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Review

Room acoustic target values in offices: a global review

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HIGHLIGHTS

- Acoustic regulations for offices are collected from more than 30 countries worldwide.
- Reverberation time and building services noise levels are the most widely adopted metrics.
- Only a few countries adopt ISO 3382–3 spatial decay metrics in their national regulations.
- A gap exists between current regulations and the scientific literature on speech privacy.
- Updated national frameworks should adopt distraction distance and comfort distance.

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ABSTRACT

This work presents a global analysis of national regulations and guidance documents regarding indoor acoustic conditions in office environments. The authors collected data from over 30 countries across six continents through an extensive review, supported and validated by expert consultation. Considering five recurrent space types, i.e., single-worker rooms, shared office rooms, open-plan offices, meeting rooms, and audio/video rooms, allowed for a consistent comparison among the acoustic requirements worldwide. The results reveal that conventional metrics, such as reverberation time and background noise level, remain the most widely adopted for setting acoustic targets across all office types. Conversely, advanced speech privacy and spatial acoustic descriptors defined in the ISO 3382-3, such as distraction distance and speech spatial decay rate, are explicitly integrated into national regulations in only a few countries. Findings indicate a significant gap between the current legislative framework and scientific evidence on speech privacy, underscoring the need for updated building codes to improve workers' comfort and well-being.

1. Introduction

1.1. Background

Noise and insufficient speech privacy are the primary factors undermining overall acoustic comfort in offices [1]. An in-field study shows that perceived noise disturbance is primarily driven by distracting background speech, emphasising the importance of acoustic strategies, such as absorption and masking [2]. Distraction from colleagues' speech impairs concentration and work performance, particularly for cognitively demanding tasks, while insufficient privacy hinders confidential conversations. Multi-talker environments can be more distracting than single talkers, especially at lower broadband sound-masking levels [3]. Several experimental studies in field and laboratory settings indicate that reducing speech intelligibility can decrease subjective disturbance, particularly for noise-sensitive individuals [4,5]. Therefore, specific attention should be given to all features affecting room acoustics in office environments, such as ceiling absorption, workstation layout, furniture, and floor coverings [6–8].

Research has shown that acoustic comfort and privacy are primarily governed by speech intelligibility rather than overall sound levels, making control of speech propagation a central design challenge [9]. Early studies revealed that relocating workers from cellular offices to open-plan layouts led to a decline in perceived privacy despite unchanged noise levels, with dissatisfaction primarily attributed to the loss of conversational confidentiality [10]. Subsequent research identified intelligible speech as a dominant source of distraction and performance

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degradation in open-plan environments [11–13], leading to the development of quantitative models linking cognitive performance to the Speech Transmission Index (STI), with performance declining above 0.20 and reaching a maximum effect beyond 0.60 [4]. These findings established that achieving acceptable speech privacy requires a multi-layered design approach that combines architectural measures, such as ceiling absorption and screen height [14,15]. Therefore, assessment methods and design-oriented metrics were introduced to characterize entire open-plan offices [16]. Large-scale field studies demonstrated that sound masking might be an effective intervention for reducing the spatial reach of intelligible speech [17], although long-term field experiments highlighted the importance of workers' familiarity with masking sounds over laboratory-tested alternatives [18,19]. These research outcomes built a strong literature foundation for the drafting of national regulations and international standards, such as ISO 3382–3 [20], providing standardised procedures and target values for the acoustic design of open-plan offices [21,22]. Recent studies suggest that sound pressure level–based metrics may better predict acoustic dissatisfaction and privacy loss, highlighting the need for a user-centred design approach [23].

1.2. Scientific rationale

Many nations accept that the acoustic quality of rooms in open-plan offices should be primarily measured using the method described in ISO 3382–3 [20,24]. The method explores the spatial decay of A-weighted speech level, $L_{p,A,S}$ (dB), and STI. The measurement is conducted in an unoccupied office. Activity noise in the office is not taken into account, since the activity level (38–73 dB) depends largely on the type of work and occupation of the office [25]. The measurement is conducted along a straight path passing at least five workstations, and the sound source is placed at one end of the path, and measurements are conducted at the workstations along the path. The resulting single-number quantities are distraction distance, r_D (m) (the distance where the STI falls below 0.50), spatial decay rate of A-weighted SPL of speech, $D_{2,S}$ (dB) (the reduction of $L_{p,A,S}$ per distance doubling from the sound source), $L_{p,A,S,4m}$ (dB) (A-weighted SPL of speech at 4 m distance from the speaker), $L_{p,A,B}$ (dB) (background noise level along the measurement path), and comfort distance r_C (m) (the distance from the sound source where $L_{p,A,S}$ falls below 45 dB). The latter can also be calculated from $D_{2,S}$ and $L_{p,A,S,4m}$.

The scientific progress underpinning this method warrants deeper examination, as it partially explains the rationale for this review of standards and national regulations. The first scientific steps pointing out the importance of spatial decay assessment were made already in the 1970s [26–29]. Although clear evidence was obtained that open-plan offices significantly deviated from diffuse sound fields, and spatial decay rates up to 6 dB/doubling distance were observed, these studies were not powerful enough to change the general beliefs about the adequacy of using reverberation time as a primary room acoustic indicator in open-plan offices. In addition, none of these studies contained a serious experimental design, so they could not provide clear room acoustic design guidelines.

Probably driven by these studies, Bradley & Wang [30] conducted the first laboratory experiment on this topic. The setup consisted of a pair of face-to-face workstations in a semi-anechoic room, separated by a screen. Speech sounds were produced at one workstation, and measurements were taken at the other workstation. The sound absorption coefficient of the ceiling, the screen height between workstations, and the sound masking level were manipulated, and measurements were taken in several combinations of these variables. This led to the first important and evidence-based design guideline for room acoustic design [31], which remains one of the most cited. Inspired by Ref. [30], further research was conducted in Finland in 2001–2003 [32]. Their work complemented Ref. [30] by providing a broader range of ceiling absorption coefficients, screen absorption coefficients, screen heights, and masking sound levels. However, both of these independent laboratory experiments [30,32] provided an incomplete understanding of sound propagation in real offices, as horizontal reflections were absent. Most office walls are reflective and are often very close to the measurement positions in both of these experiments, so the reflections are strong and dominate sound propagation over the screen. Similar measurements (between face-to-face workstations) were also conducted in several acoustically different open-plan offices. They demonstrated that the proposed noise control measures (sound-absorbing ceiling, high screens, and sufficient sound masking) were unexpectedly inefficient at the shortest relevant source-receiver distance, i.e., between two adjacent workstations separated by a screen [33]. The reason was the room reverberation and flanking transmission paths. This proved that the choice of Refs. [30,32] of conducting the measurements in horizontally anechoic rooms was a strongly biasing factor and prevented the application of their results for real office environments at arbitrary distances from the speaker.

At the same time, ISO 11690-2:1996 [34] standard had taken an important initiative to measure spatial decay rates in industrial spaces, i.e., factories, which often contain high levels of equipment (machines, storage), thereby preventing the direct propagation of horizontal sound. Later, this measurement concept was separately standardized in ISO 14257:2001 [35], except that reverberation time was no longer used. Experimental data showed that this method is highly valuable in industrial halls [36]. Based on the experience from Refs. [33,36], Virjonen et al. [16] started a broad measurement campaign in several open-plan offices. A group of 16 open-plan offices was chosen from a large pool of measured open-plan offices to allow for a proper understanding of sound propagation and spatial decay. The offices were chosen to represent the largest observed variations in room absorption area, screen height, room dimensions, and sound masking levels. The outcomes provided indisputable evidence that room acoustic design has a drastic effect on the spatial decay rate of speech [16]. The $D_{2,S}$ values ranged from 4 to 12 dB, indicating that the potential of room acoustic design (absorbers, screens) was significant. The absence of any correlation between spatial decay and reverberation time in these offices proved that reverberation time does not describe room acoustic conditions in open-plan offices. Virjonen et al. [16] also suggested the first target values (Table 1). The measurement method of Virjonen et al. [16] was adopted for the ISO 3382-3:2012 [24] standard.

Keränen & Hongisto [6] conducted additional measurements in accordance with Ref. [16] and developed a regression model to predict ISO 3382–3 parameters for a total of 26 offices (considering Refs. [6,16]) from simple room data. However, the measured offices in Refs. [6,16] did not contain systematically controlled variations of room absorption, screen height, and masking level. In other words, the pool of measured offices was not representative enough to propose evidence-based design guidelines on how the ISO parameters depend on room acoustic properties. Therefore, an extensive laboratory experiment was conducted in a full-scale open-plan office in 2010–2011, where all relevant components could be changed: ceiling absorption, wall absorption, screen height, screen absorption, and sound masking level [7]. This evidence was used to revise the target values reported in Ref. [16], and these values were also reflected in the first widely adopted target values in ISO 3382-3:2012 Annex A (Table 1). Finland was the first country to adopt the concepts of the ISO standard in building regulations [21].

Following the publication of ISO 3382-3:2012, several studies were conducted in different countries (see the review in Ref. [37]). The ranges of r_D and $D_{2,S}$ agreed well with the data of Refs. [6,16]. This provided confirmation that the methodological development taken in ISO 3382-3:2012 was justified. Based on international experiences, the ISO standard was revised ten years later to ISO 3382-3:2022 [20]. At that point, comfort distance was introduced as a new parameter, since Ref. [37] suggested it to be an easier parameter for communication than $D_{2,S}$ and $L_{p,A,S,4m}$. The target values were also slightly revised (Table 1).

Table 1
Some frequently cited reference values of the acoustic metrics related to the spatial decay of the speech and the background noise level [16,20,24].

	$D_{2,S}$ (dB)	$L_{p,A,S,4m}$ (dB)	r_D (m)	r_C (m)	$L_{p,A,B}$ (dB)
Virjonen et al. (2009)					
class A	> 11	< 48	< 5	–	–
class B	9 – 11	48 – 51	5 – 8	–	–
class C	7 – 9	51 – 54	8 – 11	–	–
class D	< 7	> 54	> 11	–	–
ISO 3382-3:2012 Annex A					
Poor conditions	< 5	> 50	> 10	–	–
Moderate*	5 – 7	48 – 50	5 – 10	–	–
Good conditions	≥ 7	< 48	< 5	–	–
ISO 3382-3:2022 Annex C					
Poor conditions	< 5	> 52	> 11	> 11	< 35 or > 48
Moderate*	5 – 8	48 – 52	5 – 11	5 – 11	35 – 40 or 45 – 48
Good conditions	> 8	< 48	< 5	< 5	40 – 45

$D_{2,S}$ is the rate of spatial decay of A-weighted sound pressure level (SPL) of speech per distance doubling.
$L_{p,A,S,4m}$ is the A-weighted SPL of speech at the distance of 4 m from the omnidirectional sound source.
r_D is the shortest distance from the middle point of the omnidirectional sound source where the STI is lower than 0.50.
r_C is the shortest distance from the middle point of the omnidirectional sound source where the A-weighted SPL of speech is lower than 45 dB.
$L_{p,A,B}$ is the A-weighted SPL of background noise at the workstations along the measurement path during working hours when occupants are absent.
* Ranges are not written in the standard but are based on logical thinking.

1.3. AIM of the work

Despite the advanced status of ISO 3382-3, the single-number quantities describing spatial decay are not used in most regulations worldwide. One reason may be that the ISO 3382-3 standard is still new, and regulations are not updated every year. Regarding this point, research to date has not produced a comprehensive database of national regulations on office buildings worldwide, nor has it compared the requirements in these documents with international standards.

The aim of this study is to assess global trends in national regulations and compare them with the ISO 3382–3 approach and databases collected during a previous review of national target values for classroom acoustics [38]. The data were systematically collected by directly contacting experts from several countries. Expert interaction helped to explain country-specific document structures and interpretations.

This work focuses exclusively on indoor room acoustic parameters related to office environments, including reverberation, background noise, and speech privacy descriptors. Sound insulation requirements related to façades and partitions were excluded because they are generally addressed separately during structural and shell design stages. Consequently, external environmental noise transmitted indoors was considered outside the scope of this review.

2. Materials and methods

The study began with a preliminary search for relevant national and international regulations and acoustics experts using online databases. Following these initial searches, additional papers, standards, and expert opinions were gathered to establish contact with acousticians in each country. Translating the different materials allowed for the extraction and identification of relevant information from each document, resulting in substantial data unification. Subsequent follow-ups with the selected experts were conducted to enrich the dataset, verify the accuracy of the information, and resolve any ambiguities in interpretation. Finally, the collected data were organized and classified to provide an updated overview of office acoustics regulations, structured by country and continent. Fig. 1 presents a schematic view of the data collection process. Each step is described in detail below.

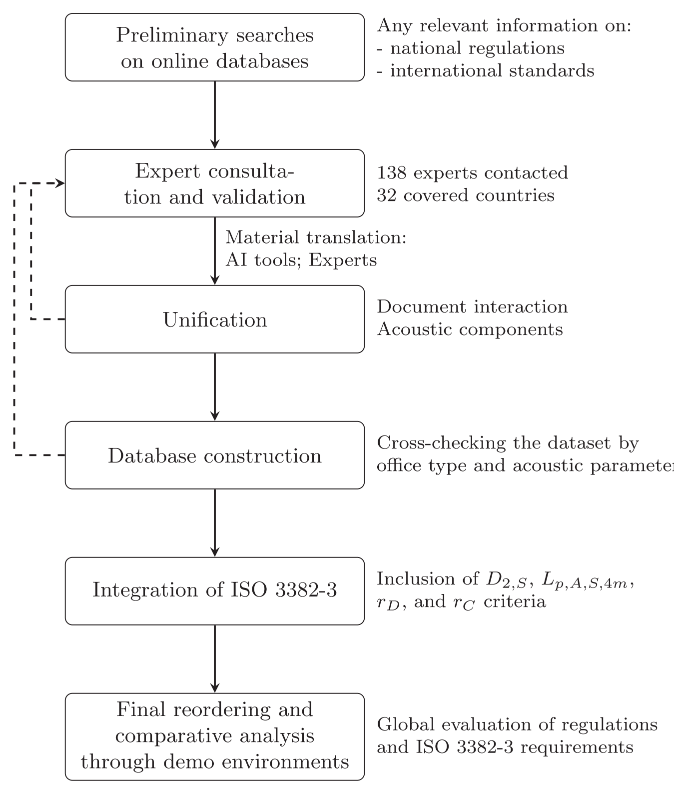

Fig. 1. Schematic view of the procedure adopted to collect data from online databases and experts' consultations.

2.1. Data collection and document review

A comprehensive dataset of regulations, together with peer-reviewed papers and conference contributions discussing or comparing national regulatory frameworks, such as [39,40], was gathered to identify acoustic requirements for office environments worldwide. The data collection followed a similar approach to the international survey on classroom acoustics recently conducted by Tardini et al. [38,41]. The official documents were collected directly from the websites of national and regional standardization bodies, as well as from governmental repositories or professional associations. Where documents were not publicly available, they were obtained through institutional subscriptions or by direct request to national representatives. When possible, the most recent, valid versions were included; withdrawn or superseded editions were excluded after verification. Each identified document was reviewed to determine whether it explicitly provided acoustic criteria for office spaces or fell within broader categories (e.g., administrative, commercial, or non-residential buildings). Whenever a standard referenced another document, both were checked to ensure consistency. For example, when national regulations cited ISO 3382-3, that reference was cross-verified against the latest version (2022) to confirm alignment of terminology and measurement principles.

2.2. Expert consultation and validation

To ensure the accuracy and reliability of the collected material, the same validation process used in the classroom acoustics survey [38] was applied here. In that earlier study, 138 national experts, including acousticians, researchers, and members of standardization committees, were interviewed to confirm the interpretation of regulatory documents and resolve language ambiguities.

Experts were identified through peer-reviewed publications, conference proceedings, standardization activities, and professional networks in room and building acoustics. The selection process aimed to include researchers, consultants, and members of national or international standardization committees with demonstrated expertise in acoustics regulations or design practices. In some cases, more than one expert per country was contacted to reduce the risk of misinterpretation and to clarify overlapping or ambiguous regulatory frameworks.

The expert consultation process was iterative and conducted primarily between 2024 and 2025 through email correspondence and follow-up discussions. 138 experts were contacted worldwide, resulting in contributions covering 32 countries. Overall, approximately 80 experts actively contributed to the validation process. Not all contacted experts responded or completed the full validation process. The consultation process aimed to validate document interpretation, identify the most authoritative national references, clarify the hierarchy between regulations and standards, and reduce translation ambiguities.

Expert feedback was collected in different forms, including direct email responses, annotated documents, excerpts from standards, references to additional technical reports or guidelines, and clarification of country-specific terminology and regulatory practices. The collected information was analysed qualitatively and used to verify, refine, and cross-check the comparative database rather than as quantitative survey data.

Their feedback established a verified reference network worldwide, which was also employed in this study. The experience and verified knowledge gained from those previous consultations provided a solid methodological foundation, ensuring that the national documents included here are the most authoritative and up-to-date references. When uncertainties arose during this study (for example, regarding overlapping or hierarchical standards), clarifications were obtained through direct correspondence with experts.

The consultation process was not intended as a formal questionnaire-based sociological survey, but rather as a technical validation procedure focused on document interpretation, applicability, and regulatory consistency.

2.3. Unification and database structure

The validation phase also involved document unification, specifically the homogenization and translation of the collected material. Many national regulations were originally written in languages other than English; therefore, official English translations were preferred whenever available. When official translations were unavailable, working translations were prepared and reviewed by national experts familiar with the corresponding regulatory frameworks to confirm their correctness. Whenever possible, translated content was cross-checked by at least one native-speaking expert, while additional experts were consulted in cases involving ambiguous terminology, overlapping regulations, or uncertainties in interpretation.

After validation, all national documents were analysed and classified by scope and the level of detail with which they addressed office environments. Three categories were identified:

- Standards providing distinct targets for various non-residential building types (e.g., schools, hospitals, restaurants, offices);
- Office-specific standards or guidelines addressing administrative or commercial spaces;
- Documents where offices were included within broader building categories (e.g., educational or mixed-use facilities).

Each document was coded and entered into a comparative database that stores country, source, publication year, regulated space types, and quantitative acoustic criteria. This database structure replicates the one developed for classroom acoustics [38], allowing worldwide comparison and temporal tracking of regulatory evolution.

2.4. Integration of speech privacy indicator

In addition to $D_{2,S}$ and $L_{p,A,S,4m}$, the standardised indicator for speech privacy introduced in ISO 3382-3:2022 [20], r_D, was also considered for unoccupied office rooms. This metric represents the only quantitative measure currently available to describe how intelligible speech remains over distance in open-plan offices. By integrating this quantitative indicator with national regulatory values, the resulting database provides a comprehensive overview of global office acoustics requirements.

2.5. Common space types

The present study examines five space types, based on the most prevalent typologies found in regulations and standards: the single-worker office room, the shared office room for 2–4 workers, the open-plan office (at least 5 workers), the meeting room, and the audio/video room.

- The single-worker office room is an enclosed, private workspace. The primary purpose of acoustic treatments within a single-worker office room is to create a calm environment that allows the worker to perform tasks that require focus and concentration [42].
- The shared office room is intended here as a shared, enclosed workspace for 2–4 workers. The primary acoustic challenge is balancing the need for clear internal communication with the requirement for sufficient speech privacy to prevent mutual distraction among workers [43].
- The open-plan office type refers to a large workspace where multiple workers–at least 5 in this study–are simultaneously active at their workstations. The main challenge here is managing the propagation of intelligible irrelevant speech from co-workers, which is a major source of distraction and reduced productivity [20].
- The meeting room is designed for verbal communication and group collaboration. The key acoustic requirements involve ensuring high speech intelligibility within the room so that all participants can understand clearly, regardless of their position [44].
- The audio/video room is a space designed for sound and video content, as well as audio or video calls (at least 2 in-person participants). Its core acoustic objective is to create a controlled environment where both in-person and remote participants experience adequate speech intelligibility [45].

Table 2
Global overview of the national regulations on office indoor acoustics requirements collected in the present study. Documents are organized by country and continent. The common space types assessed in each document are also reported.

Country	Regulation and/or guidance documents	Space type
Oceania		
AU & NZ	AS/NZS 2107–2016 [47]	single-worker room, shared room, open-plan office, meeting room, audio/video room
North America		
CA	TDR [51]	single-worker room, open-plan office, meeting room, audio/video room
US	ANSI/ASA S12.60 [52]	shared room*
Central and South America		
AR	IRAM 4044 [53]	single-worker room, shared room, open-plan office
BR	NBR 10152 [54]	single-worker room, open-plan office, meeting room, audio/video room
Asia		
CN	T/SACS [55]	shared room*, meeting room*
ID	SNI 03-6386-2000 [56]	single-worker room, shared room, meeting room
IN	NBC 2016 [57]	shared room, open-plan office
JP	AIJES-S0001-2020 [58]	single-worker room*
TR	Regulation on the Protection of Buildings against Noise [49]	single-worker room, open-plan office, meeting room, audio/video room
Africa		
ZA	SANS 10103:2008 [59]	shared room*, open-plan office*
Europe		
AT	ÖNORM B8115-3 [60]; VOLV[61]	single-worker room, open-plan office, meeting room
BE	NBN S01-400-2 [62]	shared room*, meeting room*
CH	DIN 18041:2016 [50]	single-worker room, open-plan office, meeting room
DE	DIN 18041:2016 [50]; VDI 2569 [63]	single-worker room, shared room, open-plan office, meeting room
DK	BR 18 [64]	single-worker room, shared room, open-plan office, meeting room, audio/video room
ES	CTE DB-HR [65]	meeting room
FI	SFS 5907:2022 [48]; YMA 2017 [66]	shared room, open-plan office
FR	NF S31-080 [67]; NF S31-199 [68]	single-worker room, open-plan office, meeting room
HU	MSZ 2080:2020 [69]	single-worker room, shared room, open-plan office, meeting room, audio/video room
IE	SDG 02-05-03 [70]	shared room*, meeting room*
IS	IST 45:2016 [71]	shared room
IT	UNI 11532-2:2020 [72]	shared room*
NL	NPR 3438 [73]	single-worker room, open-plan office, meeting room
NO	NS 8175:2019 [74]	shared room, open-plan office, meeting room, audio/video room
PL	PN-B-2151-4 [75]; PN-B-02151-2 [76]	single-worker room, shared room, open-plan office
PT	Decreto-Lei 96/2008 [77]	shared room
RU	SP 51.13330.2011 [78]	shared room
SE	SS 25268 [79]	single-worker room, open-plan office, meeting room
UA	DSN 3.3.6.037-99 [80]	shared room
UK	BB93 [81]; BCO Guide [82]; Guide to Fit Out [83]; FIS Guide [84]	single-worker room, shared room(*), open-plan office, meeting room, audio/video room

* Administration offices in educational buildings.

In all these space types, the primary acoustic need is to ensure sufficient sound insulation and speech privacy from the exterior and the adjacent areas, preventing confidential discussions from being overheard and minimising external distractions. However, assuming proper sound insulation, the focus here is on the indoor acoustic conditions for each space type.

3. Results

Table 2 presents all the documents collected through the methods outlined in Section 2, including the space types addressed by each document. The data is systematically organized by geographical continents—Oceania, North America, Central and South America, Asia, Africa, and Europe—to provide, at first glance, a comprehensive overview of the regulatory framework worldwide. Within each continent, specific countries are listed along with their national codes. Each country is represented by its two-letter code, as specified in ISO 3166-1:2020 [46].

In some countries, a single regulation or standard applies to all non-residential buildings, including workplaces and offices. This is the case, for example, of Australia and New Zealand [47], and Finland [48]. In contrast, other countries rely on building codes that define acoustic requirements for workplace rooms, as in Turkey [49] and Denmark [50]. Moreover, each regulation categorises and defines workplaces differently, leading to variations in the requirements it imposes. Table 2 lists the specific work environments addressed by each regulation, referring to the aforementioned range of common space types (see Section 2.5).

Administration areas in educational buildings, including single-worker and shared office rooms as well as meeting rooms, are marked with an asterisk (*) in Table 2. These spaces are included for completeness, although their specific requirements are more closely considered in school design than in office building design.

Some national standards, regulations, and technical documents define requirements based on the acoustic quality class they address. These classes represent indices of acoustic performance, and in some building codes, compliance is achieved by meeting the requirements of a specific class. As class definitions and labeling schemes vary across countries and documents (e.g., letters, alphanumeric codes), the relevant standard, reported requirement, and corresponding class are specified in the present study whenever necessary.

In Germany, the VDI 2019 [63] addresses the acoustic design of single- and multi-person office spaces, providing guidance on building and room acoustics adapted to their intended use. Room acoustic recommendations for meeting spaces are specified in DIN 18,041 [50]. While, in Finland, the SFS 5907:2022 [48] includes all the requirements defined in the Building Code written by the Ministry of the Environment in 2017

Table 3
Summary of the different methods for defining sound absorption requirements based on geometry and occupancy features, where V is the volume, a the total equivalent sound-absorbing area, $h_{ceiling}$ the height of the room, $\overline{\alpha}$ is the average sound absorption coefficient, and S_{floor} is the floor's surface. Empty rows are retained to ensure consistency and comparability across the database's tables. Information is also provided on the condition (unfurnished, furnished, unoccupied, occupied) of the rooms. Please refer to Table 2 to identify the requirements for the shared office rooms in educational buildings, and refer to the text for further information on the sound absorption requirements.

	Ref.	Sound absorption requirements					Condition
		single-worker office room (A)	shared office room (B)	open-plan office (C)	meeting room (D)	audio/video room (E)	
Oceania							
AU & NZ	[47]	0.4≤T≤0.6	0.4≤T≤0.6	T≤0.4	T≤0.6	0.2≤T≤0.4	furn. unocc.
North America							
CA	[51]	–	–	–	–	–	–
US	[52]	–	T≤0.6	–	–	–	furn. unocc.
Central and South America							
AR	[86]	–	–	–	–	–	–
BR	[54]	–	–	–	–	–	–
Asia							
CN	[55]	–	T≤1.0	–	T≤0.8	–	unfurn. unocc.
ID	[56]	0.6≤T≤0.8	T≤0.4	–	0.6≤T≤0.8	–	furn. unocc.
IN	[57]	T≤0.75	T≤1.0	T≤1.0	–	–	–
JP	[58]	T≤0.6; $\overline{\alpha}$ = 0.2	–	–	–	–	furn. unocc.
TR	[49]	T≤0.8	–	T≤1.0	T≤0.8	T≤0.4	furn. unocc.
Africa							
ZA	[59]	–	–	–	–	–	–
Europe							
AT	[87]	$\overline{\alpha}$ = 0.2-0.25	–	$\overline{\alpha}$ = 0.2-0.25	T = (0.32 logV)-0.17*	–	–
	[61]	$\overline{\alpha}$ >0.25	$\overline{\alpha}$ >0.25	$\overline{\alpha}$ >0.25	$\overline{\alpha}$ >0.25	$\overline{\alpha}$ >0.25	unfurn. unocc.
		$\overline{\alpha}$ >0.3	$\overline{\alpha}$ >0.3	$\overline{\alpha}$ >0.3	$\overline{\alpha}$ >0.3	$\overline{\alpha}$ >0.3	furn. unocc.
BE	[62]	–	T≤1.0	–	T≤1.0	–	unfurn. unocc.
CH	[50]	A/V≥[3.13 + 4.69 log(h/1 m)]$^{(-1)}$	–	A/V≥[2.13 + 4.69 log(h/1 m)]$^{(-1)}$	T = (0.26 logV)-0.14*	–	furn. occ.
DE	[50,63]	T≤0.6	T≤0.4	T≤0.4	T = (0.26 logV)-0.14*	–	furn. unocc.
DK	[64]	T≤0.6	T≤0.6	A≥1.1 S_{floor}	T≤0.6	special project	furn. unocc.
ES	[65]	–	–	–	T≤0.5	–	furn. unocc.
		–	–	–	T≤0.7	–	unfurn. unocc.
FI	[48,66]	T≤0.8	T≤0.8	T≤0.4	0.5≤T≤0.7	–	furn. unocc.
		–	–	T≤0.6	–	–	unfurn. unocc.
FR	[67,68]	T≤0.6	–	T≤0.6	0.4≤T≤0.6	–	–
HU	[69]	T≤1.0	T≤0.8	ISO 22955:2021	T≤0.7	T≤0.5	furn. unocc.
IE	[70]	–	T≤1.0	–	T≤1.0	–	furn. unocc.
IS	[71]	–	T≤0.7	–	–	–	furn. unocc.
IT	[72]	–	T = (0.32 logV)-0.17*	–	–	–	furn. occ.
NL	[73]	A≥1.8 S_{floor}	–	A≥1.8 S_{floor}	A≥1.8 S_{floor}	–	–
NO	[74]	–	T≤0.2 $h_{ceiling}$	T≤0.2 $h_{ceiling}$	T≤0.2 $h_{ceiling}$	T≤0.16 $h_{ceiling}$	furn. unocc.
PL	[75,76]	T≤0.6	T≤0.6	A≥1.1 S_{floor}	–	–	furn. unocc.
PT	[77]	–	T≤0.15 $V^{1/3}$	–	–	–	furn. unocc.
RU	[78]	–	–	–	–	–	–
SE	[79]	T≤0.6	–	T≤0.4	T≤0.6	–	furn. unocc.
UA	[80]	–	–	–	–	–	–
UK	[81]	–	T≤1.0	–	–	–	furn. unocc.
	[82–84]	T≤0.6	T≤0.6	T≤1.0; A/V≥0.21–0.36; $\overline{\alpha}$ = 0.5–0.9	0.4≤T≤1.0	0.4≤T≤1.0	furn. unocc.

*Equations defining target reverberation time with maximum and minimum requirements.

[66], resulting in the most updated document for this country's regulation. Moreover, there are countries like the UK, in which building design is commonly informed by non-statutory guidance documents, notably the BCO Guides [82], which are frequently referenced in contracts and treated as the baseline standard. The BCO Guide to Specification applies to base build (class A) works, the Guide to Fit Out [83] addresses fit-out (class B) works, with intermediate conditions also recognized, while the FIS Guide [84] is occasionally adopted, and only limited relevant guidance is provided in BS 8233:2014 [85].

The most commonly reported parameters were the reverberation time (T), the equivalent absorption area per floor surface (A/S_{floor}), the A-weighted equivalent continuous sound pressure level ($L_{A,eq}$), and the average absorption coefficient ($\overline{\alpha}$). While widely adopted, these parameters are insufficient for the objective characterization of the acoustic quality of open-plan offices (see Section 1.3). Only a few countries (see Section 3.3) include the ISO 3382–3 additional descriptors, such as the $D_{2,S}$ and the $L_{p,A,S,4m}$. The acoustic requirements set by the overall regulatory framework are organized in separate categories: sound absorption, background noise in an unoccupied state, speech privacy and spatial acoustic metrics.

3.1. Sound absorption

Table 3 summarizes the sound absorption requirements derived from the collected national regulations. The data are organized by country, providing an overview of the different approaches and metric types adopted by each country worldwide. Since some requirements depend on the room's volume or the ceiling height, a set of demo environments is defined to provide a consistent summary of acoustic specifications. They

Table 4
A-weighted SPL of background noise type due to building services regulated for single-worker office rooms, shared office rooms, open-plan offices, meeting rooms, and audio/video rooms. Empty rows are retained to ensure consistency and comparability across the database's tables. See Table 2 to identify the requirements for the offices in educational buildings, and refer to the text for further information on the intelligibility requirements.

Country	Ref.	single-worker office room (A)	shared office room (B)	open-plan office (C)	meeting room (D)	audio/video room (E)
Oceania						
AU & NZ	[47]	35–40*	35–40*	40–45*	40–45*	30–40*
North America						
CA	[51]	–	RC 30–35	RC 30–35	RC 30–35	RC 25
US	[52]	–	35*	–	–	–
Central and South America						
AR	[53]	NC 30–35*	NC 35–40*	NC 40–45*	–	–
BR	[54]	40	–	45	35	40
Asia						
CN	[55]	–	40*	–	40*	–
ID	[56]	35*	40*	–	30*	–
IN	[57,88,89]	–	35–40	40–45	–	–
JP	[58]	–	–	–	–	–
TR	[49]	44	–	44	39	34
Africa						
ZA	[59]	35*	40*	–	–	–
Europe						
AT	[61,87]	–	–	–	–	–
BE	[62]	–	40	–	40	–
CH	[90]	–	–	–	–	–
DE	[63]	30	35	35	–	–
DK	[64]	35	35	–	30	30
ES	[91]	–	–	–	–	–
FI	[48]	33	33	33	33	33
FR	[92]	40–45*	–	45–50*	45–50*	–
HU	[69]	–	–	–	–	–
IE	[70]	–	40*	–	40*	–
IS	[71]	–	35	–	–	–
IT	[72]	–	35	–	–	–
		–	38*	–	–	–
NL	[73]	–	–	–	–	–
NO	[74]	–	33	33	33	28
PL	[75,76]	35*	30*	40*	–	–
PT	[77]	–	37	–	–	–
RU	[78,93]	–	50*	–	–	–
SE	[79,94]	–	–	–	–	–
UA	[80]	–	65*	–	–	–
UK	[81]	–	40*	–	–	–
	[82,83]	35–40*	35–40*	45–50*	35–45*	–

*A-weighted SPL of background noise levels, which include both building services and external sounds.

are differentiated by dimensions, occupancy, and activities, as follows. The demo environments are:

- A: a single-worker office room with V<120 m^3, 2.7 m≤ $h_{ceiling}$ ≤3.2 m, furnished, and N = 1 person;
- B: a shared office room with V<120 m^3, 2.7 m≤ $h_{ceiling}$ ≤3.2 m, furnished, and N = 2–4 workers;
- C: an open-plan office with V≥120 m^3, furnished, and N ≥ 5 workers;
- D: a meeting room, furnished;
- E: an audio/video room, furnished.

The sound absorption requirements are applied to each of the five demo environments to facilitate comparison among the different approaches. In this study, the absorption treatments integrated into the building (e.g., wall, ceiling, and floor finishes) and any sound masking systems are kept constant across conditions, while the "furnished" and "unfurnished" states refer only to the presence or absence of mobile office furniture. The reference condition (i.e., occupied or unoccupied) is also reported.

The findings reported in Table 3 are aligned with those reported by Rasmussen et al. [40]. Moreover, in Australia and New Zealand [47], the reverberation time requirement for open-plan offices is minimized for noise control. Table 3 collects high standard requirements for China [55], while the lower standard requirement is set at T<1.0 s for meeting rooms or T<1.2 s for offices in the 500—2000 Hz range, in both cases in empty conditions. All the reverberation times for India [57] are specified at 500 Hz. Turkey [49] requires at least an acoustic performance class C. In Austria [87], the sound absorption coefficient $\overline{\alpha}$ is specified for 250—4000 Hz. Switzerland (and Germany) [50] distinguish between single-worker and open-plan offices depending on ceiling height: for h>2.5 m, values are given in the table, whereas for h<2.5 m DIN 18,041 [50] requires A/V≥0.2 (single-worker) and A/V≥0.25 (open-plan). Moreover, in Germany, the VDI 2569 [63] defines reverberation time requirements (250–4000 Hz) for single-worker offices, shared offices, and open-plan offices in an unoccupied state, whereas the requirements for meeting rooms are specified in DIN 18,041 [50] and apply in an occupied state. All the reported values for the VDI 2569 [63] are in class A. In Finland, SFS 5907:2022 [48] defines an unfurnished condition requirement for open-plan offices, intended to mean an open-plan office with fixed absorbers at the room boundaries but without the user's own furniture. The reverberation time requirements in Finland correspond to SFS 5907:2022 [48] class A2. In France [67,68], T≤0.8 s at 125 Hz applies, with individual and open-plan offices classified as type 3 (low-collaboration) and meeting rooms as type 2 (collaborative work). In Hungary [69], requirements vary by ceiling height and occupancy: single-worker office rooms with h<3.2 m and more than two workers, or with one to two workers, are included in Table 3, while h≥3.2 m requires A/V≥0.15. The Netherlands [73] specifies absorption in 125—4000 Hz, Norway [74] and Iceland [71] apply class C, and in the UK [81] Table 3 reports values for new construction, with refurbished buildings limited to T≤1.2 s, while the [84] provides A/V and $\overline{\alpha}$ requirements for open-plan offices, within and between a working cluster. The values of T reported in Table 3 for the UK refer to the objective targets for privacy speech grade at 500 Hz as defined in the Guides to Fit Out [83], and aligned with the BS 8233:2014 [85]. It is interesting to note that only a few countries adopt the target values of reverberation time as a function of the hall's volume.

3.2. Background noise (unoccupied state)

In this work, background noise refers to the permanent noise in the room in the absence of workers originating from building services (e.g., ventilation, heating, cooling, and artificial sound-masking systems). External environmental noise sources are beyond the scope of this study. Background noise measurements shall represent the acoustic conditions occurring during normal working hours. Therefore, any time-dependent operating modes of building services (such as night-time reductions or alternative control settings) shall be disregarded. For the same reason, measurements shall be conducted under the corresponding daytime operational conditions of building services. Artificial sound-masking systems, when part of normal operation, may be included in the measured $L_{p,A,B}$ as designed components of the acoustic environment. For clarity and regulatory consistency in the following sections, where regulations specify generic ambient/background noise limits without distinguishing between sources, the requirement is interpreted to apply to both building services and external noise sources.

Table 4 presents the international comparison of recommended or mandatory A-weighted sound pressure levels for background noise requirements in various office settings. A critical aspect is the inconsistent use of acoustic metrics and descriptions across countries. While most regions use the A-weighted sound pressure level, American standards, such as those in the US and Canada, often employ Noise Criterion (NC) or Room Criterion (RC) curves, which are frequency-dependent metrics.

Table 5
National regulations and guidelines adopting ISO 3382–3 indicators, showing the parameters, classes, and conditions defined for open-plan office acoustics. Refer to the text below the table for further information on the adopted classification schemes.

Country	Ref.	$L_{p,A,S,4m}$ (dB)	$D_{2,S}$ (dB)	r_D (m)	r_C (m)	$L_{p,A,B}$ (dB)	class	condition
DE	[63]	≤47	≥8	–	–	–	class A	furn. unocc.
FI	[48]	–	–	≤6	–	≤42	class A2	furn. unocc.
		–	–	≤8	–	≤42	class A2	unfurn. unocc.
FR	[68]	–	>7	–	–	–	type 3	furn. unocc.

In Canada, the TDR [51] specifies the room criterion (RC) for different office types, while in Argentina, the IRAM 4044 standard [53] specifies the noise criterion (NC). In Austria, the VOLV [61] establishes two limits for the equivalent continuous A-weighted sound level ($L_{A,eq}$), depending on the degree of space concentration: $L_{A,eq}$ ≤50 dB for concentrated spaces and $L_{A,eq}$ ≤65 dB for mildly concentrated spaces. In Finland, the SFS 5907 [48] provides values for open-plan offices under both furnished and unfurnished conditions, with a limit of $L_{A,eq}$ ≤33 dB in the unfurnished case. In the UK, the BB93 [81] also defines an indoor ambient noise level of up to 45 dB(A) for refurbished offices.

3.3. Speech privacy and spatial acoustic metrics

Few national standards have developed dedicated acoustic classification systems for open-plan offices, including metrics for distraction and the spatial decay of speech levels. Each of these countries adopts its own design philosophies and evaluation criteria. As also shown by [39], only a few countries include the ISO 3382–3 indicators in their national regulations, along with subjective classifications of acoustic conditions. These requirements are collected in Table 5.

The Finnish standard SFS 5907 [48] includes guidelines for open-plan offices. This document defines acoustic categories ranging from class A to class D, with subjective ratings spanning from “excellent” to “poor”. It also specifies distraction distances, with $r_D = 8$ m for unfurnished and $r_D = 5$ m for furnished open-plan offices. This is in line with publication 28/2019 of the Ministry of the Environment [95], which recommends that the STI should remain below 0.5 at distances exceeding these values from an omnidirectional loudspeaker.

In France, background noise levels are defined by the NF S 31–199 standard [68], with specifications linked to the type of space, including single-worker office rooms and open-plan offices as low-level collaborative work (type 3), and meeting rooms as collaborative work (type 2). The NF S 31–199:2016 [68] standard departs from a generic classification scheme and instead defines requirements based on the intended use of the space. Acoustic comfort is therefore characterized for different office-use scenarios, ranging from telephone-intensive activities (e.g., call centers) to more collaborative work environments. Overall, these classification systems rely on different acoustic parameters and performance thresholds to characterize open-plan office conditions.

In the UK, the FIS Guide [84] requires, for open-plan offices, an STI≤0.4 between working clusters, and an STI≥0.6 within working clusters.

In Germany, the revised standard VDI 2569:2019 [63] addresses both single-worker rooms and open-plan offices, introducing three acoustic classes (A, B, and C) that represent different levels of acoustic performance and design intent. Class C corresponds to a minimum acceptable level of comfort, while Class A represents the best achievable acoustic conditions for open-plan offices. According to VDI 2569:2019 [63], the parameters used in this standard exclusively refer to the acoustical conditions of the room in connection with furnishing. Acoustical comfort at the workstation is influenced by other key determinants, e.g., the number of workstations per area, content-related zoning of the workstations, and the presence of masking noise. Masking noises are not part of the classification procedure.

In SFS 5907 [48], Class A2 corresponds to the Finnish building code [95]. In the French standard, type 3 corresponds to a low-level collaborative work office, whereas a type 2 collaborative work office corresponds to $D_{2,S} > 9$ dB. In contrast, the German standard sets lower requirements for $L_{p,A,S,4m}$, allowing for more collaborative and lively work environments.

4. Discussion

The comprehensive analysis of national regulations presented in Tables 3 and 4 reveals variability in the metrics and target values specified for office acoustics worldwide. Across all continents, reverberation time and background noise limits generally remain the most frequently prescribed acoustic parameters for office rooms (see Tables 3 and 4). The continued prevalence of reverberation time and background noise criteria may also reflect their long-standing inclusion in national building regulations, the relative simplicity of their measurement procedures, and their historical use in enclosed-room acoustic assessment prior to the development of spatial acoustic indicators for open-plan offices. These findings are consistent with earlier comparative reviews of office regulations [39,40]. Reverberation time is often defined either as a fixed upper limit or as a function of room volume, ceiling height, or occupancy. However, the worldwide reliance on reverberation time requirements contrasts with experimental and field evidence demonstrating that reverberation time alone does not adequately describe speech privacy in open-plan offices [16,32,33]. Large-scale field studies have shown that speech propagation in such environments deviates significantly from diffuse-field assumptions, with spatial decay rates varying widely depending on absorption, screens, and layout [6,7,16]. As a result, compliance with reverberation time targets does not necessarily ensure acceptable speech privacy or reduced distraction, a limitation already recognized during the development of ISO 3382–3 [24]. The persistence of reverberation time requirements is also evident in regulations addressing open-plan offices, where criteria originally developed for enclosed rooms are often applied without adaptation. This mismatch helps explain why satisfactory acoustic performance is not always achieved in practice, despite formal compliance with the regulations.

Background noise requirements exhibit considerable variability, both in numerical limits and in the adopted descriptors (see Table 4). While most European and Asian regulations specify A-weighted equivalent sound pressure levels, some North, Central, and South American standards (e.g., TDR in Canada [51], and IRAM 4044 [53] in Argentina) rely on RC or NC curves, reflecting a stronger focus on mechanical system noise control. Despite these methodological differences, the target values generally fall within comparable ranges, suggesting a broad international consensus on acceptable noise levels from building services. To avoid ambiguity between different noise sources, the background noise criteria considered in this study were limited to building services, as external noise levels depend primarily on façade sound insulation and environmental noise regulations. Existing criteria for external noise ingress are often inconsistently interpreted, and evidence on occupant satisfaction, especially with open windows, remains limited. The vast majority of regulations define background noise under unoccupied conditions and explicitly exclude noise associated with activity. Experimental and field studies have shown that low background noise levels can enhance speech intelligibility and increase distraction in open-plan offices, provided that spatial sound attenuation is sufficient [2,5,25]. The results, therefore, confirm that background noise criteria should be considered alongside spatial acoustic indicators. Moreover, the background noise ($L_{p,A,B}$) in ISO 3382–3 refers to the steady, non-intermittent sound from building-service systems (e.g., HVAC), environmental noise entering through façades or openings, and sound caused by artificial speech masking sound systems running in the office. It explicitly excludes noise from workers, whose activity level and behaviour cannot be standardised. For completeness, it is worth noting that ISO 22955:2021 [96], developed under ISO/TC 43/SC 1 "Noise," addresses activity-based acoustic design for open-plan offices. The purpose and methodology of ISO 22,955 differ fundamentally from ISO 3382–3 (developed under ISO/TC 43/SC 2 Building Acoustics), as ISO 22,955 provides design recommendations and target values for intelligibility and discretion during normal occupancy, where background noise may include workers' activities. Because its framework is activity- and noise-oriented rather than room acoustics, ISO 22,955 is not included in the quantitative comparison presented in this work.

The results of the present work highlighted the limited inclusion of spatial acoustic metrics in most national regulations. The findings demonstrate that, while there is an internationally accepted scientific method for assessing open-plan offices, national regulatory bodies are still in the early stages of adopting indicators related to the spatial decay of speech levels. Future research should focus on evaluating how the adoption of spatial acoustic indicators influences real-world office performance and user satisfaction. Long-term field studies and post-occupancy evaluations could further support the translation of ISO 3382–3 requirements into local regulatory frameworks.

As far as the authors know, this is the first study to review office acoustic target values across several countries. Rasmussen et al. [40] presented a review that included 10 countries. This review included 32 countries. In addition, the authors conducted in-depth interviews, as noted in Ref [40]. Therefore, this work is unique regarding both methodology and extent. This study is highly necessary for authorities and professionals so they can more easily begin discussing future developments in target values. Although the authors conducted in-depth interviews with professionals from over 30 countries, this work still suffers from the weakness that individual professionals may provide a biased picture of national practices. Some of the cited documents may not represent the most authoritative document applied in that country. It is important that the national target values are now openly published so that this review can be updated when significant developments in the target levels or documents occur.

5. Conclusions

This paper provides an overview of current national regulations and guidelines worldwide for indoor office acoustics. The work collected documents from over 30 countries on room acoustic targets in various office room types. Despite evidence linking speech intelligibility and distraction to reduced comfort and performance in workspaces, results reveal that most national regulations still rely primarily on parameters such as reverberation time and background noise levels. Indicators outlined in ISO 3382–3 are adopted in only a limited number of countries (e.g., Finland, France, and Germany). The findings support and highlight the need to integrate additional acoustic descriptors, such as distraction distance (the distance from the speaker at which the Speech Transmission Index falls below 0.50) and comfort distance (the distance at which the speech level falls below 45 dB $L_{A,eq}$), into national frameworks.

CRediT authorship contribution statement

Virginia Tardini: Writing – review & editing, Writing – original draft, Visualization, Methodology, Investigation, Data curation. **Giulia Fratoni:** Writing – review & editing, Writing – original draft, Visualization. **Jack Harvie-Clark:** Supervision, Conceptualization. **Valtteri Hongisto:** Writing – review & editing, Writing – original draft, Supervision, Project administration, Investigation, Funding acquisition, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Data availability

Data will be made available upon request.

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