


Identifying barriers to engage with soundscape standards: Insights from national standards bodies and experts^{a)}

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Abstract: This study explores the engagement of national standards bodies and practitioners with the ISO 12913 series on soundscape. It reveals critical challenges in stakeholder engagement, communication, competence, and practical application. A strategic roadmap, aligned with the normalization process theory, is proposed, comprising meaningful stakeholder engagement, building workability and integration, and community building and reflective monitoring. Results underscore the influence of national priorities, communication gaps, limited resources, and the need for practical guidance. Future efforts should focus on promoting cross-disciplinary collaboration and developing tools to quantify the societal and economic impact of soundscape interventions, addressing the multifaceted barriers identified. © 2024 Author(s). All article content, except where otherwise noted, is licensed under a Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

[Editor: Charles C. Church]

<https://doi.org/10.1121/10.0025454>

Received: 21 January 2024 **Accepted:** 13 March 2024 **Published Online:** 1 April 2024

1. Introduction

In 2008, the International Organization for Standardization (ISO) established Working Group 54 “Perceptual Assessment of Soundscape Quality,” within ISO/TC 43/SC 1 Noise Committee, with the aim of standardizing key definitions and framework, as well as methods for data collection and analysis, for soundscape research and practice: this led to the ISO 12913 series on soundscape. This standardization is especially valuable for urban planning, architecture, and environmental management, helping to create healthier acoustic environments (Jiang *et al.*, 2022; Kang *et al.*, 2023; Kang *et al.*, 2016). Part 1 (full standard) and Part 2 (technical specifications) of the ISO 12913 give a definition of soundscape with a framework (ISO 12913-1:2014, 2014) and methods to measure physical, psychological, and psychoacoustic parameters (ISO/TS 12913-2:2018, 2018). Part 3 (technical specifications) covers the analysis of data collected via the methods from Part 2 (ISO/TS 12913-3:2019, 2019). ISO Working Group 54 is currently working on Part 4 of ISO 12913, introducing protocols to design and manage soundscape interventions (ISO/AWI TS 12913-4, 2023).

Since the ISO 12913 series was initiated, it has made an impact on soundscape research in both academia and policy (McVay, 2023; Aletta and Torresin, 2023). However, this is still limited to specific regions of the world, which poses the question of how to widen the engagement with the ISO 12913 development from different stakeholders elsewhere. This study explored what barriers might exist to get more countries engaged with the development and implementation of ISO 12913 and how to address these challenges. The normalization process theory (NPT) was applied as a framework to identify the barriers for meaningful stakeholder engagement (May and Finch, 2009).

2. Methodology

2.1 Theoretical framework: NPT

The NPT (May and Finch, 2009) provides a conceptual framework to understand the processes and dynamics involved in the implementation, embedding, and integration of new practices, technologies, or interventions into everyday routines within various settings. The implementation can be realized through four interrelated mechanisms influenced by the organizational context and interpersonal behaviors: coherence (the meaningful qualities of a practice), cognitive participation (stakeholder engagement), collective action (interaction with existing practice), and reflexive monitoring (how a practice is understood and assessed by actors involved). NPT is often seen as a tool for researchers to think through issues or barriers to the implementation of new

^{a)}This paper is part of a special issue on “Advances in Soundscape: Emerging Trends and Challenges in Research and Practice.”

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practices and evaluate the normalization potential (Murray et al., 2010). It is increasingly used in the built environment sector to examine the normalization process of various environmental standards responding to climate crisis and human wellbeing. For example, looking at ways to normalize healthy building design, Callway et al. (2020) applied the NPT to analyze how stakeholders describe and evaluate their intentions of applying specific sustainability standards (i.e., BREAM and LEED) and health-related standards (i.e., WELL Building and WELL Communities) in different projects.

In accordance with the NPT framework, an analysis was conducted to explore the normalization process of the ISO 12913 soundscape series, outlining specific inquiries and investigations within this framework, as represented in Fig. 1. Two areas of knowledge gaps were acknowledged at both the organizational and operational levels. Thus, this study was designed to reach out to stakeholders of ISO 12913 to identify areas of problems to implement the standards, from understanding the organizational structure and social norms of policymakers in the international context to workability and skillsets in the existing routine practice by acousticians and built environment professionals.

2.2 Semi-structured interviews with members from national standards bodies (NSBs)

An invitation email was sent to all the publicly available contact points (n = 127) of the ISO members’ NSBs, as retrieved from the ISO website, to request an interview with a representative from their organization. In total, 12 representatives from NSBs across 9 countries were interviewed. The interviews were conducted online via Microsoft Teams (May to June 2022). The questions addressed the social context of standards development and implementation across countries, including the process of appointing experts to join ISO working groups, awareness of, interest in, and involvement in ISO 12913 development, and barriers to implementing ISO 12913 at the policy level (see supplementary material).

2.3 Focus group discussion and interviews with soundscape experts

In parallel, soundscape experts from countries with different levels of engagement in soundscape research (see supplementary material), were invited via purposive sampling to attend a focus group. Emails were sent to 23 experts across 15 countries. Twelve of them accepted the invitation. In the end, nine attended a focus group discussion hosted online (June 2022) via Microsoft Teams, and the other three who could not make it took an interview on a different date. The session started with a brief introduction about the background of the study. This was followed by discussion of three questions in sequence: (1) What are the barriers that prevent people from engaging with the development process of ISO 12913? (2) How can we respond to remove these barriers? (3) How can ISO 12913 be used more innovatively to make wider impacts?

3. Results: Barriers to engaging with the ISO 12913 soundscape series

The key barriers to engaging with the development of the ISO 12913 series that the NSBs identified include the following: (1) lack of national interest; (2) lack of resources, including time, expertise and financial resources; and (3) lack of soundscape theory literacy and effective communication on the standards and associated impact (see Fig. 2).

The barriers identified by NSBs were also echoed by the soundscape experts in the focus group discussion. Additionally, they identified several factors preventing the implementation and wider impact of the ISO 12913 among industry practices and local authorities, including the following: (1) lack of applied cases and guidance on using ISO 12913 beyond academia; (2) lack of mechanisms to document and measure the socio-economic impact of the soundscape

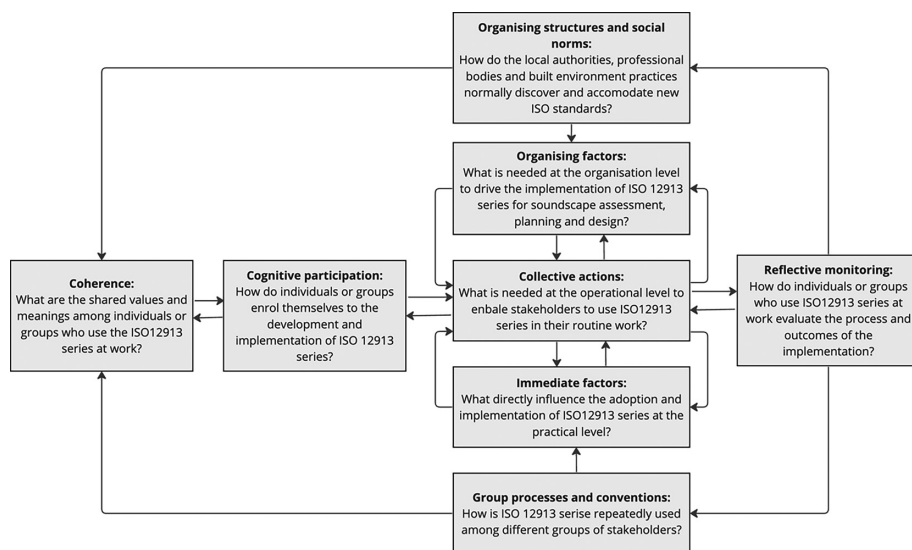


Fig. 1. Interpreting the inquiries of implementing the ISO 12913 soundscape series using the NPT framework by May and Finch (2009).

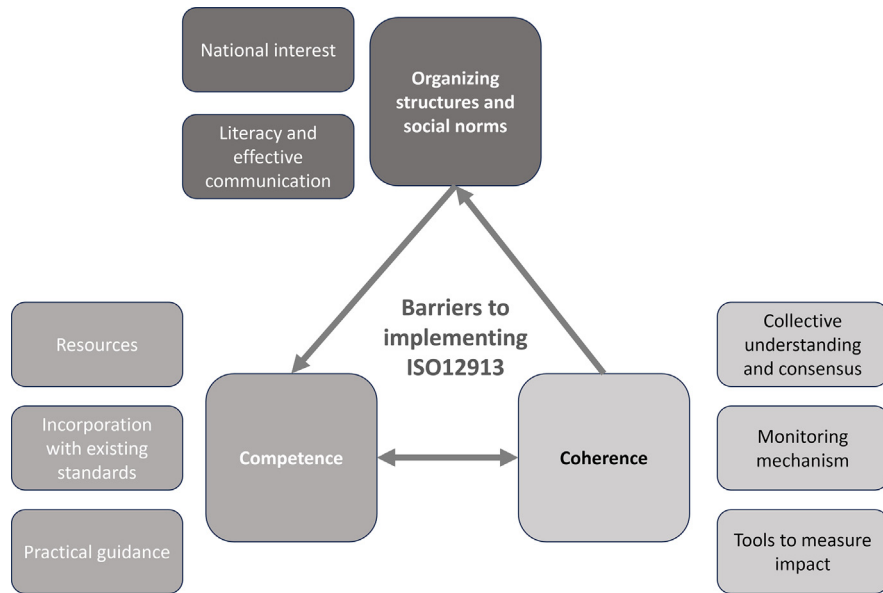


Fig. 2. Barriers identified to implement ISO 12913 based on the NPT framework.

approach, and (3) lack of consensus and reflective monitoring. The subsequent quotes are coded as follows: (1) for NSBs (NSB), the codes differentiate between experts (exp) and officers (off), and (2) for experts from industry (IND), academia (ACA), government (GOV), and non-governmental organizations (NGO), the codes differentiate between acousticians (aco), built environment professionals (bep), and designers (des).

3.1 Organizing structure and social norms

3.1.1 Lack of national interest in soundscape and environmental noise

The NSBs confirmed that most of them have an open application process to appoint experts to join a technical working group. Either an expert applies to join, or the NSB nominates an expert to participate in a standardization process. However, whether to participate mostly depends on the level of national interest. For example:

“According to the Committee’s internal regulations (developed in accordance with regulations of European and international standards organizations), implementation of ISO standards as national standards is voluntary and the decision is made by the national technical committee (and only national technical committee is entitled to do so); ISO 12913 hasn’t been implemented yet, because no one was interested in using this standard at the national level.” (NSB, off)

Particularly, in developing countries, basic environmental issues such as droughts, floods, and poor sanitary conditions are seen as more “urgent” than soundscape quality. A national expert commented:

“The national interest and investment are in energy, lighting and thermal comfort. There is no national-level research project on soundscape or environmental noise.” (NSB, exp)

“Only recently, the government revised the Law on Noise Pollution Prevention and Control. In the last 20 years, we are still dealing with noise pollution both indoors and outdoors such as transport noise pollution, aircraft noise pollution, noise transmission between floor slabs and walls.” (ACA, bep)

“We just established an acoustics committee. The barrier is that we are not prepared to participate [in ISO WG 54]. In academia, we have some interest in soundscape. But we don’t have a national policy on noise pollution. A translation of this policy will be useful. We need more time....” (NSB, exp)

Understanding the political-economical contexts in developing countries to explore strategic benefits to integrate the ISO 12913 series at the current stage of development is crucial:

“The difference in the urgency of managing the sound environment in developing countries and developed countries also matters a lot. In developed countries, where environmental noise is much more controlled, people care more about perceptual quality. But it is not the case in developing countries where essential environmental quality is not guaranteed.” (ACA, bep)

3.1.2 Lack of soundscape literacy and effective communication of ISO 12913 series

Some NSB interviewees said they were not aware of ISO 12913 and did not have any experts in the field. The lack of soundscape theory literacy and effective communication leads to insufficient appreciation of the ISO 12913 value in the

national context. The initial advertising of new ISO working groups and standards is important to raise wider interest, as commented by national officers:

“I would only know any ISO or other standards if the information has been sent through.” (NSB, off)

“We are not aware of the technical Working Group 54. When we see new standards, we send the information to some universities, departments, and relevant industries. It depends on who sends the comments to us. We assess the feasibility and importance to filter the comments we need, and then decide which working group or technical committee to engage with.” (NSB, exp)

“Industry participation is crucial. Any committee must have industry participants. However, joining ISO is quite opaque. My application has been under review for one year and it’s not been approved yet.” (ACA, aco)

3.2 Competences: Organizing factors, collective actions and immediate factors

3.2.1 Limited resources to enable participation

Although soundscape studies have now been established as a research field for a while, people outside academia will still consider soundscape a “new” concept. The absence of soundscape expertise in the NSBs is a key barrier that leads to inactive participation towards the development and implementation of the ISO 12913 series. For example:

“There is a lack of knowledge on soundscape and even environmental noise. This subject is absent in education and professional training. [...] We also don’t have a specialized lab on soundscape with devices and software to do measurement, recording or simulation. These are typical issues in developing countries.” (NSB, exp)

“There is already interest to look at the noise technical standards which only emerged from 2020 in our country. However, it is upheld because of COVID-19. We haven’t heard about this [ISO 12913] before and are not aware of the working group. The field is new in the country, and we haven’t identified the soundscape experts. We are also short of staff to go through all working groups to identify the interests. We are interested to engage in the future but depends on the ISO sponsorship to attend meetings.” (NSB, exp)

3.2.2 Lack of guidance on how to interact with noise control practice and standards

However, there are also countries that have different types of concerns where the NSBs are not sure how the soundscape approach and ISO 12913 can be useful in addition to the existing noise control standards:

“The soundscape concept is too specific. It cannot be used for highway noise, for example.” (NSB, exp)

“The only focus perhaps is on noise from airplanes. Because it is a small population, we do not have much noise pollution. There aren’t government restrictions on noise levels. We might have some issues around party noise in neighborhoods.” (NSB, off)

3.2.3 Lack of practical guidance and applied examples

The lack of applied examples creates barriers to building trust and values in adopting the framework, particularly for those who use an evidence-based approach. It also raises questions on feasibility, cost, and resources needed for decision-makers:

“The most frequently asked questions after the seminar [on soundscape to local authorities] were 1) the concept of soundscape is not clear to apply in their fields and 2) what are the design practices of soundscape? These questions imply that many people are not familiar with the concept and they also want to see practices and examples of soundscape designs. The lack of demonstrating and proving the usefulness and feasibility of the soundscape concept would be the main barrier to getting people in the industries and governmental bodies to engage with ISO 12913.” (ACA, aco)

At the individual level, this barrier also brings confidence issues around initiating the adoption of the ISO 12913 in practice.

3.3 Coherence: Cognitive participation and reflective monitoring

3.3.1 Lack of collective understanding and consensus on the scope

Concerns were raised about the need and scope for ISO 12913. It is important to strive for consistency and clarity in defining the soundscape approach:

“It is also difficult for all disciplines to agree on the same understanding and interpretation of soundscape. To reach consensus, this means each discipline may have to give up some unique characteristics of soundscape in their field. This might not be something we wish to see. It might be worth asking whether we need to develop a standard for soundscape? Or should we structure soundscape in such specific ways? For people who do sound ecology, for example, shall we include them? Cross-disciplinarity is important to discuss here. I am curious to know how people from other disciplines perceive the ISO 12913 series.” (ACA, bep)

This also implies that shared values and beliefs of embedding the ISO 12913 into individual practices need to be explored. The internalization process of individuals identifying the components in their practice of using the ISO 12913 and changes in behaviors are essential to the formalization of a new practice.

3.3.2 Lack of mechanisms to monitor engagement

It is important to learn from how people use ISO 12913 in their work. This helps identify common practices among different groups. People need to actively engage with the development and use of ISO 12913, and this can happen either because they genuinely want to (intrinsic engagement) or because they are encouraged through monitoring and reporting activities (extrinsic engagement):

“There is a disconnection between [soundscape] researchers and the ISO Working Group 54. If the working group approach the National Technical Committee, it will be a good starting point.” (NSB, exp)

Although soundscape research is widely conducted across many countries, the experiences of using ISO 12913 are not effectively shared or communicated:

“Most of the time people or institutions work independently. They don’t communicate with each other. [Soundscape] is only related to individuals’ interests. It is not from the national side. In my opinion, it should be. [...] People can apply to become a member of the technical committee. Normally, it will be people from higher education and private sector, or industry. However, there isn’t a ‘checking mechanism’ on how much each member is engaging with the standards development.” (NSB, exp)

3.3.3 Lack of tools to measure the socio-economic impact

In terms of reflective monitoring and practicality the focus group experts acknowledged that quantifiable evidence is still essential for decision-makers:

“The comment we got from the beginning was that this [ISO 12913 soundscape series] can potentially benefit practitioners. Industries and governments have to make evidence-based decisions so that the decision-makers can resource and cost. Lack of solid evidence in the real world is the biggest challenge.” (NGO, bep)

This is not only an issue about the ISO 12913 series, but also a challenge to the implementation of soundscape approach overall. In a way, the development of ISO 12913 series aims to provide rigor and structure to soundscape in the field of environmental assessment and planning.

4. Roadmap to implement ISO 12913 series in routine practices in the built environment

A roadmap is drawn from the conversations about ISO 12913, and barriers to its implementation identified by NSBs and experts through three stages, to enable the flow of the process in the NPT framework (Fig. 3).

4.1 Meaningful stakeholder engagement to initiate public and organizational interest

Meaningful engagement starts with a willingness to establish a relationship with stakeholders to change the current organizational behaviors to adapt to the observed societal changes (Jeffery, 2009). Quoting from the discussion:

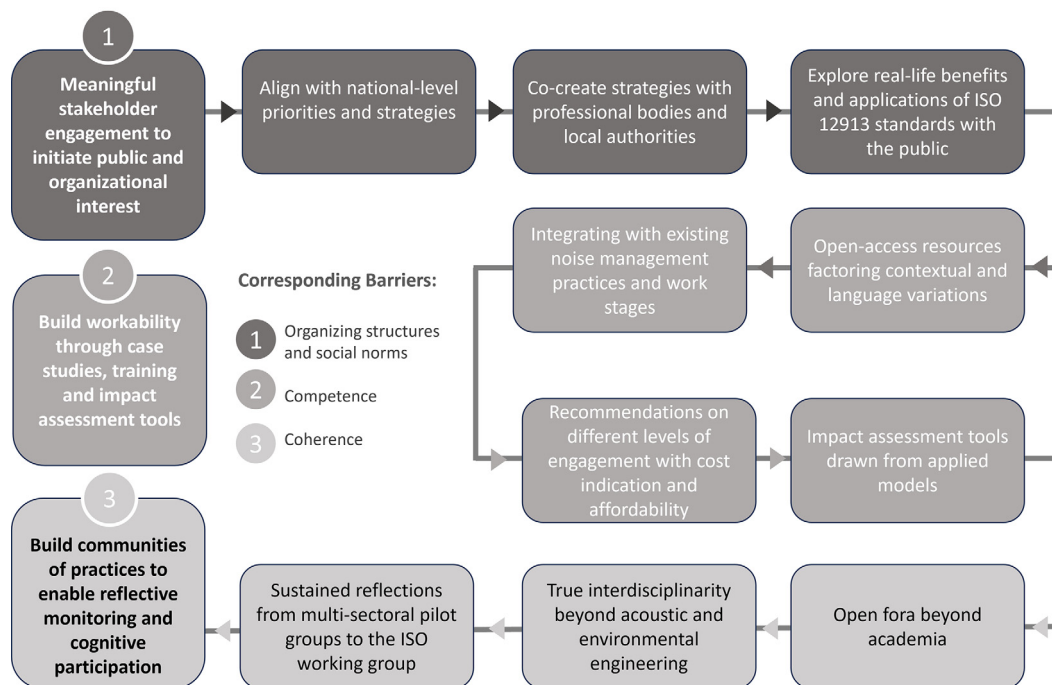


Fig. 3. Roadmap to implement the ISO 12913 series responding to barriers identified using the NPT framework.

“In soundscape, the standards and projects are driven by acousticians and engineers. The committee could perhaps combine ways of working with other standards, particularly for Part 4. For those in practice, we might need to challenge ourselves to work with other disciplines to do something out of purely acoustic engineering.” (NGO, bep)

Aligning with national and organizational interests is critical to enable the transition of ISO 12913 to planning policies. A successful example is the Welsh Noise and Soundscape Action Plan 2018–2023, which mentions the ISO 12913 Parts 1 and 2 for definition and assessment methods (McVay, 2023). Comments from an expert:

“The use of soundscape concept in our policies happened naturally. Although we used it in a generic way at the start, the purpose was to consider human experiences. The ISO12913 standards have enabled us to use the soundscape concept more precisely. The three pillars in the definition, the acoustic environment, people, and context, fit well with the planning process to make decisions. It involves people in the place to shape the policies and respond to specific contexts.” (GOV, bep)

An outreach strategy, such as the participatory framework in Xiao *et al.* (2018), can trigger conversations with local authorities and stakeholders on what benefits the soundscape approach would bring to each community, and it can help assessing the contribution of ISO 12913 and identifying ways to intertwine with the other environmental policies (see Ratcliffe, 2021; Jiang *et al.*, 2022; Kang *et al.*, 2023). To promote the soundscape approach, it is essential to inform local participants and stakeholders in communities; this involves utilizing available resources while considering the impact on future generations, as well as considering socio-cultural, aesthetic, and economic effects (Schulte-Fortkamp, 2018). In this sense, participatory soundwalks and workshops with stakeholders and communities are effective in making real-life behavioral changes in managing and perceiving environmental sounds (Radicchi *et al.*, 2016).

4.2 Building workability through case studies, training, and impact assessment tools

Collective actions and workability are at the heart of the NTP framework, which is enabled by the organizing and immediate factors—how practitioners and authorities adopt the ISO 12913 series is heavily dependent on technical readiness and contextual integration. Leveraging on existing practices in noise management is the starting point to introduce the soundscape approach and bring in the human focus. Acknowledging the overlaps and differences is essential to interact with the existing noise management practices. Quoted from the City of London Noise Strategy 2016 to 2026, p. 40: “The management of soundscape overlaps with, and arguably embraces and develops the better established but narrower concept of environmental noise management” (City of London – Pollution Control Team, 2017). Terminologies, such as soundscape design and soundscape planning, also need to be further defined and explained in future work.

Embedding soundscape and the ISO 12913 into higher education and professional training can advance the implementation agenda. Engagement by educators (e.g., Milo, 2020; Xiao *et al.*, 2022) and leading industry stakeholders will certainly make the difference in this sense. Quoted from the discussions:

“How to quantify the values of soundscapes and holistic well-being from soundscapes will be the key challenge. From a design aspect, it is good to give a standard measuring method, but not clear how to apply it in the design process.” (IND, des)

Building the ISO 12913 series into existing practice can take steps to integrate with different work stages. For example, the Royal Institute of British Architects (RIBA) has seven stages where ISO 12913 Part 1 could be used for stages 0 (strategic definition.) and 1 (preparation and briefing). Parts 2 and 3 can be introduced to stage 2 (concept design) and 3 (spatial coordination). Part 4 might serve stages 4 (technical design) and 5 (manufacturing and construction). However, this would mean that more information on the implementation cost at different stages needs to be defined. Quoted from the discussion:

“Knowing the cost of the [soundscape] interventions is going to help. For public authorities, we don’t have evidence to show this [Part 4] will be a useful and effective intervention. They will need to see how feasible it is to maintain these interventions in time.” (NGO, bep)

Case studies into real-life examples of managing sounds or designing with sounds provide insights into ways to integrate ISO 12913 into planning. As commented by one of the experts:

“The Agency has an economics department, they did the social cost of road noise on the society. The analysis of this has led to more attention from the authorities to look at the noise issue. But, yes, they are looking at mainly decibels. But now, they are more open to factors linked to social-psychological attributes.” (NGO, bep)

4.3 Building communities of practices to enable reflective monitoring and cognitive participation

Kang and Aletta (2018) used Altmetric data to explore mentions of soundscape research in social media, news outlets, public policies, and patents. This revealed that outreach beyond academia for soundscape studies is currently limited. It might be useful to consider approaching stakeholders from different sectors to try out ISO 12913 in their practice and feedback to the working group members. It is useful to be project-based for real-life lessons at various scales of practice, including changes in operational actions in assessing environmental sounds, organizational attitudes towards the soundscape concept, and societal understanding of the impact of quality of sounds on well-being and the environment. For instance, similar conversations are now happening within an emerging scientific community looking at the application of

the soundscape approach to indoor contexts, considering how that could be integrated to architectural design (Erçakmak and Dökmeçi Yörükoğlu, 2019). The periodic conversations among the Working Group 54 members, not only to discuss the development of new ISO 12913 parts, but also to reflect on the engagement and outreach activities outside the standardization landscape, will be essential to advance the implementation of the soundscape approach.

5. Conclusions

This study, framed within the NPT, identified barriers to engagement with the ISO 12913 series for both NSBs and other stakeholders, via expert interviews and a focus group. The main conclusions are:

- Discussing soundscape quality within NSBs and other policymakers is sometimes difficult due to existing organizing structures and entrenched social norms that prioritize other environmental aspects.
- Competence-related challenges exist, emphasizing the need for accessible technical training on the soundscape approach for all stakeholders, to overcome limited resources and literacy gaps.
- Coherence challenges are perceived, specifically skepticism due to the absence of applied examples and practical guidance for incorporating soundscape principles.

The proposed three-stage roadmap aims to address the identified barriers by (1) fostering meaningful stakeholder engagement, (2) establishing workability with accessible training resources, and (3) creating communities of practice for sustained participation. In structuring the proposed roadmap for soundscape implementation, consideration was given to prioritizing competence-building as the initial step. However, the decision to commence with stakeholder engagement was maintained based on observed barriers, particularly the identified lack of national interest revealed in NSB interviews. Addressing this fundamental issue aligns strategically with the NPT, establishing a foundation conducive to subsequent competence-building. The successful case of the Noise and Soundscape Plan for Wales, guided by ISO 12913, underscores the pivotal role of governmental interest in driving effective implementation. The chosen sequence is designed to proactively tackle engagement barriers, creating a context conducive to the development of competences essential for a robust soundscape framework. This has the potential to overcome barriers, integrating soundscape principles into built environment practices for improved well-being.

Supplementary material

See the supplementary material for the current ISO/TC 43/SC 1/WG 54 membership, and for the questions used in the semi-structured interviews with NSBs.

Acknowledgments

This research was funded via the UCL Research Culture Awards (2022), “Knowledge Exchange” pathway. The authors are grateful to all focus group and interviews participants. Participating NSBs include the Polish Committee for Standardisation, Malawi Bureau of Standards, Instituto Português da Qualidade, Rwanda Standards Board, Iran National Standards Organization, New Zealand Standards Organisation, Türk Standardları Enstitüsü, Magyar Szabványügyi Testület, and Bahamas Bureau of Standards & Quality. Participating experts in the interviews are from industry or institutions in the United Kingdom, Singapore, China, Brazil, Spain, South Korea, Algeria, India, Norway, and Belgium.

Author Declarations

Conflict of Interest

The authors have no conflicts to disclose.

Ethics Approval

The study was approved through the Research Ethics Committee at Faculty of Art, Design and Media, Birmingham City University, UK (Approval No. 10619).

Data Availability

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to ethical restrictions.

References

- Aletta, F., and Torresin, S. (2023). “Adoption of ISO/TS 12913-2: 2018 protocols for data collection from individuals in soundscape studies: An overview of the literature,” *Curr. Pollut. Rep.* **9**, 710–723.
- Callway, R., Pineo, H., and Moore, G. (2020). “Understanding the role of standards in the negotiation of a healthy built environment,” *Sustainability* **12**(23), 9884.
- City of London – Pollution Control Team (2017). *City of London Noise Strategy 2016 to 2026* (Department of Markets and Consumer Protection, London).

- Erçakmak, U. B., and Dökmeçi Yörükoğlu, P. N. (2019). "Comparing Turkish and European noise management and soundscape policies: A proposal of indoor soundscape integration to architectural design and application," *Acoustics* 1(4), 847–865.
- ISO 12913-1:2014 (2014). "Acoustics—soundscape—Part 1: Definition and conceptual framework" (International Organization for Standardization, Geneva).
- ISO/AWI TS 12913-4 (2023). "Acoustics—soundscape—Part 4: Design and intervention" (International Organization for Standardization, Geneva).
- ISO/TS 12913-2:2018 (2018). "Acoustics—soundscape—Part 2: Data collection and reporting requirements" (International Organization for Standardization, Geneva).
- ISO/TS 12913-3:2019, "Acoustics—soundscape—Part 3: Data analysis" (International Organization for Standardization, Geneva, 2019).
- Jeffery, N. (2009). "Stakeholder engagement: A road map to meaningful engagement," in *The Doughty Centre 'How to Do Corporate Responsibility' Series* (Cranfield University, Bedford, UK).
- Jiang, L., Bristow, A., Kang, J., Aletta, F., Thomas, R., Notley, H., Thomas, A., and Nellthorp, J. (2022). "Ten questions concerning soundscape valuation," *Build. Environ.* 219, 109231.
- Kang, J., Aletta, F., Gjestland, T. T., Brown, L. A., Botteldooren, D., Schulte-Fortkamp, B., Lercher, P., van Kamp, I., Genuit, K., Fiebig, A., Bento Coelho, J. L., Maffei, L., and Lavia, L. (2016). "Ten questions on the soundscapes of the built environment," *Build. Environ.* 108, 284–294.
- Kang, J., and Aletta, F. (2018). "The impact and outreach of soundscape research," *Environments* 5(5), 58.
- Kang, J., Aletta, F., Oberman, T., Mitchell, A., Erfanian, M., Tong, H., Torresin, S., Xu, C., Yang, T., and Chen, X. (2023). "Supportive soundscapes are crucial for sustainable environments," *Sci. Total Environ.* 855, 158868.
- May, C., and Finch, T. (2009). "Implementing, embedding, and integrating practices: An outline of normalization process theory," *Sociology* 43(3), 535–554.
- McVay, M. (2023). "Noise and soundscape in Welsh planning policy," *INTER-NOISE NOISE-CONG. Conf.* 265(7), 686–693.
- Milo, A. (2020). "The acoustic designer: Joining soundscape and architectural acoustics in architectural design education," *Build. Acoust.* 27(2), 83–112.
- Murray, E., Treweek, S., Pope, C., MacFarlane, A., Ballini, L., Dowrick, C., Finch, T., Kennedy, A., Mair, F., O'Donnell, C., and Ong, B. N. (2010). "Normalisation process theory: A framework for developing, evaluating and implementing complex interventions," *BMC Med.* 8, 63.
- Radicchi, A., Henckel, D., and Memmel, M. (2016). "Citizens as smart, active sensors for a quiet and just city. The case of the 'open source soundscapes' approach to identify, assess and plan 'everyday quiet areas' in cities," *Noise Mapp.* 5(1), 1–20.
- Ratcliffe, E. (2021). "Sound and soundscape in restorative natural environments: A narrative literature review," *Front. Psychol.* 12, 570563.
- Schulte-Fortkamp, B. (2018). "Soundscape, standardization, and application," in *Proceedings of the 11th Euronoise Conference*, May 27–31, 2018, Crete, Greece (European Acoustics Association, Madrid, Spain).
- Xiao, J., Aletta, F., and Ali-Maclachlan, I. (2022). "On the opportunities of the soundscape approach to revitalise acoustics training in undergraduate architectural courses," *Sustainability* 14(4), 1957.
- Xiao, J., Lavia, L., and Kang, J. (2018). "Towards an agile participatory urban soundscape planning framework," *J. Environ. Plan. Manag.* 61(4), 677–698.