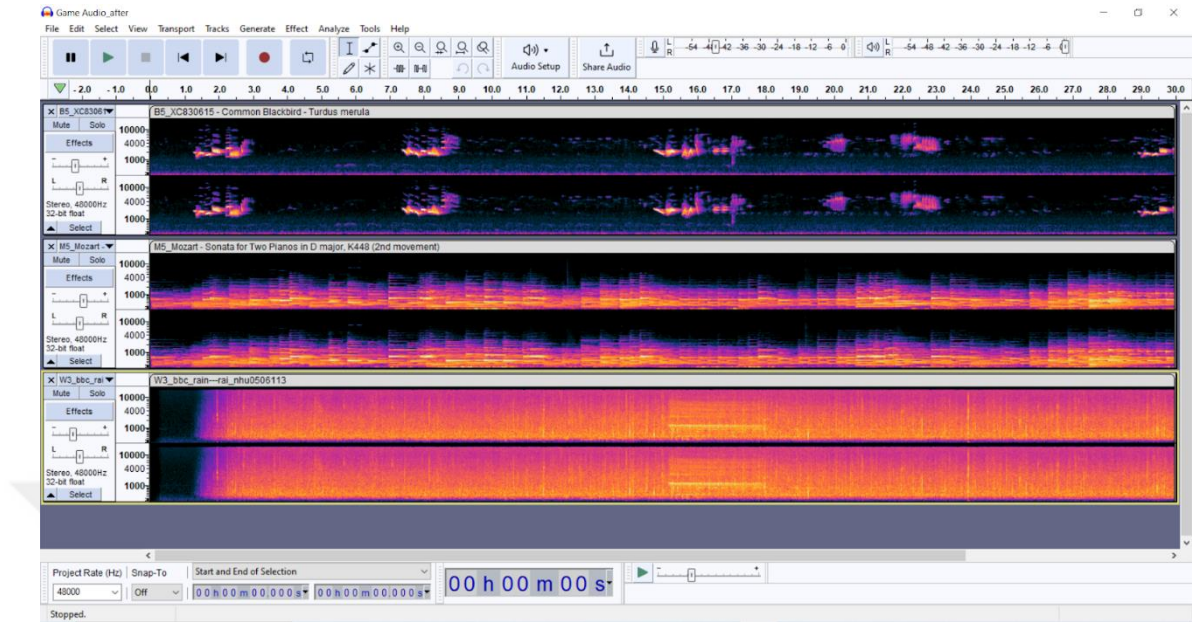


Figure 34. Spectrograms of the manipulated volumes of the selected sound clips.

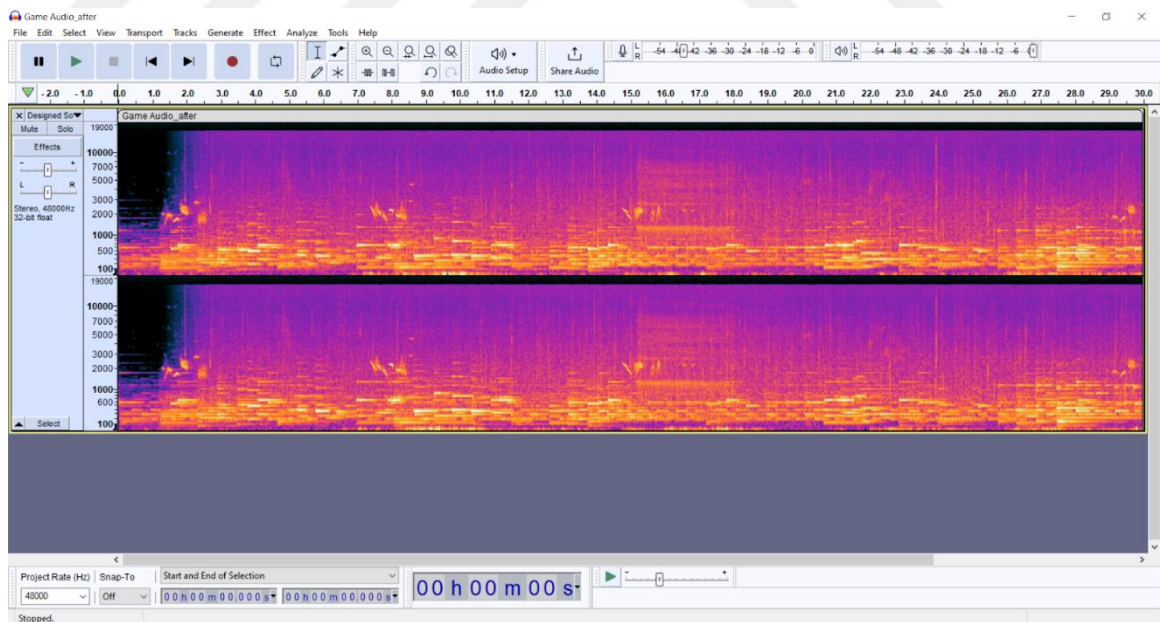


Figure 35. Spectrogram of the designed pleasant soundscape mix by users after the co-design session.

Once each participant approved the final sound mix, we merged the sound clip with the short animation. In this last part, participants watched the animation and were asked to evaluate both the end design and the PD process. To better guide this evaluation part, we developed discussion questions based on the literature (see Appendix F) (Bakhanova et al., 2020; Bromark et al., 2023; Priya et al., 2020). Some of the participants' comments were as follows:

CLINICIAN 4: It felt right that we were asked for our opinion on the unit's design.

CLINICIAN 1: Well considering that we do not even have a private space here, I wish we were asked about our needs before they design the hospital.

CLINICIAN 5: It was good to come together and talk about our needs. This way, I could engage with patients better...

PATIENT 1: I have so much fun.

TEACHER: To heal and educate people in better-quality environments, it is ideal to design these spaces by consulting the users' opinions. This would help create environments that truly serve their needs. That is why I appreciate that you involved us in the design process. This study is critical in that sense.

The findings revealed that collaboration between clinicians, families, and patients and their involvement in the design process were desired. Some expressed that their involvement helped them to engage better with the other users. Some indicated that their input and perspectives must be considered before designing healthcare facilities, as they will be the end users. Overall, the responses suggest that user involvement can contribute to creating soundscapes that better meet everyone's needs and improve user satisfaction.

CHAPTER V

DISCUSSION

The first hypothesis of this research is that applying PD methods can create more inclusive and holistic hospital soundscapes. To evaluate this, first we conducted observations in PIU and semi-structured interviews with its users. These two phases of the study is one of the standardized methods of soundscape research (ISO, 2018; Acun & Yilmazer, 2018; Acun et al, 2018; ISO, 2019; Orhan & Yilmazer, 2021; Çankaya Topak& Yilmazer, 2022; Orhan & Yilmazer, 2024). We documented the findings via conceptual framework, which clearly showed individual responses and perceptions towards the soundscape (Figure 14). Figure 36 illustrates the different findings between individual interviews and PD methods. After we conducted participatory methods; workshops and expert evaluation sessions, we observed that the same components of the conceptual framework evolved in line with all users' needs instead of individual items. This finding demonstrated that interpreting hospital soundscapes with PD methods would lead to more inclusive soundscape solutions. Our findings also supported the second hypothesis, which suggests that the use of co-design workshops would enhance stakeholder engagement, collaborative decision-making, and lead to empathic hospital soundscape solutions. Lastly, the third hypothesis is also supported with the findings as PD methods helped create context and culture rich data, while limiting the universal

generalizability of the findings. The following section discusses the most important outcomes of our study in-depth.

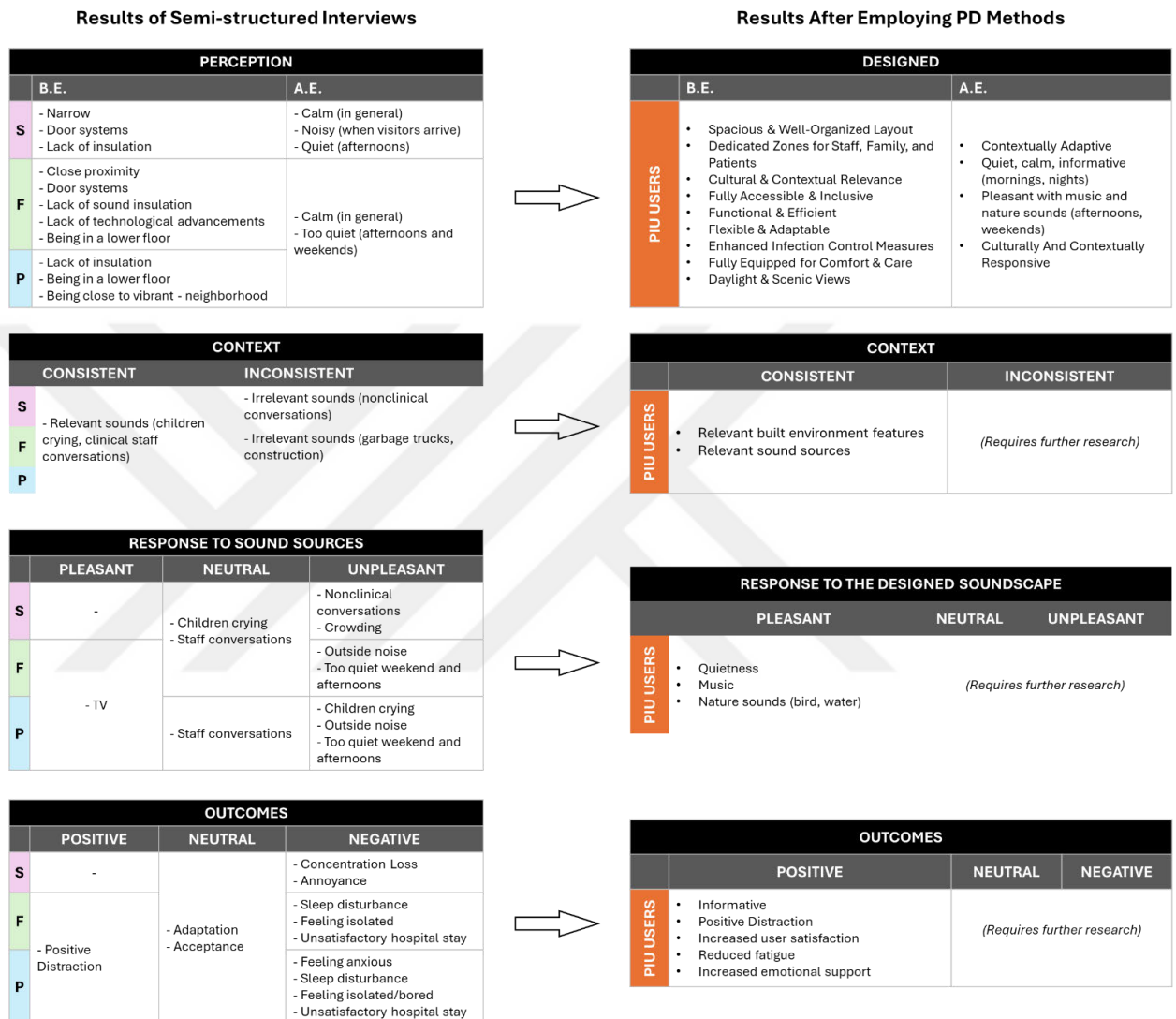


Figure 36. Comparison of the results of semi-structured interviews with the PD methods.

5.1 Lessons Learned: Promises and Pitfalls

5.1.1. PD Methods and Hospital Soundscapes

The main objective of this study was to reinterpret the hospital soundscapes integrating PD methods. Previous studies with standardized soundscape

methods have demonstrated positive results in healthcare settings such as improved speech privacy and decreased sound levels (Kinjo et al., 2023) and gathering rich subjective assessments (Orhan & Yilmazer, 2023; Orhan & Yilmazer, 2024). However, the existing soundscape literature is limited to either objective and/or subjective assessments and lack active involvement of users in the following process (Kim et al., 2023). These limitations called for alternative, more inclusive, user-centered indoor soundscape methods as participatory approaches (Torresin et al., 2020b).

The difference between the standardized soundscape approach and participatory methods can be seen in two key points within this thesis. First, our preliminary study, although we gathered rich data from NICU nurse interviews, the results were limited to assessing the NICU soundscape instead of creating one for every NICU user (Orhan & Yilmazer, 2024). Similarly, if the main study were completed after the second phase, the results would not go further than reporting the individual preferences and a general indoor soundscape assessment. Our findings are consistent with the prior studies that have demonstrated that PD methods and tools, such as design games, would empower participants and foster collaborative design (Ferreira et al., 2016; Vaajakallio & Mattelmaki, 2014). Therefore, as suggested by Schulte-Fortkamp (2023), we have found that integrating participatory approaches in soundscape process would be a promising alternative for more inclusive soundscape solutions.

Despite its methodological promises, we experienced some challenges. The study involved six phases, and the researcher played a central role in each phase. The researcher developed design and research methods, collected data, analyzed findings, and created design outcomes. Whereas the involvement of a single researcher in all phases provided consistency, past researchers have found that collaborative data analysis and multiple perspectives reduce bias and

strengthen results through data triangulation (Lipson-Smith et al., 2019). A similar conclusion was reached by Mackieson, Shlonsky, and Connolly (2018) that researcher bias can be observed in qualitative research, given that a researcher's perspective may influence the interpretation of data and the findings. One example of potential researcher bias in our study was the selection of game tools used during the built environment co-design workshop. The researcher herself generated 2D game tools based on her interpretation and analyses of the interview data instead of discussing the possible furniture samples and styles with other relevant stakeholders. For instance, participants were given a drawing of a table with four chairs adjacent to it, but they asked, *'Isn't there one with two chairs?'* We observed that some participants used empty cards to draw the furniture as they wished; however, they typically used the cards created by the researcher to design the inpatient room.

Prior research has demonstrated that storytelling approaches during the co-design process minimize bias and engage participants to empathize with the users' experiences (Heiss & Kokshagina, 2021; Heiss et al., 2024). Our findings tied well with previous studies, as using scenarios during the acoustic environment expert evaluation session helped experts select sound sources based on user preferences instead of theirs. However, another possible bias can be seen in creating a sound source pool for the expert evaluation session. The researcher selected five sound sources from sound libraries and previous literature (Ratcliffe et al., 2018). Eventually, acoustic experts rated the most pleasant sound sources among the pre-created sound pool instead of collaboratively creating a pool. These findings may be explained by the idea that the provided options may only partially capture participant preferences. However, although the researcher created the sound source pool, the selection was made based solely on end-users' preferences in contrast to previous studies that generated audio-visuals without user involvement (Watts et al., 2016; Yilmazer & Ugurlu, 2022). In line with previous studies, we suggest that

more direct user involvement in tool selection enriches the design process and increase user satisfaction (Yüksel et al., 2024).

An important methodological observation concerns the structure of the workshops focused on built and acoustic environments. Unlike conventional soundscape studies that typically treat built and acoustic components as a unified perceptual whole, these workshops were conducted separately. This approach allowed for a more concentrated exploration of each aspect, although the stages were not entirely distinct in practice. As illustrated in Figure 6, each phase informed the subsequent one. For example, the 2D layouts produced during the built environment co-design workshop were utilized and further developed in the architectural expert evaluation session, leading to 3D visualizations and animations. These visuals were then used as audio-visual stimuli during the acoustic expert evaluation session and functioned as game boards in the acoustic co-design workshop. Although the same user participants did not take part in all four stages, every tool and scenario was developed exclusively based on user outputs. While the holistic nature of the soundscape concept is acknowledged, future studies may benefit from conducting integrated co-design workshops that address both built and acoustic environments simultaneously. This approach could enhance the synthesis of user perspectives and help create more cohesive and inclusive soundscape solutions.

Despite these challenges, our study highlights important differences after applying PD methods in hospital soundscapes. The most unique methodological contribution of this study is that it demonstrates how PD can be used not only to explore user perceptions, but also to actively inform the design of inclusive future hospital soundscapes. This pattern of results is consistent with the previous literature that emphasizes the importance of engaging stakeholders, defined as those familiar with the area, such as residents or individuals who engage with the space daily, who can provide context-specific insights that

enhance the sensitivity and relevance of design solutions, particularly in soundscape research (Schulte-Fortkamp & Fiebig, 2023; De Winne et al., 2020).

5.1.2. User Involvement, Interdisciplinary Collaboration, and Empathy

Sanoff (1979, 1985, 1990, 2008) documented that people naturally desire involvement in decisions that affect their lives and are dissatisfied if excluded from decision-making. A clinician's statement further supports this: *"We do not even have a private space here, and honestly, we should have been asked about our needs before they designed the hospital. This is our workplace, not someone else's."* One interpretation of these findings is that meeting the users' needs is essential for a successful healthcare design project and user satisfaction (Blyth & Worthington, 2010; Carthey, 2020b; Elf, Frost, Lindahi, & Wijk, 2015; Johnson & Hellem, 2024). Users can be involved in any phases of design process, including planning, design, construction, or evaluation (Tucker et al., 2021). User involvement in the design process not only fosters more appealing design solutions (Aule et al., 2022) but also provides an opportunity to express their preferences regarding the spaces they will occupy (Andrews et al., 2023; Moghimi et al., 2017). Studies highlighted the importance of user involvement in healthcare facilities, stressing that they often feel vulnerable and disconnected from their surroundings in such spaces (Bubric, Harvey, & Pitamber, 2020; Johnson & Hellem, 2024). Moreover, earlier studies demonstrated the significance of user involvement in the design process to enhance user experience and satisfaction in hospital exam rooms (Matić et al., 2022) and waiting rooms (Juliá-Nehme, Yoon, Cumsille, & Rodriguez, 2023). Supporting that, our findings demonstrate participants were satisfied with being involved in the design process, expressing that they felt their voices and preferences were valued. This is a unique finding in the scope of soundscape research that, to our knowledge, has not been discussed yet.

The nature of PD processes in pediatric settings introduces additional challenges related to participant engagement. While past researchers have found that design games encourage effectively involving young participants in the design process (Pinter, 2019; Rollins, 2024), the present study has shown that pediatric patients were less active in the decision-making process, often treating the game tools as a fun activity rather than a design task. This can be seen when asked to evaluate the overall PD process, a patient responded as “*I had so much fun!*” This finding may be explained by the idea that patients had limited activities to distract them during the hospital stay, so they often perceived the co-design session as a “play” and quickly switched focus from involving in the study to playing with cards. Given that, the patients’ needs often were captured indirectly through family and clinician input throughout the co-design workshops. Therefore, the researcher had to ask patients direct questions about what they prefer. Although the primary aim was to gather insights into the pleasant soundscapes, children were often distracted by the enjoyment of the design game. According to Piaget’s theory of child development (1962), children interact with their environment differently than adults. So, this finding may be explained by the idea that aligning PD processes with young participants can be challenging, as their capacities for participation may differ from those of adults (Faerden et al., 2022).

Our findings support the previous research and highlight that the PD methods, compared to traditional methods in design, help facilitate interdisciplinary collaboration (Denham et al., 2018; Johnson & Hellem, 2024) and create more inclusive design solutions. For instance, during the built environment co-design workshop, patients and families wanted to place the bed near a window for natural light and a view. However, clinicians disagreed and stated that if they place the bed in the middle of the room, it could increase accessibility and reduce medical errors. Eventually, families and patients agreed to place the bed in the middle of the room considering its potential contributions to patient care.

Another conflicting discussion revealed that families wanted to have an additional seating area and coffee tables for their visitors, indicating that there is no adequate seating to host them. However, clinicians did not agree and explained their reasoning by stressing the importance of having minimal furniture to prevent infection diseases and enhance circulation needed for quality patient care. Patients also did not want to have more furniture, instead they requested a bigger room for an extra infection-free space to move around. Consequently, participants engaged in collaborative dialogues and created a layout that balanced clinical, functional, and emotional needs. This aligns with the work of Larsson et al. (2024), who emphasized the importance of inclusive communication in achieving collaborative success.

Research has shown that collaborative approaches can improve design goal identification by up to 40% compared to conventional methodologies (Shanthi Priya et al., 2020). Our results strongly imply that empirical research outcomes helped experts translate research-driven information into design solutions. Similar patterns of this finding can be seen in previous research that has suggested that collaboration between practitioners (architecture and acoustic experts, in our study) and academic consultants (researcher, in our study) enhances the application of empirical research into practice (Hamilton, 2013). Bayramzadeh and Patel (2020) highlighted that many design practitioners lack formal training in conducting empirical research and this can create challenges for the implications of research-driven design. In this study, to overcome such challenges, we created structured design briefs based on users' inputs, and it helped experts to navigate the difficulties of research-driven data. As research suggested and our findings demonstrated, applying research-informed outcomes would create best practices in design (Hamilton, 2018).

One interesting finding of our study is that the clinicians solely focused on clinical features and functionality of the spaces during semi-structured

interviews. However, after patients and families expressed their needs during the workshop sessions, clinicians began to address non-clinical needs alongside clinical aspects from others' perspectives. Additionally, we observed that both families and clinicians primarily focused on the patient's needs when making decisions. This finding may be explained by the idea that valuing is an important situational aspect of feeling empathy for a *person in need* (Batson et al., 2007; Davis, 2024; Sassenrath et al., 2022). In our study, the *person in need* was the patients, and every decision regarding both the built and acoustic environments was made primarily based on patients' needs. For instance, although some participants initially wanted sound sources with more 'fun' melodies, others argued that the 'pleasant' sounds sources must be selected for the patients to enhance their hospital stay. The idea of considering what patients need was the participants' priority, therefore, everyone agreed to select sound sources that would support that purpose.

Empathy acts as an emotional bridge between individuals (Riess, 2017; Sandman et al., 2020). It is a highly used term in healthcare, mostly refers to engaging patients to understand their personal goals, values, and experiences (Houssaini et al., 2023). We argue that inquiring about the subjective responses of PIU users via interviews and workshops, giving insights into the thoughts, feelings, and experiences, can and should inform the designers and create design solutions that align closely with users' clinical and non-clinical needs. This pattern of results is consistent with the other research that suggests using narrative inquiry as a design tool could reinforce empathetic solutions and show strong alignment between individuals and environments (Carmel-Gilfilen & Portillo, 2015).

Sachs (2024) suggests that encouraging empathy in designers can help them become more effective in their careers by fostering a deeper cognitive, emotional, and physical understanding of people and their surroundings. Such

empathetic design decisions were also observed in expert evaluation sessions. The design briefs helped architecture and acoustic experts better understand user needs and quickly plan for the design process. After experts evaluated the participants' design, the end design appealed to the needs of individuals who occupied the PIU. This pattern of results is consistent with the previous literature that demonstrates the importance of collaboration between representatives from various backgrounds to achieve optimal results in healthcare facility design (Carthey, 2020a; Keys et al., 2017; Suter et al., 2009). One of the most unique contributions of this study is to see that empathic hospital soundscape design is possible using PD methods, and to our knowledge, this is the first soundscape study demonstrates that.

Although we observed significant benefits of using PD in reinterpreting hospital soundscape, some challenges affected the degree of collaboration. Administrative and environmental restrictions were the main limitations of our study. As the hospital's policies required, patients were not allowed to leave the unit, and they could only be allowed to spend maximum of 45 minutes with others to prevent infection risks. Considering these conditions, the only available space to gather all participants at a time was the classroom, which was not physically and acoustically designed for workshops and lacked adequate size and furniture. Past researchers have found that using a virtual platform for co-design workshops facilitated collaboration (Kuhlmann et al., 2024; Thorburn et al., 2024). Although we had considered conducting online sessions to bring experts and PIU users together simultaneously, the classroom lacked technological devices that would enable productive remote meetings. A more suitable environment with better technological support could have enhanced the PD process, enabling better collaboration between users and designers (Molesh & Larsen, 2020). The constraints imposed by the hospital's policies and the physical characteristics of the classroom setting were important factors that

influenced degree of collaboration, highlighting the role of the environment in shaping engagement and participation (Calvo & Sclater, 2021).

5.1.3. Generalizability: Context and Culture-Specific Data and Demographics

Studies have demonstrated that co-design outcomes may not always apply to broader contexts (Constantin et al., 2022; Malinverni et al., 2016; Thabrew et al., 2020) as they are too specific to the sample and the context (Jessen et al., 2018). We found that the participants' design preferences were expectedly context-specific, focusing on children's needs. Although this provided rich data, the generalizability of the findings was limited. For example, our study confirms that findings from pediatric settings should not be automatically generalized to adult care environments, as the needs and experiences of pediatric patients differ significantly from those of adults (Nourmusavi Nasab, McLaughlan, & Smith, 2024). Specifically, restorative soundscapes for children may not have the same effect on adults (Shu & Ma, 2018). Therefore, the findings of this study should be revised in accordance with the context before used as evidence for future implications.

Cultural factors further complicated the generalizability of our findings as they influence users' spatial preferences in healthcare settings (Nash, O'Rourke, Memmott, & Haynes, 2021). In Turkey, the Ministry of Health, private and state children's hospitals do not have a family centered care (FCC) policy (Feeg et al., 2016). However, hospitals allow families to stay with their children in the units. Studies demonstrated that even nurses leave most of the physical care of children to mothers because of lacking number of staff that results in heavy workloads (Boztepe & Cavusoglu, 2009; Kuzlu, Kalinci, & Topan, 2011). Although not mandated by law, family presence at bedside is encouraged; however, one should ask whether the current hospital environments are adequately designed to support this practice. In our study, families expressed

their desire to have a larger space for themselves and visitors within the patient room, indicating that there is no place to sit, eat, move, store things comfortably. They requested a seating area and a kitchenette to support their role in patient care. A similar conclusion was reached by Al Mutair, Plummer, O'Brien, & Clerehan (2024), who demonstrated that family members in Saudi Arabia needed a single-bed patient room with designated family areas. Like ours, in some cultures, such as Taiwanese, Japanese, and Arabic, families take on some of the care responsibility during the hospitalization, and they need specific requirements in the patient room (Al Mutair et al., 2024; Hamilton, 2023). Our findings can be applicable in cultures where families directly involved in patient care, however; in western cultures these spatial requirements would not work efficiently as families are not involved in patient care as much (Feeg et al., 2016).

From our results, it was clear that cultural factors also influenced sound preferences. For instance, participants used local metaphors while selecting sounds such as "walking under the rain," evoking pleasant memories tied to the city. This pattern of results is consistent with the previous literature that has demonstrated that different musical genres or natural sounds evoke varying emotional responses depending on cultural background (Creech Hodges, & Hallam, 2021; Good et al., 2000; Greenberg et al., 2022; Lahdelma & Eerola, 2020; Yeoh & Spence, 2023). As previous studies have demonstrated, cultural factors influence environmental preferences in healthcare design (Huber & Bailey, 2023; Nash et al., 2021). Therefore, the applicability of our findings may vary among different cultures and therefore as it was indicated previously it may limit designing universally appealing soundscape design (Schulte-Fortkamp & Fiebig, 2023).

Another pitfall that we observed in this study was caused by the participant demographics. Considering the hospital policies, patients with severe medical

conditions were excluded during recruitment. Given that patients with different medical conditions may have distinct sensory needs (Gupta et al., 2019; Iyendo et al., 2016), excluding these patients may have affected the study's conclusions and cause underrepresentation of important populations. Moreover, 14 staff members, three family members, and four patients were involved in the co-design workshops. Among those participants, 17 were female, and four were male. As Sousa (2014) highlighted, ensuring a representative sample is critical for the validity and generalizability of qualitative findings. Therefore, excluding the patients with severe medical conditions and the dominance of clinician and female populations may cause making hard to generalize the findings.

Overall, the study findings support our hypotheses, and highlight promises of reinterpreting hospital soundscapes with PD methods, tools, and techniques. This study aligns with and reinforces existing arguments on the importance of employing user-centric soundscape methodologies to develop more effective design solutions in healthcare settings (Kim et al., 2023; Torresin et al., 2020b; Zhu et al., 2024). We have found that integrating participatory methods such as co-design workshops and design games foster deeper understanding of user needs and help create more inclusive and empathetic soundscape designs. We found that our third hypothesis was supported in terms of adaptability of PD approaches across diverse contexts, emphasizing the significance of context-specific insights to achieve user-centered solutions. Although the culture- and context-specific nature of our study may limit the findings' generalizability, it is a valuable foundation for future research to explore further and broader applicability of PD methods in soundscapes. Ultimately, this research contributes to advancing the knowledge of soundscape studies by demonstrating the promising potential of PD approaches to create more inclusive and holistic indoor soundscapes.

CHAPTER VI

CONCLUSION

This study offers an innovative contribution to the integration of PD processes with the emerging field of hospital soundscape research. For the first time, PD applies to the creation of healthcare soundscapes, establishing a comprehensive multi-phase framework that weaves together spatial analysis, qualitative inquiry, collaborative co-design activities, and expert acoustic evaluation. This multifaceted approach enables the gathering of context-rich, user-centered data that accurately reflects the varied experiences and perspectives of multiple stakeholders, including patients, their families, and healthcare professionals.

Traditionally, soundscape assessments have largely depended on objective acoustic measurements or on the subjective feedback of individual users. However, this research advances a more inclusive and context-sensitive methodology that recognizes the complexities of auditory experiences in healthcare settings. A significant finding of the study reveals that PD can effectively facilitate consensus-building among stakeholders who may have divergent priorities and perspectives. For instance, initial preferences voiced by clinicians often leaned toward clinical and functional solutions aimed at

enhancing efficiency and operational effectiveness. Yet, through engaging discussions during the co-design workshops, stakeholders gradually acknowledged the critical importance of emotionally supportive interventions that contribute to overall well-being.

These dynamic interactions fostered a collaborative environment where architects and acoustic experts were able to devise soundscape proposals that not only adhered to technical standards but also resonated with the emotional and experiential needs of users. In this light, PD emerged not merely as a design tool but also as a vital platform for cultivating empathy, shared ownership, and accountability in the design process—elements that are particularly crucial in sensitive environments like pediatric inpatient units where the implications of design choices can profoundly affect patient experiences.

The study highlights the importance of structuring built and acoustic co-design processes as interconnected but clearly defined phases. In this framework, the outputs from each phase inform and guide subsequent stages, resulting in a cohesive and iterative design experience. This modular approach facilitates a focused exploration of both architectural elements and soundscapes, and it promotes an understanding of how these aspects influence each other.

Additionally, future research could benefit from the integration of collaborative workshops that bring together stakeholders from both fields. Such workshops may foster dialogue and collaboration among architects, acousticians, and community members, potentially enhancing the soundscape design process. An integrated approach could ensure that sound considerations are integral to the built environment and contribute to the overall design strategy, potentially leading to more immersive sound experiences in urban and architectural spaces.

While the design outcomes obtained from this research are tailored specifically to the context studied, the methodological framework devised is versatile and can be adapted to a range of other healthcare settings and high-stakes environments. This adaptability positions PD as a robust, process-oriented research methodology capable of generating actionable insights that are culturally relevant and contextually appropriate. Nevertheless, certain limitations exist, particularly concerning the specificity of the findings, which raises pertinent questions about their generalizability. Additionally, researcher bias may influence the outcomes, underscoring the necessity for future research to build upon this framework and explore its application across a broader spectrum of institutional and cultural contexts to assess its durability and versatility.

In conclusion, this study sets forth a methodological pathway for advancing soundscape research by linking empirical acoustic studies with participatory, human-centered design practices. The research advocates for the integration of PD throughout all stages of soundscape design, especially in intricate healthcare settings where user needs are diverse yet can converge around the paramount priority of enhancing patient care. By illustrating how participatory methodologies can yield more inclusive, responsive, and emotionally resonant soundscapes, this research makes a valuable contribution to the evolving landscape of healthcare design, emphasizing the need for environments that truly support the well-being of all who inhabit them.

REFERENCES

- Acun, V., & Yilmazer, S. (2018). Understanding the indoor soundscape of study areas in terms of users' satisfaction, coping methods and Perceptual Dimensions. *Noise Control Engineering Journal*, 66(1), 66–75. <https://doi.org/10.3397/1/37667>
- Acun V, Yilmazer S, Orhan C. (2018). Indoor soundscape of historical spaces: the case of Çengelhan Caravanserai. *Euronoise 2018*, Crete.
- Al Mutair, A. S., Plummer, V., O'Brien, A., & Clerehan, R. (2014). Providing culturally congruent care for Saudi patients and their families. *Contemporary Nurse*, 2747–2761. <https://doi.org/10.5172/conu.2013.2747>
- Aletta, F., Vander Mynsbrugge, T., Van de Velde, D., De Vriendt, P., Thomas, P., Filipan, K., Botteldooren, D., & Devos, P. (2018). Awareness of 'sound' in nursing homes: A large-scale soundscape survey in Flanders (Belgium). *Building Acoustics*, 25(1), 43–59. <https://doi.org/10.1177/1351010x17748113>
- Andrade, C. C., & Devlin, A. S. (2015). Stress reduction in the hospital room: Applying Ulrich's theory of supportive design. *Journal of Environmental Psychology*, 41, 125–134. <https://doi.org/10.1016/j.jenvp.2014.12.001>
- Arcia, A., Stonbraker, S., Mangal, S., & Lor, M. (2024). A practical guide to participatory design sessions for the development of information visualizations: Tutorial. *Journal of Participatory Medicine*, 16. <https://doi.org/10.2196/64508>
- Baek, J.-S., & Lee, K.-P. (2008). A participatory design approach to information architecture design for children. *CoDesign*, 4(3), 173–191. <https://doi.org/10.1080/15710880802281026>
- Barnhill, C., West, J. E., Hsu, T., & Ryherd, E. E. (2010). Further studies in hospital noise control at the Johns Hopkins Hospital: Part 1. *The Journal of the Acoustical Society of America*, 127(3_Supplement), 1805–1805. <https://doi.org/10.1121/1.3384081>

- Barrett, P., & Baldry, D. (2009). *Facilities management towards best practice* Peter Barrett ; David Baldry. John Wiley & Sons.
- Becker-Haimes, E. M., Ramesh, B., Buck, J. E., Nuske, H. J., Zentgraf, K. A., Stewart, R. E., Buttenheim, A., & Mandell, D. S. (2022). Comparing output from two methods of participatory design for developing implementation strategies: Traditional contextual inquiry vs. rapid crowd sourcing. *Implementation Science*, 17(1). <https://doi.org/10.1186/s13012-022-01220-9>
- Birch, J., Curtis, P., & James, A. (2007). Sense and sensibilities: in search of the child-friendly hospital. *Built Environment*, 33(4), 405-416.
- Bliefnick, J., Ryherd, E. E., & Jackson, R. (2017). Evaluating hospital soundscapes to improve patient experience. *The Journal of the Acoustical Society of America*, 142(4_Supplement), 2571–2572. <https://doi.org/10.1121/1.5014398>
- Blyth, A., & Worthington, J. (2010). *Managing the brief for better design*. Routledge.
- Bowler, L., Wang, K., Lopatovska, I., & Rosin, M. (2021). The meaning of “participation” in co-design with children and youth: Relationships, roles, and interactions. *Proceedings of the Association for Information Science and Technology*, 58(1), 13–24. <https://doi.org/10.1002/pra2.432>
- Brandt, E., Binder, T., & Sanders, E. B. N. (2012). Tools and techniques: Ways to engage telling, making and enacting. In *Routledge international handbook of participatory design* (pp. 145-181). Routledge.
- Brandt, E., & Messeter, J. (2004). Facilitating collaboration through Design Games. Proceedings of the Eighth Conference on Participatory Design Artful Integration: Interweaving Media, Materials and Practices - PDC 04. <https://doi.org/10.1145/1011870.1011885>
- Brooks, B. M., Schulte-Fortkamp, B., Voigt, K. S., & Case, A. U. (2014). Exploring our sonic environment through Soundscape Research & Theory. *Acoustics Today*, 10(1), 30–40. <https://doi.org/10.1121/1.4870174>
- Bubric, K., Harvey, G., & Pitamber, T. (2020). A user-centered approach to evaluating wayfinding systems in Healthcare. *HERD: Health Environments Research & Design Journal*, 14(1), 19–30. <https://doi.org/10.1177/1937586720959074>
- Busch-Vishniac, I., & Ryherd, E. (2023). Hospital soundscapes. *Springer Handbook of Auditory Research*, 277–311. https://doi.org/10.1007/978-3-031-22779-0_10

- Busch-Vishniac, I. J., West, J. E., Barnhill, C., Hunter, T., Orellana, D., & Chivukula, R. (2005). Noise levels in Johns Hopkins hospital. *The Journal of the Acoustical Society of America*, 118(6), 3629-3645.
- Buur, J., & Soendergaard, A. (2000). Video Card Game: An Augmented Environment for User Centred Design Discussions. Proceedings of DARE 2000 on Designing Augmented Reality Environments. <https://doi.org/10.1145/354666.354673>
- Bødker, S., Dindler, C., & Iversen, O. S. (2017). Tying knots: Participatory infrastructuring at work. *Computer Supported Cooperative Work (CSCW)*, 26(1–2), 245–273. <https://doi.org/10.1007/s10606-017-9268-y>
- Bødker, S., & Grønbaek, K. (2020). Design in action: From prototyping by demonstration to Cooperative Prototyping. *Design at Work*, 197–218. <https://doi.org/10.1201/9781003063988-12>
- Bødker, S., Dindler, C., Iversen, O. S., & Smith, R. C. (2022). Participatory Design. In *Synthesis Lectures on Human-Centered Informatics* (pp. 1-143). Cham: Springer International Publishing.
- Bødker, S., & Iversen, O. S. (2002). Staging a professional participatory design practice. Proceedings of the Second Nordic Conference on Human-Computer Interaction. <https://doi.org/10.1145/572020.572023>
- Cardoso, S. M., Kozlowski, L. de, de Lacerda, A. B., Marques, J. M., & Ribas, A. (2015). Newborn physiological responses to noise in the neonatal unit. *Brazilian Journal of Otorhinolaryngology*, 81(6), 583–588. <https://doi.org/10.1016/j.bjorl.2014.11.008>
- Carthey, J. (2020a). Interdisciplinary user groups and the design of Healthcare Facilities. *HERD: Health Environments Research & Design Journal*, 13(1), 114–128. <https://doi.org/10.1177/1937586719843877>
- Carthey, J. (2020b). User Group Consultation: Design Quality and Project Success. *HERD: Health Environments Research & Design Journal*, 13(2), 143–169. <https://doi.org/10.1177/1937586719873143>
- Cartland, J., Ruch-Ross, H. S., Carr, L., Hall, A., Olsen, R., Rosendale, E., & Ruohonen, S. (2018). The role of hospital design in reducing anxiety for pediatric patients. *HERD: Health Environments Research & Design Journal*, 11(3), 66-79.
- Casey, L., Fucile, S., Flavin, M., & Dow, K. (2020). A two-pronged approach to reduce noise levels in the Neonatal Intensive Care Unit. *Early Human Development*, 146, 105073. <https://doi.org/10.1016/j.earlhumdev.2020.105073>

- Casimir, G. (2019). Why children's hospitals are unique and so essential. *Frontiers in pediatrics*, 7, 305
- Chawla, S., Barach, P., Dwaihy, M., Kamat, D., Shankaran, S., Panaitescu, B., Wang, B., & Natarajan, G. (2017). A targeted noise reduction observational study for reducing noise in a neonatal intensive unit. *Journal of perinatology : official journal of the California Perinatal Association*, 37(9), 1060–1064.
<https://doi.org/10.1038/jp.2017.93>
- Dewey, J. (1954). *The Public and Its Problems*. Swallow Press.
- Coad, J., & Coad, N. (2008). Children and young people's preference of thematic design and colour for their hospital environment. *Journal of Child Health Care*, 12(1), 33-48.
- Costa, A. R. (2024). Homing into school to create the ideal classroom: Young people want to combine the best of Home and School Learning Environments. *CoDesign*, 21(1), 74–94. <https://doi.org/10.1080/15710882.2024.2363925>
- Creech, A., Hodges, D. A., & Hallam, S. (2021). *Routledge International Handbook of Music Psychology in Education and the community*. Routledge.
- Cross, N. (1972). Design participation. Academy Ed.
- Cullen, C., & Metatla, O. (2019). Co-designing inclusive multisensory story mapping with children with mixed visual abilities. *Proceedings of the 18th ACM International Conference on Interaction Design and Children*, 361–373.
<https://doi.org/10.1145/3311927.3323146>
- Cvach, M. M., Currie, A., Sapirstein, A., Doyle, P. A., & Pronovost, P. (2013). Managing clinical alarms: Using data to drive change. *Nursing management*, 44(11), 8-12.
- Dantec, C. A., & DiSalvo, C. (2013). Infrastructuring and the formation of publics in participatory design. *Social Studies of Science*, 43(2), 241–264.
<https://doi.org/10.1177/0306312712471581>
- Daraiseh, N. M., Hoying, C. L., Vidonish, W. P., Lin, L., & Wagner, M. (2016). Noise exposure on pediatric inpatient units. *JONA: The Journal of Nursing Administration*, 46(9), 468-476.
- Darcy, A. E., Hancock, L. E., & Ware, E. J. (2008). A descriptive study of noise in the neonatal intensive care unit: ambient levels and perceptions of contributing factors. *Advances in Neonatal Care*, 8(5), S16-S26.
- Dawson, D., Barham, R., Hamilton, M., & Philips, B. (2022). Sound in time: An observational study to identify the sources of sound and their relative

- contribution to the sound environment of an Intensive Care Unit. *Applied Acoustics*, 188, 108485. <https://doi.org/10.1016/j.apacoust.2021.108485>
- Deng, Z., Xie, H., & Kang, J. (2023). The effectiveness of acoustic treatments in general hospital wards in China. *Building and Environment*, 244, 110728.
- Denham, M. E., Bushehri, Y., & Lim, L. (2018). Through the eyes of the user: evaluating neonatal intensive care unit design. *HERD: Health Environments Research & Design Journal*, 11(3), 49-65.
- Dopp, A. R., Parisi, K. E., Munson, S. A., & Lyon, A. R. (2019). A glossary of user-centered design strategies for implementation experts. *Translational Behavioral Medicine*, 9(6), 1057–1064. <https://doi.org/10.1093/tbm/iby119>
- Downing, J., Marston, J., & Fleming, E. (2014). Children's palliative care: considerations for a physical therapeutic environment. *Journal of palliative care*, 30(2), 116-124.
- Drain, A., & Sanders, E. B. N. (2019). A collaboration system model for planning and evaluating participatory design projects. *International Journal of Design*, 13(3), 39–52.
- DuBose, J., MacAllister, L., Hadi, K., & Sakallaris, B. (2018). Exploring the Concept of Healing Spaces. *Health Environments Research and Design Journal*, 11 (1), 43–56.
- Ehn, P. (2017). Scandinavian design: On participation and Skill. *Participatory Design*, 41–77. <https://doi.org/10.1201/9780203744338-4>
- Ehn, P., & Sjögren, D. (2020). From system descriptions to scripts for action. *Design at Work*, 241–268. <https://doi.org/10.1201/9781003063988-14>
- Eisen, S. L., Ulrich, R. S., Shepley, M. M., Varni, J. W., & Sherman, S. (2008). The stress-reducing effects of art in pediatric health care: art preferences of healthy children and hospitalized children. *Journal of Child Health Care*, 12(3), 173-190.
- Elf, M., Fröst, P., Lindahl, G., & Wijk, H. (2015). Shared decision making in designing new healthcare environments—time to begin improving quality. *BMC Health Services Research*, 15(1). <https://doi.org/10.1186/s12913-015-0782-7>
- Engel, M. S., Fiebig, A., Pfaffenbach, C., & Fels, J. (2018). A review of socio-acoustic surveys for soundscape studies. *Current Pollution Reports*, 4(3), 220–239. <https://doi.org/10.1007/s40726-018-0094-8>
- Eurostat Data (2009). (n.d.-a). <https://ec.europa.eu/eurostat/data/database>

- Faerden, A., Rosenqvist, C., Håkansson, M., Strøm-Gundersen, E., Stav, Å., Svartsund, J., Røssæg, T., Davik, N., Kvarstein, E., Pedersen, G., Dieset, I., Nyrud, A. Q., Weedon-Fekjær, H., & Kistorp, K. M. (2022). Environmental transformations enhancing dignity in an acute psychiatric ward: Outcome of a user-driven service design project. *HERD: Health Environments Research & Design Journal*, 16(2), 55–72. <https://doi.org/10.1177/19375867221136558>
- Feeg, V. D., Paraszczuk, A. M., Çavuşoğlu, H., Shields, L., Pars, H., & Al Mamun, A. (2016). How is family centered care perceived by healthcare providers from different countries? an international comparison study. *Journal of Pediatric Nursing*, 31(3), 267–276. <https://doi.org/10.1016/j.pedn.2015.11.007>
- Ferreira, S. M., Gouin-Vallerand, C., & Hotte, R. (2016, September). Game based learning: A case study on designing an educational game for children in developing countries. In *2016 8th International Conference on Games and Virtual Worlds for Serious Applications (VS-GAMES)* (pp. 1-8). IEEE.
- Fiebig, A. (2023). Soundscape: A construct of human perception. *Springer Handbook of Auditory Research*, 23–48. https://doi.org/10.1007/978-3-031-22779-0_2
- Fiebig, A., & Schulte-Fortkamp, B. (2023). How to put Soundscape into practice. *Springer Handbook of Auditory Research*, 313–330. https://doi.org/10.1007/978-3-031-22779-0_11
- Fiebig, A., Schulte-Fortkamp, B., & Genuit, K. (2016). The city of the future—noise initiative in the “Year of Science 2015.” *Journal of the Acoustical Society of America*, 139(4_Supplement), 1982–1982. <https://doi.org/10.1121/1.4949784>
- Fischer, G., Giaccardi, E., Eden, H., Sugimoto, M., & Ye, Y. (2005). Beyond binary choices: Integrating individual and Social Creativity. *International Journal of Human-Computer Studies*, 63(4-5), 482–512. <https://doi.org/10.1016/j.ijhcs.2005.04.014>
- Gaminiesfahani, H., Lozanovska, M., & Tucker, R. (2020). A scoping review of the impact on children of the built environment design characteristics of healing spaces. *HERD: Health Environments Research & Design Journal*, 13(4), 98-114.
- Gennari, R., Matera, M., Melonio, A., & Roumelioti, E. (2019). A board-game for co-designing smart nature environments in workshops with children. *End-User Development*, 132–148. https://doi.org/10.1007/978-3-030-24781-2_9

- Gholami, N., Borimnejad, L., Jafari, R., Rasouli, M., & Ranjbar, F. (2023). Effect of a noise reduction program on stress of premature neonates in Neonatal Intensive Care Unit. *Journal of Neonatal Nursing*, 29(1), 194–198. <https://doi.org/10.1016/j.jnn.2022.05.011>
- Good, M., Picot, B. L., Salem, S. G., Chin, C.-C., Picot, S. F., & Lane, D. (2000). Cultural differences in music chosen for pain relief. *Journal of Holistic Nursing*, 18(3), 245–260. <https://doi.org/10.1177/089801010001800306>
- Greenberg, D. M., Wride, S. J., Snowden, D. A., Spathis, D., Potter, J., & Rentfrow, P. J. (2022). Universals and variations in musical preferences: A study of preferential reactions to western music in 53 countries. *Journal of Personality and Social Psychology*, 122(2), 286–309. <https://doi.org/10.1037/pspp0000397>
- Guidelines for design and construction of outpatient facilities*. (2022). . Facility Guidelines Management.
- Grønbæk, K., Grudin, J., Bødker, S., Grudin, J., & Bannon, L. (2017). Achieving Cooperative System Design: Shifting from a product to a process focus. *Participatory Design*, 79–97. <https://doi.org/10.1201/9780203744338-5>
- Habraken, N. J., & Gross, M. D. (1987). *Concept design games: A report submitted to the National Science Foundation Engineering Directorate, design methodology program*. Dept. of Architecture, Massachusetts Institute of Technology.
- Hall, J., Gaved, M., & Sargent, J. (2021). Participatory research approaches in times of covid-19: A narrative literature review. *International Journal of Qualitative Methods*, 20, 160940692110100. <https://doi.org/10.1177/16094069211010087>
- Hamilton, D. K., & Shepley, M. M. (2010). *Design for critical care: An evidence-based approach*. Oxford: Elsevier/Architectural Press.
- Hanington, B., & Martin, B. (2022). *The Pocket Universal Methods of Design, Revised and Expanded: 125 Ways to Research Complex Problems, Develop Innovative Ideas, and Design Effective Solutions*. Rockport Publishers.
- Hannula, O. (2020). *Knowledge Co-creation in Design Games-Conversation Analysis of an Interorganizational Design Game Session* (thesis).
- Hansen, N. B., Dindler, C., Halskov, K., Iversen, O. S., Bossen, C., Basballe, D. A., & Schouten, B. (2019). How participatory design works. *Proceedings of the 31st Australian Conference on Human-Computer-Interaction*, 30–41. <https://doi.org/10.1145/3369457.3369460>

- Hansen, P., Fourie, I., & Meyer, A. (2021). Third space. *Synthesis Lectures on Information Concepts, Retrieval, and Services*, 33–46.
https://doi.org/10.1007/978-3-031-02327-9_4
- Harviainen, J. T., & Melkko, R. (2022). Organizational Information Creation through a design game: A sensemaking perspective. *Library & Information Science Research*, 44(3), 101172. <https://doi.org/10.1016/j.lisr.2022.101172>
- Harviainen, J. T., Vaajakallio, K., & Sproedt, H. (2016). Service design games as innovation tools, knowledge creators, and simulation/games. *Simulation & Gaming*, 47(5), 559–565. <https://doi.org/10.1177/1046878116662953>
- Hasegawa, Y., & Ryherd, E. (2020). Clustering acoustical measurement data in pediatric hospital units. *The Journal of the Acoustical Society of America*, 148(1), 265–277.
- Hasegawa, Y., Ryherd, E., Ryan, C. S., & Darcy-Mahoney, A. (2020). Examining the utility of perceptual noise categorization in pediatric and neonatal hospital units. *HERD: Health Environments Research & Design Journal*, 13(4), 144–157.
- Haynes, M., O'Rourke, T., Nash, D., Baffour, B., York, S., Chainey, C., Betros, G., & Memmott, P. (2020). Aboriginal and Torres Strait Islander preferences for healthcare settings: Effective use of Design Images in Survey Research. *Australian Health Review*, 44(2), 222. <https://doi.org/10.1071/ah18196>
- Hernandez-Molina, R., Jiménez, J. B., Rodríguez-Montano, V., Zacarías, F. F., Bienvenido-Huertas, D., López, S. L., & Cueto-Ancela, J. L. (2020). Characterizing the acoustic environment in a neonatal intensive care unit. *Applied Acoustics*, 165, 107301.
- Herriott, R. (2017). Patient involvement in Danish Hospital Design. *CoDesign*, 14(3), 203–217. <https://doi.org/10.1080/15710882.2017.1292295>
- Hsu, T., Ryherd, E., Waye, K. P., & Ackerman, J. (2012). Noise pollution in hospitals: impact on patients. *JCOM*, 19(7), 301–309.
- Huber, A. M. (2021). Exploring informed–design services during the project–defining phases in commercial interior design. *Journal of Interior Design*, 46(2), 11–33. <https://doi.org/10.1111/joid.12191>
- International Organization for Standardization. (2014). ISO 12913-1 Acoustics — Soundscape — Part 1: Definition and conceptual framework. ISO.
- International Organization for Standardization. (2018). ISO/TS 12913-2:2018 Acoustics — Soundscape — Part 2: Data collection and reporting requirements. ISO.

- International Organization for Standardization. (2019). ISO/TS 12913-3:2019 - Acoustics — Soundscape — Part 3: Data analysis. <https://www.iso.org/standard/69864.html>
- Iversen, O. S., & Buur, J. (2002). Design is a Game: Developing Design Competence in a Game Setting. In *Proceedings of Participatory Design Conference (PDC'02)* (pp. 22–28). Malmö, Sweden; CPSR.
- Iyendo, T. O. (2016). Exploring the effect of sound and music on health in hospital settings: A narrative review. *International journal of nursing studies*, 63, 82-100.
- Jha, A. K., Orav, E. J., Zheng, J., & Epstein, A. M. (2008). Patients' perception of hospital care in the United States. *New England Journal of Medicine*, 359(18), 1921-1931.
- Jessen, S., Mirkovic, J., & Ruland, C. M. (2018). Creating gameful design in mhealth: A participatory co-design approach. *JMIR mHealth and uHealth*, 6(12). <https://doi.org/10.2196/11579>
- Jiang, S. (2020). Positive distractions and play in the public spaces of pediatric healthcare environments: A literature review. *HERD: Health Environments Research & Design Journal*, 13(3), 171-197.
- Johansson, M. (2005). *Participatory Inquiry - Collaborative Design* (thesis). Blekinge Institute of Technology, Ronneby.
- Johnson, E. A., & Hellem, T. L. (2024). Working from within: The Rural Community Participatory Design Framework. *HERD: Health Environments Research & Design Journal*, 17(3), 428–445. <https://doi.org/10.1177/19375867241250323>
- Jung, S., Kim, J., Lee, J., Rhee, C., Na, S., & Yoon, J. H. (2020). Assessment of noise exposure and its characteristics in the intensive care unit of a tertiary hospital. *International journal of environmental research and public health*, 17(13), 4670.
- Juliá-Nehme, B., Yoon, S.-Y., Cumsille, P., & Rodríguez, E. (2023). Assessing spatial user experience for design guidelines: A comparative study of outpatient waiting rooms with conventional versus modern features. *HERD: Health Environments Research & Design Journal*, 16(3), 83–103. <https://doi.org/10.1177/19375867231163338>
- Kannabiran, G., & Bødker, S. (2020). Prototypes as objects of desire. *Proceedings of the 2020 ACM Designing Interactive Systems Conference*, 1619–1631. <https://doi.org/10.1145/3357236.3395487>

- Kang, J., Chourmouziadou, K., Sakantamis, K., Wang, B., & Hao, Y. (2013). Soundscape of European cities and landscapes. *COST TUD Action TD-0804*.
- Kaur, H., Rohlik, G., Nemergut, M., & Tripathi, S. (2016). Comparison of staff and family perceptions of causes of noise pollution in the Pediatric Intensive Care Unit and suggested Intervention Strategies. *Noise and Health*, 18(81), 78. <https://doi.org/10.4103/1463-1741.178480>
- Kebapçı, A., & Güner, P. (2021). “Noise factory”: A qualitative study exploring healthcare providers’ perceptions of noise in the intensive care unit. *Intensive and Critical Care Nursing*, 63, 102975. <https://doi.org/10.1016/j.iccn.2020.102975>
- Kensing, F., Simonsen, J., & Bodker, K. (1998). Must: A method for participatory design. *Human–Computer Interaction*, 13(2), 167–198. https://doi.org/10.1207/s15327051hci1302_3
- Khowaja, S., Ariff, S., Ladak, L., Manan, Z., & Ali, T. (2022). Measurement of sound levels in a neonatal intensive care unit of a Tertiary Care Hospital, Karachi, Pakistan. *Pediatrics & Neonatology*, 63(6), 618–624. <https://doi.org/10.1016/j.pedneo.2022.04.010>
- Kim, J.-W., Lee, B.-A., Park, Y.-S., Chung, J., Choi, S.-H., & Kim, Y.-T. (2023). Efficacy of active noise-canceling headphones in patients undergoing ultrasonic scaling. *Journal of Periodontal & Implant Science*, 53(4), 269. <https://doi.org/10.5051/jpis.2202200110>
- Kinjo, Y., Tomiku, R., Okamoto, N., & Otsuru, T. (2023). Finite element analysis of sound fields in the corridors of the hospital ward: Investigation on installing patterns of sound absorbing materials. *INTER-NOISE and NOISE-CON Congress and Conference Proceedings*, 268(4), 4651–4658. https://doi.org/10.3397/in_2023_0662
- Kirwan, G., Demirci, B., Welch, H., Boyla, K., Özen, M., Castell, P., & Marlow, T. (2010). *The birds of Turkey*. Bloomsbury Publishing.
- Kooshanfar, Z., Ashrafi, S., Paryad, E., Salmanghasem, Y., Khaleghdoost Mohammadi, T., Kazemnezhad Leili, E., & Mohammad Javad Golhosseini, S. (2022). Sources of noise and their effects on nurses in Intensive Care Units: A cross sectional study. *International Journal of Africa Nursing Sciences*, 16, 100403. <https://doi.org/10.1016/j.ijans.2022.100403>
- Kwieciński, K., & Słyk, J. (2023). Interactive generative system supporting participatory house design. *Automation in Construction*, 145, 104665. <https://doi.org/10.1016/j.autcon.2022.104665>

- Kyng, M. (2015). On creating and sustaining alternatives: The case of Danish telehealth. *Aarhus Series on Human Centered Computing*, 1(1), 12. <https://doi.org/10.7146/aahcc.v1i1.21297>
- Könings, K. D., Bovill, C., & Woolner, P. (2017). Towards an interdisciplinary model of practice for participatory building design in Education. *European Journal of Education*, 52(3), 306–317. <https://doi.org/10.1111/ejed.12230>
- Lahdelma, I., & Eerola, T. (2020). Cultural familiarity and musical expertise impact the pleasantness of consonance/dissonance but not its perceived tension. *Scientific Reports*, 10(1). <https://doi.org/10.1038/s41598-020-65615-8>
- Lam, B., Phillips, M., Kelemen, M., Zamenopoulos, T., Moffat, S., & de Sousa, S. (2018). Design and creative methods as a practice of liminality in community-academic research projects. *The Design Journal*, 21(4), 605–624. <https://doi.org/10.1080/14606925.2018.1469329>
- Latta, L. C., Dick, R., Parry, C., & Tamura, G. S. (2008). Parental responses to involvement in rounds on a pediatric inpatient unit at a teaching hospital: a qualitative study. *Academic Medicine*, 83(3), 292-297.
- Lavia, L., Dixon, M., Witchel, H. J., & Goldsmith, M. (2016). Applied soundscape practices. *Soundscape and the built environment*, 1.
- Lawi, R. A. (2017). *Healing by design: interior architecture and interior design of public spaces of children's hospitals*. Lancaster University (United Kingdom).
- Lerwick, J. L. (2016). Minimizing pediatric healthcare-induced anxiety and trauma. *World journal of clinical pediatrics*, 5(2), 143.
- Lewin, K. (1946). Action research and minority problems. *Resolving Social Conflicts and Field Theory in Social Science.*, 143–152. <https://doi.org/10.1037/10269-013>
- Lim, K. H., Nam, K. J., Rah, Y. C., Cha, J., Lee, S.-J., Lee, M.-G., & Choi, J. (2019). The effect of natural ocean sound exposure and ocean-side relaxation on chronic tinnitus patients: A pilot study in Korea. *Ear, Nose & Throat Journal*, 100(5). <https://doi.org/10.1177/0145561319873907>
- Litwin, S., Clarke, L., Copeland, J., Tyrrell, J., Tait, C., Mohabir, V., & Campbell, F. (2023). Designing a Child-, Family-, and Healthcare Provider–Centered Procedure Room in a Tertiary Care Children’s Hospital. *HERD: Health Environments Research & Design Journal*, 16(3), 195-209.

- Lorusso, L., Lee, J. H., & Worden, E. A. (2021). Design thinking for healthcare: Transliterating the creative problem-solving method into architectural practice. *HERD: Health Environments Research & Design Journal*, 14(2), 16-29.
- Lozanovska, M., & Xu, L. (2013). Children and university architecture students working together: a pedagogical model of children's participation in architectural design. *CoDesign*, 9(4), 209-229.
- Luck, R. (2003). Dialogue in participatory design. *Design Studies*, 24(6), 523–535. [https://doi.org/10.1016/s0142-694x\(03\)00040-1](https://doi.org/10.1016/s0142-694x(03)00040-1)
- Luck, R. (2007). Learning to talk to users in participatory design situations. *Design Studies*, 28(3), 217–242. <https://doi.org/10.1016/j.destud.2007.02.002>
- Luck, R. (2018a). Participatory design in architectural practice: Changing practices in future making in uncertain times. *Design Studies*, 59, 139–157. <https://doi.org/10.1016/j.destud.2018.10.003>
- Luck, R. (2018b). What is it that makes participation in design participatory design? *Design Studies*, 59, 1–8. <https://doi.org/10.1016/j.destud.2018.10.002>
- Lynch, K. A., Omisore, A. D., Famurewa, O., Olasehinde, O., Odujoko, O., Vera, J., Kingham, T. P., Alatise, O. I., Egberongbe, A. A., Morris, E. A., Atkinson, T. M., & Sutton, E. J. (2021). Designing participatory needs assessments to support global health interventions in time-limited settings: A case study from Nigeria. *International Journal of Qualitative Methods*, 20, <https://doi.org/10.1177/16094069211002421>
- MacAllister, L., Zimring, C., & Ryherd, E. (2016). Environmental variables that influence patient satisfaction: A review of the literature. *HERD: Health Environments Research & Design Journal*, 10(1), 155-169.
- Mackay, W. E., & Beaudouin-Lafon, M. (2023). Participatory design and prototyping. In *Handbook of Human Computer Interaction* (pp. 1-33). Cham: Springer International Publishing.
- Mackieson, P., Shlonsky, A., & Connolly, M. (2018). Increasing rigor and reducing bias in qualitative research: A document analysis of parliamentary debates using applied thematic analysis. *Qualitative Social Work*, 18(6), 965–980. <https://doi.org/10.1177/1473325018786996>
- Mackrill, J., Cain, R., & Jennings, P. (2013). Experiencing the hospital ward soundscape: Towards a model. *Journal of Environmental Psychology*, 36, 1–8. <https://doi.org/10.1016/j.jenvp.2013.06.004>

- Madaras, G. (2017). An overview of the key misperceptions that are preventing any significant improvements when addressing operational noise in Acute Care Hospitals. *The Journal of the Acoustical Society of America*, 142(4_Supplement), 2572–2572. <https://doi.org/10.1121/1.5014400>
- Malenbaum, S., Keefe, F. J., Williams, A. C. D. C., Ulrich, R., & Somers, T. J. (2008). Pain in its environmental context: implications for designing environments to enhance pain control. *Pain*, 134(3), 241-244.
- Malinverni, L., Mora-Guiard, J., & Pares, N. (2016). Towards methods for evaluating and communicating participatory design: A multimodal approach. *International Journal of Human-Computer Studies*, 94, 53–63. <https://doi.org/10.1016/j.ijhcs.2016.03.004>
- Malone, E., Harmsen, C., Reno, K., Edelstein, E., Hamilton, D., & Salvatore, A. (2008). An introduction to evidence based design: exploring healthcare and design (EDAC Study Guide Series, Vol: 1). Concord, CA: *The Center for Health Design*.
- Manahasa, O., Özsoy, A., & Manahasa, E. (2021). Evaluative, inclusive, participatory: Developing a new language with children for school building design. *Building and Environment*, 188, 107374. <https://doi.org/10.1016/j.buildenv.2020.107374>
- Markkanen, P., & Herneoja, A. (2024). Constructing a theory-informed workplace design framework: Co-design Case study for knowledge work environment satisfaction improvement. *Building Research & Information*, 52(8), 870–886. <https://doi.org/10.1080/09613218.2024.2372024>
- Matić, Z., Oh, Y., Lim, L., & Zimring, C. (2022). Placing users at the Center: Evaluating Exam Room Design for Improved User Experience. *HERD: Health Environments Research & Design Journal*, 15(4), 152–166. <https://doi.org/10.1177/19375867221101886>
- Mayhew, K. J., Lawrence, S. L., Squires, J. E., & Harrison, D. (2022). Elevated sound levels in the Neonatal Intensive Care Unit: What is causing the problem? *Advances in Neonatal Care*, 22(6). <https://doi.org/10.1097/anc.0000000000000996>
- McLaughlan, R. (2018). Psychosocially supportive design: The case for greater attention to social space within the pediatric hospital. *HERD: Health Environments Research & Design Journal*, 11(2), 151-162.
- McLaughlan, R., Sadek, A., & Willis, J. (2019). Attractions to fuel the imagination: Reframing understandings of the role of distraction relative to well-being in the Pediatric Hospital. *HERD: Health Environments Research & Design Journal*, 12(2), 130–146. <https://doi.org/10.1177/1937586718810878>

- McCormick, R. (2017). Does access to green space impact the mental well-being of children: A systematic review. *Journal of pediatric nursing*, 37, 3-7.
- Mitchell, V., Ross, T., May, A., Sims, R., & Parker, C. (2015). Empirical investigation of the impact of using co-design methods when generating proposals for Sustainable Travel Solutions. *CoDesign*, 12(4), 205–220.
<https://doi.org/10.1080/15710882.2015.1091894>
- Merkel, C. B., Xiao, L., Farooq, U., Ganoe, C. H., Lee, R., Carroll, J. M., & Rosson, M. B. (2004). Participatory design in community computing contexts. *Proceedings of the Eighth Conference on Participatory Design Artful Integration: Interweaving Media, Materials and Practices - PDC 04*, 1, 1.
<https://doi.org/10.1145/1011870.1011872>
- Moesgaard, F., Hulgaard, L., Bødker, M. (2020). Involving Users in Sound Design. In: Marcus, A., Rosenzweig, E. (eds) Design, User Experience, and Usability. Interaction Design. HCI 2020. Lecture Notes in Computer Science, vol 12200. Springer, Cham. https://doi.org/10.1007/978-3-030-49713-2_28
- Morrison, W. E., Haas, E. C., Shaffner, D. H., Garrett, E. S., & Fackler, J. C. (2003). Noise, stress, and annoyance in a pediatric intensive care unit. *Critical Care Medicine*, 31(1), 113–119. <https://doi.org/10.1097/00003246-200301000-00018>
- Moshona, C., Aletta, F., Henze, H., Chen, X., Mitchell, A., Oberman, T., Tong, H., Fiebig, A., Kang, J., & Schulte-Fortkamp, B. (2023). What is a soundscape intervention? exploring definitions and identification criteria and a platform to gather real-world examples. *INTER-NOISE and NOISE-CON Congress and Conference Proceedings*, 265(7), 854–862.
https://doi.org/10.3397/in_2022_0121
- Mourshed, M., & Zhao, Y. (2012). Healthcare providers' perception of design factors related to physical environments in hospitals. *Journal of Environmental Psychology*, 32(4), 362-370.
- Mäkelä, T., Helfenstein, S., Lerkkanen, M.-K., & Poikkeus, A.-M. (2017). Student participation in learning environment improvement: Analysis of a co-design project in a Finnish upper secondary school. *Learning Environments Research*, 21(1), 19–41. <https://doi.org/10.1007/s10984-017-9242-0>
- Nanda, U., Chanaud, C. M., Brawn, L., Hart, R., & Hathorn, K. (2009). Pediatric art preferences: Countering the “one-size-fits-all” approach. *HERD: Health Environments Research & Design Journal*, 2(4), 46-61.
- Nash, D., O'Rourke, T., Memmott, P., & Haynes, M. (2021). Indigenous preferences for inpatient rooms in Australian hospitals: A mixed-methods study in Cross-Cultural

- Design. *HERD: Health Environments Research & Design Journal*, 14(1), 174–189. <https://doi.org/10.1177/1937586720925552>
- Nightingale, F. (1859). Notes on hospitals. London: Longmans, Green, & Co.
- Nisha, B. (2022). Lost in imagined space: A psychoanalysis of Participatory design. *Design Studies*, 81, 101108. <https://doi.org/10.1177/1937586720925552>
- Nguyen, Q. (2022). Evaluation in participatory design – the whys and the notes. *Proceedings of the Participatory Design Conference 2022 - Volume 2*, 161–166. <https://doi.org/10.1145/3537797.3537828>
- Nguyen, V., MacDonald, B., Cignarella, A., & Miller, C. (2025). A descriptive investigation of alarm activation in a critical care setting. *Nursing in Critical Care*, 30(2), e13302.
- Nourmusavi Nasab, S., McLaughlan, R., & Smith, C. L. (2024). Exploring environmental considerations for terminally ill pediatric patients in palliative care inpatient units: A narrative review. *HERD: Health Environments Research & Design Journal*. <https://doi.org/10.1177/19375867241271439>
- Nygaard, K., & Terje Bergo, O. (1975). The Trade Unions-New users of research. *Personnel Review*, 4(2), 5–10. <https://doi.org/10.1108/eb055278>
- Obendorf, H., Janneck, M., & Finck, M. (2009). Inter-contextual distributed participatory design. *Scandinavian Journal of Information Systems*, 21(1), 2.
- OECD Data website. (n.d.-b). <http://www.oecd.org/els/health-systems/health-data.htm>
- O'Hara, S., Klar, R. T., Patterson, E. S., Morris, N. S., Ascenzi, J., Fackler, J. C., & Perry, D. J. (2018). Macrocognition in the healthcare built environment (mHCBE): A focused ethnographic study of “Neighborhoods” in a pediatric intensive care unit. *HERD: Health Environments Research & Design Journal*, 11(2), 104-123.
- Okcu, S., Ryherd, E. E., Zimring, C., & Samuels, O. (2011). Soundscape evaluations in two critical healthcare settings with different designs. *The Journal of the Acoustical Society of America*, 130(3), 1348–1358. <https://doi.org/10.1121/1.3607418>
- Orhan, C., & Yilmazer, S. (2021). Harmony of context and the built environment: Soundscapes in museum environments via GT. *Applied Acoustics*, 173, 107709. <https://doi.org/10.1016/j.apacoust.2020.107709>
- Orhan, C., & Yilmazer, S. (2023, November). Exploring the pediatric intensive care unit soundscape from health professionals' perspective. In *INTER-NOISE and*

- NOISE-CON Congress and Conference Proceedings* (Vol. 268, No. 2, pp. 6592-6601). Institute of Noise Control Engineering.
- Orhan, C., & Yilmazer, S. (2024). The Neonatal Intensive Care Unit (NICU) Context and the Perceived Soundscape: A Grounded Theory Approach. *HERD: Health Environments Research & Design Journal*, 19375867241229652.
- Ozkaynak, M., Sircar, C. M., Frye, O., & Valdez, R. S. (2021). A systematic review of Design Workshops for Health Information Technologies. *Informatics*, 8(2), 34. <https://doi.org/10.3390/informatics8020034>
- Park, J. G. (2009). Color perception in pediatric patient room design: Healthy children vs. pediatric patients. *HERD: Health Environments Research & Design Journal*, 2(3), 6-28.
- Park, M., Kohlrausch, A., de Bruijn, W., de Jager, P., & Simons, K. (2014). Analysis of the Soundscape in an intensive care unit based on the annotation of an audio recording. *The Journal of the Acoustical Society of America*, 135(4), 1875–1886. <https://doi.org/10.1121/1.4868367>
- Parlar Kilic, S., Karadag, G., Oyucu, S., Kale, O., Zengin, S., Ozdemir, E., & Korhan, E. A. (2015). Effect of music on pain, anxiety, and patient satisfaction in patients who present to the emergency department in Turkey. *Japan Journal of Nursing Science*, 12(1), 44-53.
- Payam, S., Hossaini, J., Zashka, K., Friedmann, A., & Mall, V. (2023). Designing Well-Being: A Qualitative Investigation of Young Patients' Perspectives on the Material Hospital Environment. *HERD: Health Environments Research & Design Journal*, 16(3), 168-181.
- Pearson, M., Gaines, K., Pati, D., Colwell, M., Motheral, L., & Adams, N. G. (2019). The physiological impact of window murals on pediatric patients. *HERD: Health Environments Research & Design Journal*, 12(2), 116-129.
- Pelliccia, L., Bojko, M., Prielipp, R., & Riedel, R. (2021). Applicability of 3D-factory simulation software for computer-aided participatory design for industrial workplaces and Processes. *Procedia CIRP*, 99, 122–126. <https://doi.org/10.1016/j.procir.2021.03.019>
- Pentecost, A. R. (2022). Are We Ready for “The Year of Design for Health”? *HERD: Health Environments Research & Design Journal*, 15(1), 36-38.
- Pope, D., & Miller-Klein, E. (2016). Acoustic assessment of speech privacy curtains in two nursing units. *Noise and Health*, 18(80), 26. <https://doi.org/10.4103/1463-1741.174377>

- Ramm, K., Mannix, T., Parry, Y., & Gaffney, M. P. (2017). A comparison of sound levels in open plan versus pods in a neonatal intensive care unit. *HERD: Health Environments Research & Design Journal*, 10(3), 30–39. <https://doi.org/10.1177/1937586716668636>
- Ratcliffe, E., Gatersleben, B., & Sowden, P. T. (2013). Bird sounds and their contributions to perceived attention restoration and stress recovery. *Journal of Environmental Psychology*, 36, 221-228
- Ratcliffe, E., Gatersleben, B., & Sowden, P. T. (2016). Associations with bird sounds: How do they relate to perceived restorative potential? *Journal of Environmental Psychology*, 47, 136–144. <https://doi.org/10.1016/j.jenvp.2016.05.009>
- Redshaw, M., & Smithells, R. (2000). *Children in hospital: The impact of the hospital environment on children, parents and nursing staff*. University of Bristol.
- Revenson, T., & Singer, D. (1978). A piaget primer: How a child thinks. *New York: Plume*.
- Restin, T., Gaspar, M., Bassler, D., Kurtcuoglu, V., Scholkmann, F., & Haslbeck, F. B. (2021). Newborn incubators do not protect from high noise levels in the Neonatal Intensive Care Unit and are relevant noise sources by themselves. *Children*, 8(8), 704. <https://doi.org/10.3390/children8080704>
- Robertson, T., & Simonsen, J. (2012). Challenges and opportunities in contemporary participatory design. *Design Issues*, 28(3), 3–9. https://doi.org/10.1162/desi_a_00157
- Ryherd, E. E., Okcu, S., Ackerman, J., Zimring, C., & Waye, K. P. (2012). Noise pollution in hospitals: impacts on staff. *Journal of Clinical Outcomes Management*, 19(11), 491-500.
- Ryherd, E. E., Waye, K. P., & Ljungkvist, L. (2008). Characterizing noise and perceived work environment in a neurological intensive care unit. *The Journal of the Acoustical Society of America*, 123(2), 747-756.
- Sabetsarvestani, R., Köse, S., Geçkil, E., Tosun, E. E., Tokan Özkılıçaslan, F., Karaarslan, F., ... & Parker, L. (2022). Noise in a neonatal intensive care unit: exploring its state and solutions. *Advances in Neonatal Care*, 22(6), E183-E190. <https://doi.org/10.1097/ANC.0000000000000985>
- Sanders, E. B.N., Brandt, E., & Binder, T. (2010). A framework for organizing the tools and techniques of participatory design. *Proceedings of the 11th Biennial Participatory Design Conference*, 195–198. <https://doi.org/10.1145/1900441.1900476>

- Sanders, E. B.-N., & Stappers, P. J. (2008). Co-creation and the new landscapes of Design. *CoDesign*, 4(1), 5–18. <https://doi.org/10.1080/15710880701875068>
- Sanoff, H. (2000). *Community participation methods in design and planning*. Wiley, New York.
- Sanoff, H. (2014). Participatory design programming. *The SAGE Encyclopedia of Action Research*, 2, 589–592. <https://doi.org/10.4135/9781446294406.n261>
- Sanoff, H. (2022). Participatory Design. *Journal of Design Planning and Aesthetics Research*, 1(2), 1–12.
- Sanoff, H. (1985). The application of participatory methods in design and evaluation. *Design Studies*, 6(4), 178–180. [https://doi.org/10.1016/0142-694x\(85\)90050-x](https://doi.org/10.1016/0142-694x(85)90050-x)
- Sanoff, Henry. (1979). Collaborative Design Processes. *JAE*, 33(1), 18. <https://doi.org/10.2307/1424459>
- Sanoff, Henry. (1990). *Participatory design: Theory & techniques*. H. Sanoff.
- Sanoff, Henry. (2008). Multiple views of Participatory design. *ArchNet-IJAR*, 2(1), 57–69. <https://doi.org/10.26687/archnet-ijar.v2i1.177>
- Santos, J., Carvalhais, C., Xavier, A., & Silva, M. V. (2018). Assessment and characterization of sound pressure levels in Portuguese neonatal intensive care units. *Archives of Environmental & Occupational Health*, 73(2), 121-127. <https://doi.org/10.1080/19338244.2017.1304883>
- Scariot, C. A., Heemann, A., & Padovani, S. (2012). Understanding the collaborative-participatory design. *WORK*, 41(S1), 2701-2705. <https://doi.org/10.3233/WOR-2012-0656-2701>
- Schafer, R. M. (1977). *The soundscape: Our sonic environment and the tuning of the world*. Destiny Books.
- Schafer, R. M. (2013). Soundscape studies: the early days and the future. *Acoustic Ecology Review*, 12(1).
- Schell, J. (2020). *The Art of Game Design: A book of lenses*. CRC Press, Taylor & Francis Group.
- Schulte-Fortkamp, B., & Fiebig, A. (2023). Soundscape: The development of a new discipline. *Springer Handbook of Auditory Research*, 1–21. https://doi.org/10.1007/978-3-031-22779-0_1

- Schulte-Fortkamp, B., & Jordan, P. (2023). Soundscape: The holistic understanding of acoustic environments. *Springer Handbook of Auditory Research*, 49–79. https://doi.org/10.1007/978-3-031-22779-0_3
- Schulte-Fortkamp, B., & Jordan, P. (2016). When soundscape meets architecture. *Noise Mapping*, 3(1). <https://doi.org/10.1515/noise-2016-0015>
- Schultz, T. J. (1978). Synthesis of social surveys on noise annoyance. *The Journal of the Acoustical Society of America*, 64(2), 377–405. <https://doi.org/10.1121/1.382013>
- Schön, D.A. (1992). *The Reflective Practitioner: How Professionals Think in Action* (1st ed.). Routledge. <https://doi.org/10.4324/9781315237473>
- Schweitzer, M., Gilpin, L., & Frampton, S. (2004). Healing spaces: elements of environmental design that make an impact on health. *Journal of Alternative & Complementary Medicine*, 10(Supplement 1), S-71.
- Schulte-Fortkamp, B., & Jordan, P. (2016). When soundscape meets architecture. *Noise Mapping*, 3(1). <https://doi.org/10.1515/noise-2016-0015>
- Shanthi Priya, R., Shabitha, P., & Radhakrishnan, S. (2020). Collaborative and participatory design approach in Architectural Design Studios. *Social Sciences & Humanities Open*, 2(1), 100033. <https://doi.org/10.1016/j.ssaho.2020.100033>
- Shepley, M. (2005). The healthcare environment. In *Meeting children's psychosocial needs across the health-care continuum* (pp. 313-349).
- Shepley, M. M. (2014). *Design for pediatric and Neonatal Critical Care*. London: Routledge.
- Sherman-Bien, S. A., Malcarne, V. L., Roesch, S., Varni, J. W., & Katz, E. R. (2011). Quantifying the relationship among hospital design, satisfaction, and psychosocial functioning in a pediatric hematology oncology inpatient unit. *HERD: Health Environments Research & Design Journal*, 4(4), 34-59.
- Smith, R. C., Vangkilde, K. T., Otto, T., Kjaersgaard, M. G., Halse, J., & Binder, T. (Eds.). (2016). *Design anthropological futures*. Bloomsbury Publishing.
- Simonsen, J., Karasti, H., & Hertzum, M. (2019). Infrastructuring and participatory design: Exploring infrastructural inversion as analytic, empirical and Generative. *Computer Supported Cooperative Work (CSCW)*, 29(1–2), 115–151. <https://doi.org/10.1007/s10606-019-09365-w>
- Simonsen, J., & Robertson, T. (Eds.). (2013). *Routledge international handbook of participatory design* (Vol. 711). New York: Routledge.

- Southworth MF (1967) The sonic environment of cities (Thesis). Massachusetts Institute of Technology, Dept. of City and Regional Planning, Boston
- Spagnol, S., Vila, N. V., Akdag Salah, A., Goos, T., Reiss, I., & Özcan, E. (2022). Towards a quieter Neonatal Intensive Care Unit: Current approaches and design opportunities. Proceedings of the DRS International Conference 2022, 25 June-3 July, Bilbao, Spain. <https://doi.org/10.21606/drs.2022.258>
- Spinuzzi, C. (2005). The Methodology of Participatory Design. *Technical Communication*, 52(2), 163–174.
- Strauss, A., & Corbin, J. (1998). Basics of qualitative research: Techniques and Procedures for Developing Grounded Theory. Thousand Oaks, CA: Sage Publications.
- Steele, D., Kerrigan, C., & Guastavino, C. (2019). Sounds in the city: Bridging the gaps from research to practice through Soundscape workshops. *Journal of Urban Design*, 25(5), 646–664. <https://doi.org/10.1080/13574809.2019.1699399>
- Sundberg, F., Olausson, S., Fridh, I., & Lindahl, B. (2017). Nursing staff's experiences of working in an evidence-based designed ICU patient room—An interview study. *Intensive and Critical Care Nursing*, 43, 75-80. <https://doi.org/10.1016/j.iccn.2017.05.004>
- Tarlao, C., Steele, D., Blanc, G., & Guastavino, C. (2023). Interactive soundscape simulation as a co-design tool for Urban professionals. *Landscape and Urban Planning*, 231, 104642. <https://doi.org/10.1016/j.landurbplan.2022.104642>
- Tivorsak, T. L., Britto, M. T., Klostermann, B. K., Nebrig, D. M., & Slap, G. B. (2004). Are pediatric practice settings adolescent friendly? An exploration of attitudes and preferences. *Clinical pediatrics*, 43(1), 55-61.
- Torresin, S., Albatici, R., Aletta, F., Babich, F., Oberman, T., Siboni, S., & Kang, J. (2020a). Indoor soundscape assessment: A principal components model of acoustic perception in residential buildings. *Building and Environment*, 182, 107152. <https://doi.org/10.1016/j.buildenv.2020.107152>
- Torresin, S., Aletta, F., Babich, F., Bourdeau, E., Harvie-Clark, J., Kang, J., ... & Albatici, R. (2020b). Acoustics for supportive and healthy buildings: Emerging themes on indoor soundscape research. *Sustainability*, 12(15), 6054. <https://doi.org/10.3390/su12156054>
- Torresin, S., Ratcliffe, E., Aletta, F., Albatici, R., Babich, F., Oberman, T., & Kang, J. (2022). The actual and ideal indoor soundscape for work, relaxation, physical and sexual activity at home: A case study during the COVID-19 lockdown in

- London. *Frontiers in psychology*, 13, 1038303.
<https://doi.org/10.3389/fpsyg.2022.1038303>
- Tripyla, N., Katsas, K., Karagkouni, K., Liosis, I., Ntelis, S., & Linos, D. (2023). Evaluation of the effect of Mozart music on pain and respiratory rate after thyroidectomy. *Hormones*, 22(1), 113-119.
- Trischler, J., Pervan, S. J., Kelly, S. J., & Scott, D. R. (2017). The value of Codesign. *Journal of Service Research*, 21(1), 75–100.
<https://doi.org/10.1177/1094670517714060>
- Ulrich, R. S., Zimring, C., Zhu, X., DuBose, J., Seo, H.-B., Choi, Y.-S., Quan, X., & Joseph, A. (2008). A review of the research literature on evidence-based healthcare design. *HERD: Health Environments Research & Design Journal*, 1(3), 61–125. <https://doi.org/10.1177/193758670800100306>
- Uğurlu, Z., & Yilmazer, S. (2021). Exploring the audio-visual interaction in a dental clinic through the restorative environment. *INTER-NOISE and NOISE-CON Congress and Conference Proceedings*, 263(4), 1970–1976.
<https://doi.org/10.3397/in-2021-2017>
- Vaajakallio, K. (2012). *Design games as a tool, a mindset and a structure* (thesis).
- Vaajakallio, K., & Mattelmäki, T. (2014). Design games in codesign: As a tool, a mindset and a structure. *CoDesign*, 10(1), 63–77.
<https://doi.org/10.1080/15710882.2014.881886>
- van de Ven, A. H., & Poole, M. S. (2017). Field research methods. *The Blackwell Companion to Organizations*, 867–888.
<https://doi.org/10.1002/9781405164061.ch38>
- Varni, J. W., Burwinkle, T. M., Dickinson, P., Sherman, S. A., Dixon, P., Ervice, J. A., ... & Sadler, B. L. (2004). Evaluation of the built environment at a children's convalescent hospital: development of the pediatric quality of life inventory™ parent and staff satisfaction measures for pediatric health care facilities. *Journal of Developmental & Behavioral Pediatrics*, 25(1), 10-20.
- Verschoren, L., Annemans, M., Van Steenwinkel, I., & Heylighen, A. (2015). How to design child-friendly hospital architecture? Young patients speaking. *Design4Health 2015*, 1-9.
- Vicencio, L. A., Ananthanarayana, R. M., Khudr, J., & Monson, B. B. (2023). Daily sound level exposure for preterm infants in the neonatal intensive care unit. *The Journal of the Acoustical Society of America*, 153(3_supplement).
<https://doi.org/10.1121/10.0018508>

- Villa Alvarez, D. P., Auricchio, V., & Mortati, M. (2022). Mapping design activities and methods of public sector innovation units through the policy cycle model. *Policy Sciences*, 55(1), 89–136. <https://doi.org/10.1007/s11077-022-09448-4>
- Vollmer, T. C., & Koppen, G. (2021). The parent–child patient unit (PCPU): Evidence-based patient room design and parental distress in pediatric cancer centers. *International journal of environmental research and public health*, 18(19), 9993.
- Yang, J. K., Su, F., Graber-Naidich, A., Hedlin, H., Madsen, N., DeSousa, C., ... & Kipps, A. K. (2025). Mitigating Alarm Fatigue and Improving the Bedside Experience by Reducing Nonactionable Alarms. *The Journal of Pediatrics*, 276, 114278.
- Yeoh, J. P. S., & Spence, C. (2023). Background music's impact on patients waiting in surgery and radiology clinics. *HERD: Health Environments Research & Design Journal*, 16(3), 278-290.
- Yilmazer, S., Fasllija, E., Alimadhi, E., Şahin, Z., Mercan, E., & Dalirnaghadeh, D. (2023). A principal component model to identify Turkish soundscapes' affective attributes based on a Corpus-Driven Approach. *Applied Acoustics*, 209, 109410.
- Yilmazer, S., & Uğurlu, Z. M. (2022). A qualitative approach to explore auditory and visual perception in a hospital environment. *The Journal of the Acoustical Society of America*, 151(4_Supplement). <https://doi.org/10.1121/10.0010794>
- Yoo, M., Odom, W., Berger, A., Barnett, S., Kenny, S., Lo, P., Shamsheer, S., Russell, G., & Knight, L. (2024). Remembering through sound: Co-creating sound-based mementos together with people with blindness. *Proceedings of the CHI Conference on Human Factors in Computing Systems*, 1–19. <https://doi.org/10.1145/3613904.3641940>
- Yu, C., Wong, E., Gignac, J., Walker, M., & Ross, T. (2023). A Scoping Review of Pediatric Healthcare Built Environment Experiences and Preferences Among Children with Disabilities and Their Families. *HERD: Health Environments Research & Design Journal*, 19375867231218035.
- Watts, G., Khan, A., & Pheasant, R. (2016). Influence of soundscape and interior design on anxiety and perceived tranquillity of patients in a healthcare setting. *Applied Acoustics*, 104, 135–141. <https://doi.org/10.1016/j.apacoust.2015.11.007>
- Weber, J. R., Ryherd, E. E., Darcy Mahoney, A., Rolfes, M., Cooper, H., & Cherven, B. (2016). Evaluating hospital quiet time from engineering, medical, and Nursing

- Perspectives. *Journal of the Acoustical Society of America*, 139(4_Supplement), 2201–2201. <https://doi.org/10.1121/1.4950560>
- Wen, X., Yang, H., & Wang, J. (2024). Application of noise reduction earplugs in patients undergoing total knee Arthroplasty: A retrospective study. *Noise and Health*, 26(120), 19–24. https://doi.org/10.4103/nah.nah_88_23
- Xiao, J., Lavia, L., & Kang, J. (2018). Towards an agile participatory urban soundscape planning framework. *Journal of Environmental Planning and Management*, 61(4), 677–698. <https://doi.org/10.1080/09640568.2017.1331843>
- Zhu, R., Yuan, L., Pan, Y., Wang, Y., Xiu, D., & Liu, W. (2024). Effects of natural sound exposure on Health Recovery: A systematic review and meta-analysis. *Science of The Total Environment*, 921, 171052. <https://doi.org/10.1016/j.scitotenv.2024.171052>
- Çankaya Topak, S., & Yilmazer, S. (2022). A comparative study on indoor soundscape assessment via a mixed method: A case of the High School Environment. *Applied Acoustics*, 189, 108554. <https://doi.org/10.1016/j.apacoust.2021.108554>

APPENDICES

APPENDIX A. ETHICS COMMITTEE APPROVAL OF THE PRELIMINARY STUDY



Bilkent Üniversitesi
Akademik İşler Rektör Yardımcılığı

Tarih : 22 Temmuz 2022
Gönderilen : Semiha Yılmaz, Cemre Orhan
Gönderen : H. Altay Güvenir
İnsan Araştırmaları Etik Kurulu Başkanı
Konu : "A Study ..." çalışması etik kurul onayı

Üniversitemiz İnsan Araştırmaları Etik Kurulu, 22 Temmuz 2022 tarihli görüşme sonucu, "A Study on Developing Pleasant Soundscape Assessment Scale via Machine Learning" isimli çalışmamız kapsamında yapmayı önerdiğiniz etkinlik için etik onay vermiş bulunmaktadır. Onay, ekte verilmiş olan çalışma önerisi, çalışma yürütücüleri ve bilgilendirme formu için geçerlidir.

Bu onay, yapmayı önerdiğiniz çalışmanın genel bilim etiği açısından bir değerlendirmedir. Çalışmamızda, kurumumuzun değerlendirmesi dışında kalabilen özel etik ve yasal sınırlamalara uymakla ayrıca yükümlüsünüz.

Kovid-19 salgını nedeniyle konulmuş olan kısıtlamaların yürürlükte olduğu süre içinde, tüm komite toplantıları elektronik ortamda yapılmaktadır; aşağıda isimleri bulunan Bilkent Üniversitesi Etik Kurulu Üyeleri adına bu yazıyı imzalama yetkisi kurul başkanındadır.

Etik Kurul Üyeleri:

Ünvan / İsim	Bölüm / Uzmanlık	
Prof.Dr. H. Altay Güvenir	Bilgisayar Mühendisliği	Başkan
Prof.Dr. Erdal Onar	Hukuk	Üye
Prof.Dr. Haldun Özaktas	Elektrik ve Elektronik Müh.	Üye
Doç.Dr. Işık Yuluğ	Moleküler Biyoloji ve Genetik	Üye
Dr. Öğr. Üyesi Burcu Ayşen Ürgen	Psikoloji	Üye
Dr. Öğr. Üyesi Didem Özkul McGeoch	İletişim ve Tasarım	Yedek Üye
Dr. Öğr. Üyesi A.Barış Özbilen	Hukuk	Yedek Üye

Kurul karar/toplantı No: 2022_07_22_03

APPENDIX B. ETHICS COMMITTEE APPROVAL OF THE MAIN STUDY



Bilkent Üniversitesi
Akademik İşler Rektör Yardımcılığı

Tarih : 10 Temmuz 2023
Gönderilen : Cemre Orhan
Danışman : Semiha Yılmaz
Gönderen : H. Altay Güvenir
İnsan Araştırmaları Etik Kurulu Başkanı
Konu : "A Participatory ..." çalışması etik kurul onayı

Üniversitemiz İnsan Araştırmaları Etik Kurulu, 10 Temmuz 2023 tarihli görüşme sonucu, "A Participatory Design Approach to Create Better Soundscapes" isimli çalışmamız kapsamında yapmayı önerdiğiniz etkinlik için etik onay vermiş bulunmaktadır. Onay, ekte verilmiş olan çalışma önerisi, çalışma yürütücüleri ve bilgilendirme formu için geçerlidir.

Bu onay, yapmayı önerdiğiniz çalışmanın genel bilim etiği açısından bir değerlendirmedir. Çalışmanızda, kurumumuzun değerlendirmesi dışında kalabilen özel etik ve yasal sınırlamalara uymakla ayrıca yükümlü/ünüz.

Kovid-19 salgını nedeniyle konulmuş olan kısıtlamaların yürürlükte olduğu süre içinde, tüm komite toplantıları elektronik ortamda yapılmaktadır; aşağıda isimleri bulunan Bilkent Üniversitesi Etik Kurulu Üyeleri adına bu yazıyı imzalama yetkisi kurul başkanındadır.

Etik Kurul Üyeleri:

Ünvan / İsim	Bölüm / Uzmanlık	
Prof.Dr. H. Altay Güvenir	Bilgisayar Mühendisliği	Başkan
Prof.Dr. Erdal Onar	Hukuk	Üye
Prof.Dr. Haldun Özaktar	Elektrik ve Elektronik Müh.	Üye
Doç.Dr. Işık Yuluğ	Moleküler Biyoloji ve Genetik	Üye
Dr. Öğr. Üyesi Burcu Aysen Ürgen	Psikoloji	Üye
Dr. Öğr. Üyesi Didem Özkul McGeoch	İletişim ve Tasarım	Yedek Üye
Dr. Öğr. Üyesi A.Barış Özbilen	Hukuk	Yedek Üye

Kurul karar/toplantı No: 2023_07_10_01

APPENDIX C. SEMI-STRUCTURED INTERVIEW QUESTIONS

The Built Environment

- 1. What do you expect pediatric inpatient room to have in the built environment? (Orhan & Yilmazer, 2021)**
- 2. How satisfied are you with working/staying/being in this environment? Why? (ISO, 2018)**
- 3. How do you feel about the physical environment in this pediatric inpatient room? (ISO, 2018; Orhan & Yilmazer, 2021)**

The Acoustic Environment

- 4. What do you expect to hear in this pediatric inpatient room? (Orhan & Yilmazer, 2021)**
- 5. What kind of sounds do you hear in this place and how do they make you feel? (ISO, 2018; Orhan & Yilmazer, 2021)**
- 6. What kind of sounds you hear are pleasing/disturbing? Why? (ISO, 2018; Orhan & Yilmazer, 2021)**
- 7. What do you do to avoid unwanted sounds? (ISO, 2018)**
- 8. What should be done to improve the sound environment in this environment? (ISO, 2018)**

APPENDIX D. ACOUSTIC EXPERT EVALUATION TOOL

SECTION 1 – DEMOGRAPHICS

AGE:

GENDER:

EXPERIENCE (on acoustics, soundscapes, etc.):

SECTION 2 – SCENARIO

"Ali is 13 years old and has been hospitalized for two weeks. He and his mother are staying in an inpatient unit together. On a casual day, they hear mainly nurses' conversations. They often get bored of the library-like stillness and expect to hear pleasant, calming, and relaxing sounds in their room. Now, as an expert, you are expected to suggest relaxing sounds that would best meet Ali and his mother's needs."

I have read and understood the scenario.

Yes

No

SECTION 3 – LISTENING TEST

To what extent listening to this sound help inpatient unit users to relax in this scenario?

Please point out your opinion on a **scale of 1 (not at all) to 5 (completely)** for **EACH** sound sources and write your score down to related sound source.

1- Please select **two (2) most pleasant BIRD sound** considering the scenario and the audio-visual you experienced.

	BIRD1	BIRD2	BIRD3	BIRD4	BIRD5
Your score:	_____	_____	_____	_____	_____

2- Please select **two (2) most pleasant MUSIC piece** considering the scenario and the audio-visual you experienced.

	MUSIC 1	MUSIC2	MUSIC3	MUSIC4	MUSIC5
Your score:	_____	_____	_____	_____	_____

3- Please select **two (2) most pleasant WATER sound** considering the scenario and the audio-visual you experienced.

	WATER1	WATER2	WATER3	WATER4	WATER5
Your score:	_____	_____	_____	_____	_____

APPENDIX E. THE SOUND SOURCE POOL CREATED FOR ACOUSTIC EXPERT EVALUATION SESSION

	NO	ID	REFERENCE
BIRD	1	Barn Swallow - <i>Hirundo rustica</i>	(Kirwan et al., 2010)
	2	Spanish Sparrow - <i>Passer hispaniolensis</i>	
	3	House Sparrow - <i>Passer domesticus</i>	
	4	Great Tit - <i>Parus major</i>	
	5	Common Blackbird - <i>Turdus merula</i>	
MUSIC	1	12th Street Rag by Euday L. Bowman	(Lynar et al., 2017)
	2	Acemaşiran Makamı	(Parlar Kilic et al., 2015)
	3	Jazz [lofi hip hop beats]	(Yeoh & Spence, 2023)
	4	Instrumental Music_Souvenirs D'Enfance	(Shu & Ma, 2020 ; Shu, 2023)
	5	Mozart - Sonata for Two Pianos in D major, K448	(Tripyla et al., 2023; Zheng, Lin, & Zeng, 2023)
WATER	1	Ocean waves	(Liu et al., 2022; Mado Proverbio et al., 2015)
	2	Fountain	(Galbrun & Calarco, 2014)
	3	Rain	(Garza et al., 2012)
	4	Sea wash	(Liu et al., 2022)
	5	Stream	(Galbrun & Calarco, 2014)

APPENDIX F. PD EVALUATION INTERVIEW DOMAINS

Interview Domain	Sample Interview Questions
General perspectives on the PIU soundscape	<i>How do you feel about the built/auditory environment of the patient room?</i> <i>How would you describe the differences between the existing room and the designed room?</i>
General perspectives on participatory design process	<i>How was the overall process?</i> <i>How did you feel about participating to the design process?</i>