

# SOUNDSCAPING THE FUTURE LIBRARY

*Explorations of the auditory library experience*

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# ABSTRACT

*This research investigates from an atmospheric viewpoint how architectural elements contribute to the creation of distinct soundscapes for quiet work, group work, and leisure zones in a library setting. The goal of this research is to lay the groundwork for decision making in the redesign of the KB, the National Library of the Netherlands.*

*This research is focused on atmospheric qualities of the library typology with a focus on the auditory. Several studies already exist about soundscapes, but these are often set in either urban surroundings or in other building typologies. This research fills that gap in knowledge by focussing on library soundscapes. The study is guided by the central question: "How can the auditory experience of library users be enhanced in redesigning the soundscape for a 21st century library?"*

*To address this question, the research*

*is structured around three sub-questions, the first of which goes as follows: What should a 21st century library's auditory atmosphere be like according to library users? The second one is: What spatial strategies can enhance a library's soundscape? Lastly, the third question is: How are these strategies applied in existing libraries to enhance specific soundscapes?*

*The methodology of the first two sub-questions is a literature review, while the third is examined through case study analysis. By combining insights from these investigations, this study aims to provide a framework for designing libraries that align with user needs through atmosphere-driven architectural strategies in soundscape design.*

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## atmosphere

**noun** [ c ]

the character, feeling, or mood of a place

## soundscape

**noun** [ c ]

the mixture of different sounds that are heard in a particular place

“The universal concert is  
always in progress, and  
seats in the auditorium  
are free.”

– R. Murray Schafer



*(Murray Schafer, 1993)*

# 1 INTRODUCTION

## 1.1 SETTING OF THIS RESEARCH



The setting of this research is the National Library of the Netherlands and the starting point of this project.

This library was founded in 1798 and was intended to serve as a repository for the nation's printed heritage (KB, n.d.-b). Materials form the "Nederlandcollectie" form a comprehensive archive of everything published in or about the Netherlands.

The collection of KB has grown immensely over the past decades (KB-catalogus, n.d.). The library has over 4 million printed works in their collection, resulting in 120 kilometers of printed heritage stored in the current KB building (KB nationale bibliotheek, 2025)

Every year there are new items being added to the KB's collection (Nieuw Boekenmagazijn Voor De KB, 2025). To be prepared for the future expansion of the collection, KB has decided to build an off-site repository for the works. Together with Office Winhov, a design has been made for 'the little jewel chest for a special collection' in the Harnaspolder, close to the Hague. The current KB building, designed in the 70s by architecture office OD205, will be mostly empty when the collection is no longer housed in it. Other organizations which currently reside within the building, like the literature / children's books museum, are also leaving (NOS, 2023).

With these enormous changes in program, the library needs to be redesigned. The municipality of the Hague wishes the area to be a multifunctional place, where living, working, greenery and relaxation all come together (Gemeente Den Haag, 2025). The typology of the library in general has undergone

large changes as well over the last decades, leaving an opportunity for the KB to be redesigned as a modern library.

In the 20th century, collections were crucial elements of the library typology (Latimer, 2018). In KB this has been the case as well, with their millions of collected works. Other elements that Latimer mentions, like quietness and imposingness, also fit the current KB building well. Their house rules state that users ought to be quiet when using the reading rooms (Vind Je Weg in De KB, n.d.). Visitors are not allowed to enter the reading rooms unless they become a member or register for a reading room pass first. One could argue that this creates a rather unwelcoming atmosphere.

The movement away from the collections programme could create possibilities for the KB to transform into what Latimer would call a '21st century library', where connections with people, information and internet are prioritised over housing collections in a library. The building could become more welcoming since there would be less security needed without the collections present.

A future library, as Latimer describes it, has both quiet and social spaces. This would mean that a certain zoning plan is necessary were the auditory experience will play a big role. How can one design a library where quiet and louder atmospheres co-exist?

This research will dive into the concept of soundscapes and what it means to design one for a library. It will explore library sounds from a people-oriented perspective, moving from atmosphere in architecture to soundscapes specifically. The study is guided by the central question:

*"How can the auditory experience of library users be enhanced in redesigning the soundscape for a 21st century library?"*

To address this question, the research is structured around three sub-questions:

1. *What should a 21st century library's auditory atmosphere be like according to library users?*
2. *What spatial strategies can enhance a library's soundscape?*
3. *How are these strategies applied in existing libraries to enhance specific soundscapes?*

Several studies already exist about soundscapes, but these are often set in either urban surroundings (Kang et al., 2013) or in other building typologies (Helmeffalk & Hultén, 2017). Research in library design also rarely focusses on the auditory aspect of library architecture. In architectural design, acoustics are often overlooked and implemented only at the last moment, when necessary, in the interior design phase (Fowler, 2015). The dominance of visual design traditions makes auditory integration difficult. This research aims to address the knowledge gap by examining how auditory design principles can be applied specifically within the context of library architecture.

20 <sup>TH</sup> CENTURY	21 <sup>ST</sup> CENTURY
<i>imposing</i>	<i>welcoming / relaxed</i>
<i>stability</i>	<i>flexibility / transience</i>
<i>solitude</i>	<i>communal / choice</i>
<i>quiet</i>	<i>zoned / quiet - social</i>
<i>status quo</i>	<i>innovations</i>
<i>collections</i>	<i>connections</i>

Table 1: Library buildings: A changing typology. The changing character of the library (Latimer, 2018)

Image 1: The reading room of KB (Image by Roos Aldershoff)



Image 2: The entrance of KB (Own image)

## 1.2 ATMOSPHERE IN ARCHITECTURE

Before narrowing the focus of this research to the auditory dimension of library architecture, a broader, more holistic approach was initially taken by exploring the atmospheric qualities of architecture.

The concept of atmosphere in architecture has been defined in various ways. One of the earlier mentions was by Manning (1991), who described it as a set of environmental qualities that contribute to the character, mood, or ambience of a building or a specific space within it. These qualities include factors such as temperature, lighting, and sound levels.

Sufar and other scholars (2012) defines atmosphere as the interplay between users and the physical environment, emphasizing how spatial ambience influences user behaviour.

Karabašević (2016) explores the atmospheric dimensions of architecture, emphasizing that our bodies register and respond to elements such as light, heat, sound, and odour even before we consciously perceive a building as a whole. In this view, architectural experience extends beyond the purely visual.

More recently, Peterson (2023) characterizes atmospheric landscapes as spaces with a distinct sensory presence or feel.

Even though there is little research about the atmospheres of libraries in particular, the topic has been investigated for other, more commercial programmes like stores, restaurants and hotels. Since the 70s, researchers have investigated the atmospheres of stores. Over the last 30 years, the number of articles on the subject has especially grown

(Lyu et al., 2022).

Lyu and other scholars (2022) found a dozen of individual definitions for atmosphere in their systematic literature review on store atmosphere: according to Kotler (1974) store atmosphere refers to the intentional design of a retail environment to evoke specific emotional and behavioral responses in customers, achieved through various sensory dimensions such as sight, sound, scent, and touch. It is considered a key component of the overall store image (Donovan & Rossiter) and reflects the physical environment, encompassing ambient factors like temperature, lighting, music, and scent (Baker et al., 1994). These environmental cues act as stimuli that influence consumer behavior (Berman & Evans, 1995), with aesthetics and ambience—such as color, music, and the degree of crowding—playing a significant role in shaping the customer experience (Chebat et al., 2010).

Despite being drawn from different time periods, these perspectives share a common understanding: architectural atmosphere directly affects how users experience a space.

For this research, the definition of atmosphere provided by the Cambridge Dictionary will be adopted:

### **Atmosphere**

*“the character, feeling, or mood of a place or situation.”*

There are several studies which have proven that a carefully designed store atmosphere can lead to a sense of place and place attachment (Lyu et al., 2022). These elements play in turn an important role in driving desirable customer behaviours.

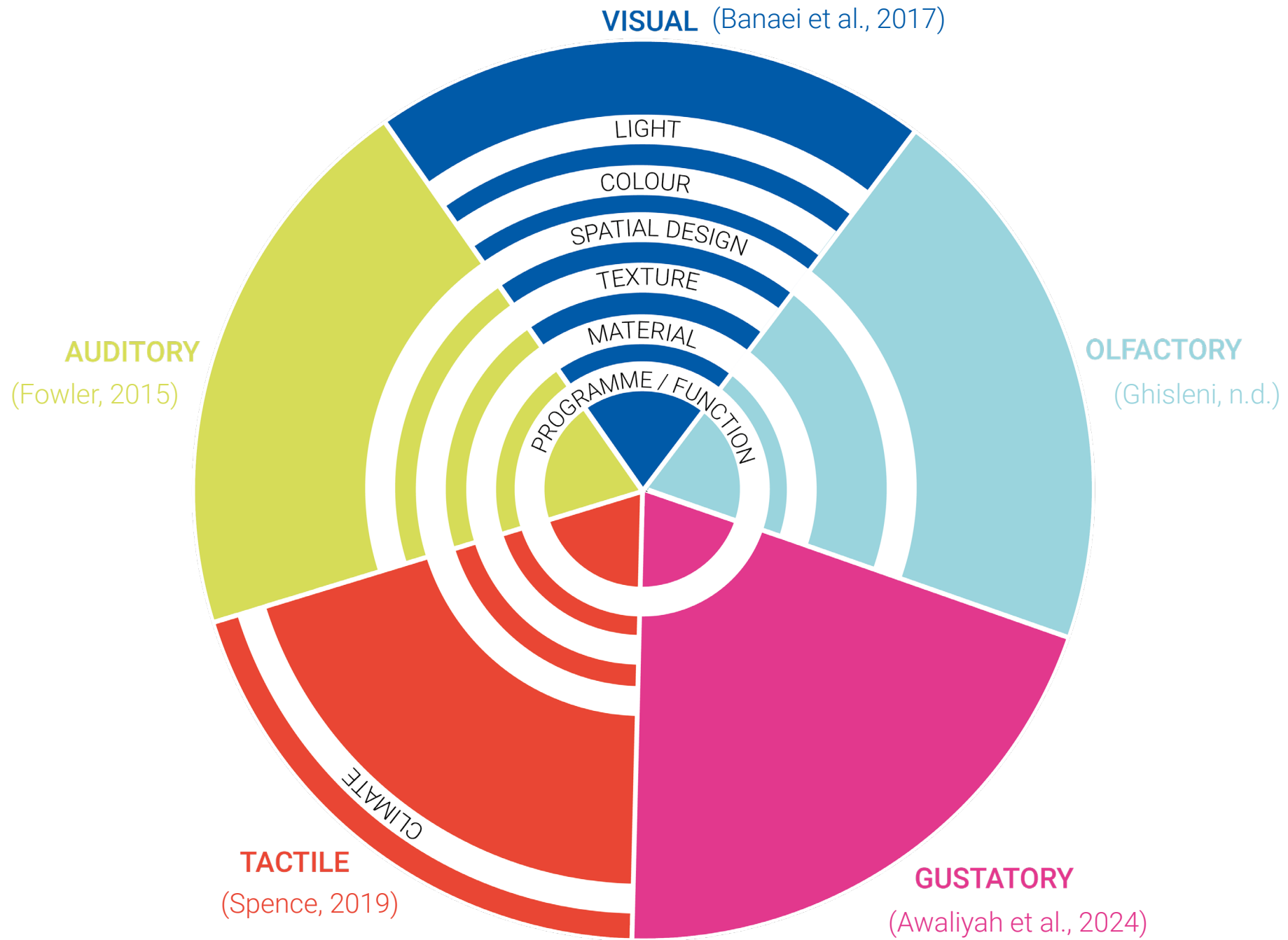


Diagram 1: Elements of Architecture that can be experienced through visual, auditory, tactile, gustatory and olfactory senses (own image)

### 1.3 EXPERIENCING WITH THE SENSES

When looking at the definitions in 1.1, the conclusion can be drawn that the atmospheric experience of architecture is often not only a visual one, but auditory, olfactory, tactile and gustatory as well.

From all five senses, encounters with different stimuli result in many different experiences. Architectural decisions can influence some of them, as shown in diagram 1. Heiling (1992) ranked their ratios, as can be seen in image 1. In both visualisations, the visual sense has the most influence. However, the second largest sense has proven very influential for the library typology (Cox 2019; Peterson 2023; Cohen, 2025).

Helmefalk and Hultén (2017) argue that multisensory cues are just as important atmospheric stimuli as visual ones. They found that stores which are not only visually appealing but also have a well designed tactile, olfactory and auditory landscape have a positive effect on the user's behaviour: it makes shoppers more likely to buy something and increases their mood. Likewise, Sayin et al. (2015)

found that introducing ambient soundscapes—such as birdsong or classical music—into a Paris underground car park increased perceived safety among users, even though the sounds were recognized as artificial.

Spence (2019) advocates for more research in auditory aspects of architecture and the built environment, as sound design in architecture currently often revolves around suppress unwanted sounds. Owen (2019) also expresses concerns about the absence of integrated sound design in architecture in their article. Owen states that this lack of attention to the auditory partly accounts for the global health crisis linked to noise pollution, which adversely affects sleep, health, and overall well-being. To further illustrate the importance of soundscape: auditory aspects of hospitals can even have impact on the recovery of hospital patients (Evans & Johnson, 2000; Burkus, 2016; Borzykowski, 2017). Studies indicate that specific soundscapes and music can enhance patient recovery across various architectural environments, including healthcare facilities,

where excessive background noise is a significant issue, and open-plan offices, where employees frequently cite noise distractions as a common concern.

Cohen (2025) argues that quiet spaces are still very much wanted, especially in academic libraries. Cox (2019) emphasizes the importance of quiet learning spaces in these types of libraries as well. Cohen and Cox found that libraries are rich sensory landscapes. More on their research will be discussed later in chapter 4.

To conclude, the bodily experiences of (library) atmospheres are important for users' mood, health, actions and concentration. This is why this article will focus on ways to improve these experiences where possible. The main focus of this research will be the auditory, the sense of hearing.

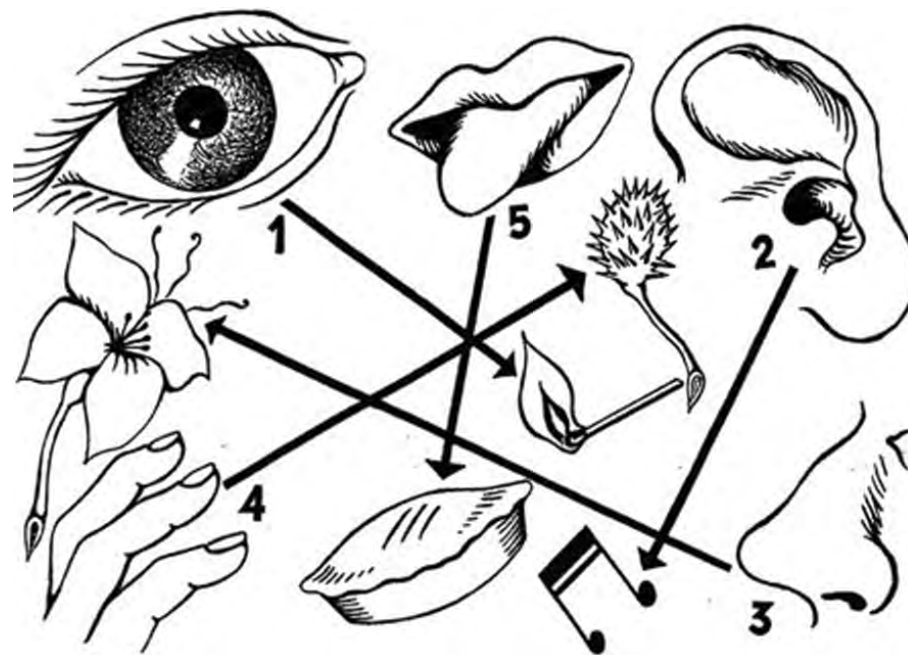
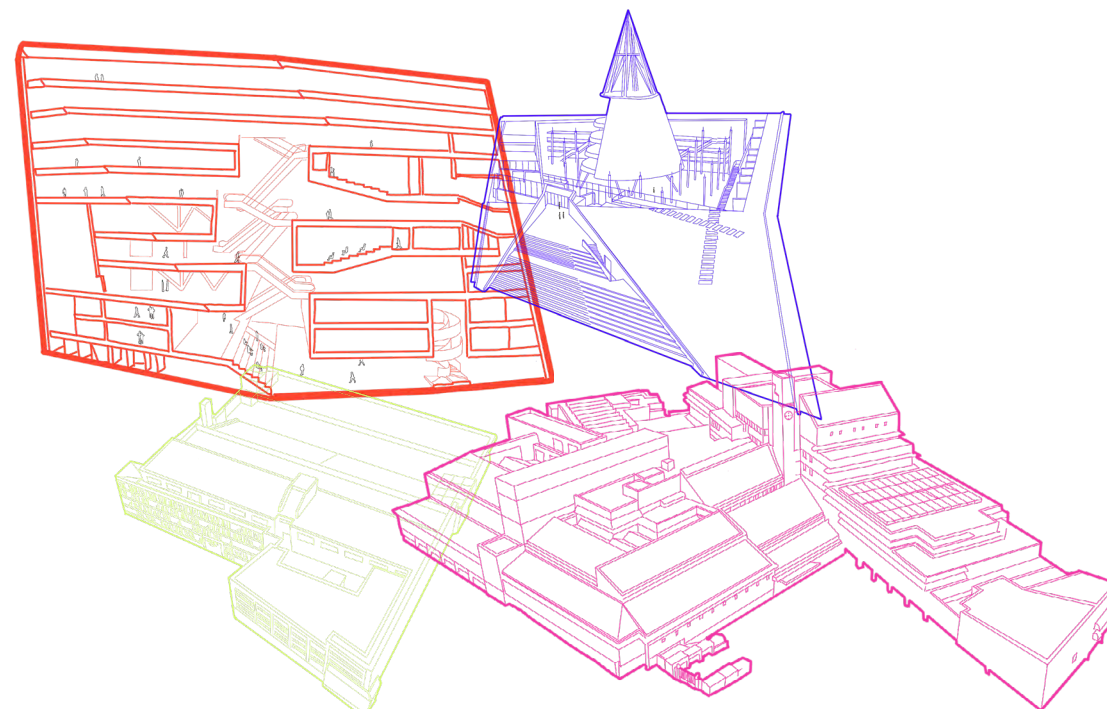


Image 3: Heiling (1992) their ranking of the senses. Vision 70%, auditory 20%, olfaction 5%, tactile 4% and gustatory 1%

## 2 METHODOLOGY



### 2.1 LITERATURE STUDY

To answer the main research question, “How can the auditory experience of library users be enhanced with physical design elements for different zones in a library’s soundscape?”, the study has been divided into two parts. The first part consists of a literature study, which aims to provide the theoretical foundation for the second, practice-based phase of the research.

This literature review seeks to understand the user perspective on the auditory experience of library spaces and to gather insights into existing theories and strategies in soundscape design. It will address the first two sub-questions:

*What should a 21st-century library’s auditory atmosphere be like according to library users?*

*What spatial strategies can enhance a library’s soundscape?*

Sources will be gathered from the peer-reviewed database ScienceDirect, which hosts journal articles and book chapters. Additional sources will be accessed via the TU Delft WorldCat catalogue, Google Scholar, and ResearchGate.

### 2.2 CASE STUDIES

Once a theoretical framework has been established, the second phase of the research will examine four case studies:

- Forum Groningen (2019): A large public library with a shopping centre-like design.
- DOK OPEN Delft (2018): A smaller-scale public library conceived as the city’s communal “living room.”
- British Library (1875): The UK’s national library, functionally comparable to the Koninklijke Bibliotheek (KB) in The Hague.
- TU Delft Library (1998): An academic library known for its distinctive zoning and innovative approach to book storage.

These libraries were selected based on their accessibility for on-site visits within the timeframe of the research. Scheduled visit dates are:

- Monday, 14 April 2025 – Forum Groningen
- Monday, 6 June 2025 – TU Delft Library
- Wednesday, 18 June 2025 – DOK OPEN Delft
- Tuesday, 29 July 2025 – British Library

In each library, various zones will be identified and analyzed. The following aspects will be observed:

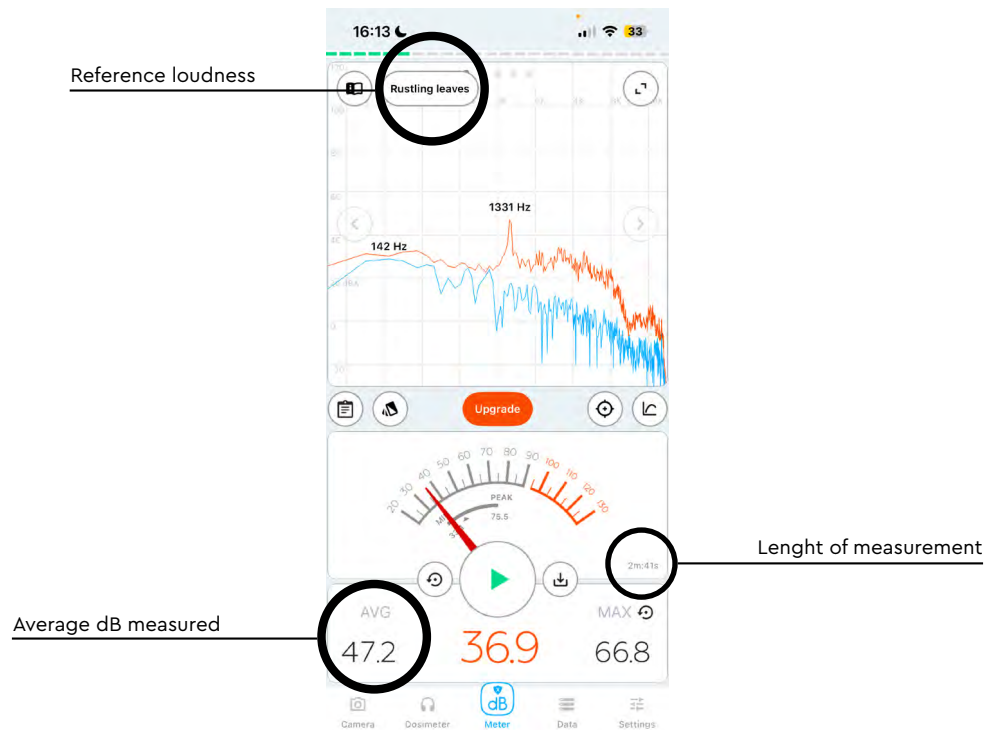
1. Zone type (quiet / silent / collaborative / leisure)
2. Loudness level (in dB)
3. Sound types (as perceived by the researcher)
4. User activities (e.g., working, talking, using headphones)
5. Interior materialization (floor, wall, ceiling, furniture)
6. Spatial design of zone transitions (closed vs. open)

For the zone types, there are several

possibilities. Stanwicks (2016) identified three types of zones in their (academic) library: quiet, silent, and collaborative. In quiet zones, infrequent and soft talking was allowed; silent zones were strictly silent, with no conversations permitted; and collaborative zones were intended for group work. In addition to these zone types, this research will also consider leisure zones, where users go to take a break, and the entrance zones of the case studies.

Based on these observations, measurements, and photographic documentation, an answer will be developed for the third sub-question:

*“How are these strategies applied in existing libraries to enhance specific soundscapes?”*



### 2.3 DATA COLLECTION

For the first two sub-questions, data will be collected online through a literature review using Scopus (Elsevier) and Google Scholar. These platforms will be used to find academic articles related to soundscapes, atmospheric design, user perception in libraries, and library design.

For the case studies, a physical, on-site approach will be taken. Specific zones within the libraries will first be identified—such as individual quiet work areas, collaborative zones where conversation is encouraged, and leisure spaces like cafés. In each of these zones, the ambient sound level will be measured using the Decibel X application on a smartphone. This will provide a general indication of loudness in each area, allowing for a comparative analysis between different zones.

In addition to measuring decibel levels, 20-minute auditory

observations will be conducted in each zone, during which notes will be taken on the types of sounds that can be heard. In the image the interface of the Decibel X App is being displayed. The app shows the average dB (down left corner), the current dB (down mid) and the maximum dB measured in the session (down right corner). In the upper half of the screen, a graph is made of the current measurement. In the top left corner, a reference category is mentioned for the loudness of the current measurement.

Observations will also include the materiality of walls, floors, and ceilings, which will be documented through notes and photographs to assess their potential acoustic impact.

The presence and behavior of users in each zone will also be recorded, including whether they are wearing



### 2.4 DATA ANALYSIS

headphones and the nature of their activities.

Photographs of the spatial layout will be taken to support further analysis of floorplans and sections. Particular attention will be paid to how transitions between different zones are designed and experienced.

If possible, an interview will be arranged with the architects of the DOK Library (DOK Architecten). This is of particular interest because, at first glance, the library appears to lack a designated quiet work area. If such a zone was originally intended, it would be valuable to explore the design intentions behind it and understand why the space may not function as intended. The results of the literature review will be collected and summarized both in text and diagram.

The case study observations will be analyzed through categorizing the heard sounds and translating them into a table. In this table, the location, overall loudness, types of sounds and the loudness per sound are being visualized.

The overall experience, transitions between zones and remarkable elements of the library visited will be added to the report in both text and image.

Image 5: Interface of Decibel X App (own screenshot)

Image 6: Silent Floor in Forum Groningen (image by Roos Aldershoff)

### 3 SOCIAL AND SCIENTIFIC IMPACT

Bossaller et al. (2020) describe the 21st century as an 'age of distraction'. This research aims to contribute to library architecture by exploring how auditory-based design can support focus, comfort, and emotional engagement.

The outcomes of this research can be implemented not only in the redesign of KB, but in other (national) libraries as well. The findings can provide a framework for improved future library soundscapes, enhancing the experience of both library users as staff.

When effectively applied, the outcomes of this research have the potential to enhance the user experience, making libraries more inviting and relevant in today's overstimulated society. If proven effective, the findings could be included in

governmental guidelines to ensure usage in future library design. In doing so, it can also help redefine the public image of libraries as contemporary, sensory-aware, and human-centered spaces.



## 4 LITERATURE STUDY

### 4.1 USER'S PERSPECTIVES ON LIBRARY SOUNDSCAPES

#### 4.1.1 UNWANTED SOUNDS

Many studies have been done on user experiences of academic libraries the past decade. Garner et al. (2021) write that noise problems have risen immensely in the last 20 years, mainly because libraries are not only repositories for collections anymore but also centres for learning and research. Especially when libraries also host events, this caused problems with the noise levels in reading rooms or study areas. In search of lower noise levels, students often make use of closed-off study rooms. In all focus groups, student mentioned the great value and need of quiet space.

Cohen (2025) also argues that quiet spaces are still very much wanted, especially in academic libraries. They studied learning commons in DeSole University and found that there were three types of student activities: quiet concentration, socialization/relaxing and computer

use. They analysed the room types needed for these activities, which were quiet study rooms, rooms with computer use and cafés.

In Cox (2019) their research, students elaborated on their favourite spot in their library. Student valued their ability to control the soundscape of the space, often through the use of headphones. These work well to suppress small unwanted sounds. Especially talking was mentioned often as an unwanted sound.

Y. Li et al. (2024) did a text mining analysis of Zhihu, an online Q&A platform. Noise issues were one of the big topics found in their analysis. The mentions of noise issues on the Q&A platform were mostly about sounds and behaviour of other library users, highlighting the recurring conflict between social needs and noise management in modern libraries. They suggest that libraries invest



in advanced soundproofing technologies to ensure the co-existence of both silent zones and social areas.

#### 4.1.2 AMBIENT SOUNDS

Not all sounds are unwanted; some can help shape the atmosphere or ambience of a space. Peterson (2023) held in-dept interviews with library users talking about their feelings and experiences in a public library in Germany. They found that the sound of rain on skylights can help users feel comfortable, connected to outside and homey. Gentle sounds of others, especially working or conversing quietly, can be a positive addition to the library's soundscape as well. It creates feelings of shared silence and togetherness. Garner et al. (2021) found that students in academic libraries value this idea of 'alone togetherness' as well.

Cox (2019) found that during

a break, some students would actively search out louder sounds outside, to wake themselves up and change their mood. Even traffic sounds or other auditory stimuli that one could see as 'brown noise' would work to this aim.

Image 7: Technical University Delft Library (image by Greg Holmes)



## 4.2 SPATIAL STRATEGIES FOR ARCHITECTURAL SOUNDSCAPE DESIGN

Fowler (2015) argues that architecture can be perceived as an auditory construct. He compares theories on sounds in architectures from two core viewpoints: aural architecture, a theory from Blesser & Salter and Soundscape theory by Schafer & Truax.

Aural architecture theory treats sound as a tool for spatial composition (Blesser & Salter, 2006). It emphasizes how spatial design, materiality and design elements can influence the auditory experience of a space. Blesser & Salter introduce active and passive strategies in sound design. Active ways of affecting the auditory experience can be through placing a new sound source, for instance chimes or a fountain. Passive methods can be including reflective surfaces or alcoves in a design. These surfaces can in fact distort the sound in a space, making them appear smaller, larger, closer or further away. This can create the impression that the

sound source sits just beside the perceiver but can also make an acoustic dead zone.

Murray Schafer (1993) perceives soundscapes through the lens of acoustic ecology: the study of sounds in relationship to human lives and societies. He states that acoustic ecology must be studied on location and never in a laboratory. The study of acoustic ecology should always precede acoustic design.

*“The universal concert is always in progress, and seats in the auditorium are free.” – R. Murray Schafer*

To perceive this universal concert, the first step Murray Schafer takes is ‘Ear cleaning’; stop making sounds for a while and listen to the world around you. Document what you hear, count how many times you hear something. ‘A tourist in soundscape’ is the second step. Murray Schafer argues that acoustic

designers should always keep a diary of sounds that they hear. ‘Soundwalks’ are the third step. Here, a soundscape is explored using a guiding map (a ‘score’). The listener does not only listen to but also interact with the soundscape by walking over different surfaces and tapping on materials they come across during their walk.

Murray Schafer praises especially older architectural design for their acoustic qualities, like the whispering galleries in the dome of the St. Paul’s Cathedral in London and the ancient Greek amphitheatres.

*“In a quiet world, building acoustics flourished as an art of sonic invention. In a noisy world it becomes merely the skill of muting internal shuffles and isolating incursions from the turbulent environment beyond.” – R. Murray Schafer*

Murray Schafer has proposed four lessons for acoustic design:

1. A respect for the ear and the voice – when the ear cannot hear softer sounds or the voice cannot be heard, the environment is harmful
2. An awareness of the sound symbolism – which is always more than functional signalling
3. A knowledge of the rhythm and tempi of the natural soundscape
4. An understanding of the balancing mechanisms by which an eccentric soundscape may be turned back on itself

Schafer sees nature as an artist in the world’s soundscape. In his soniferous garden, the sounds are created by water and wind powered movement.

*Image 6: Greek Amphitheater ‘le theatre’ (image by Frédéric Boissonnas)*

### 4.3 LITERATURE REVIEW CONCLUSIONS

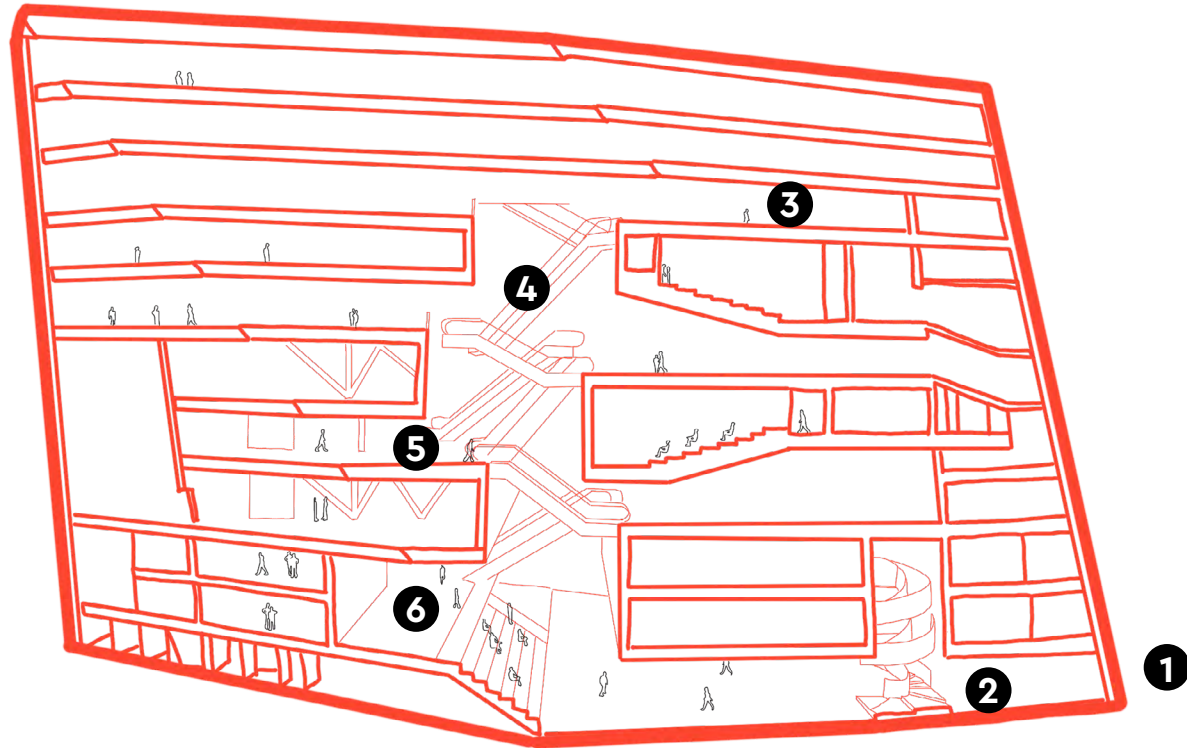
To conclude, recent studies show that noise management is a key concern in academic libraries, as their roles have expanded beyond quiet study to include collaboration and events. Students consistently express a strong need for quiet spaces, often seeking out closed-off rooms or using headphones to manage sound (Garner et al., 2021; Cohen, 2025; Cox, 2019). Unwanted noise, especially talking, remains a major issue (Y. Li et al., 2024). At the same time, some ambient sounds—like rain or quiet conversation—can enhance the atmosphere and foster a sense of shared focus (Peterson, 2023; Garner et al., 2021). To support diverse needs, libraries should offer a mix of silent, social, and ambient zones, using layout and soundproofing strategies effectively.

In terms of strategies for sound design, Murray Schafer differs from Blesser and Salter in his approach to sound as a concept. Whereas Murray

Schafer focuses his techniques on cultivating ways of listening, Blesser and Salter direct their strategy toward the manipulation of existing soundscapes through the absorption, reflection, or masking of sounds.

# 5 CASE STUDIES

## 5.1 FORUM GRONINGEN

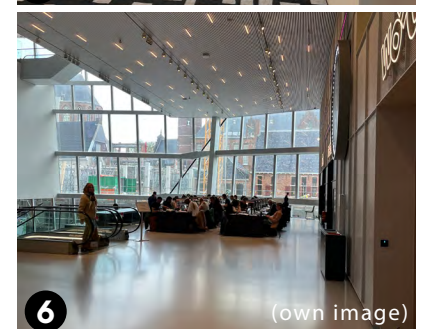
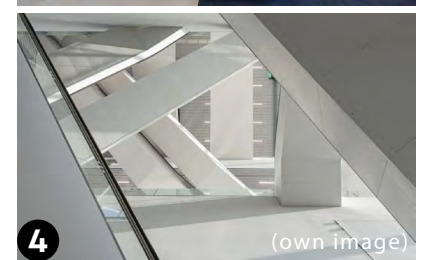
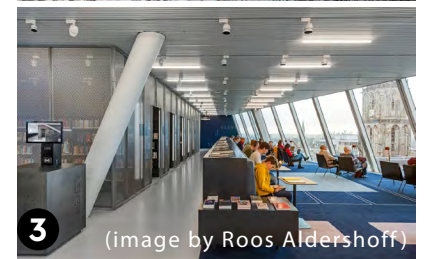
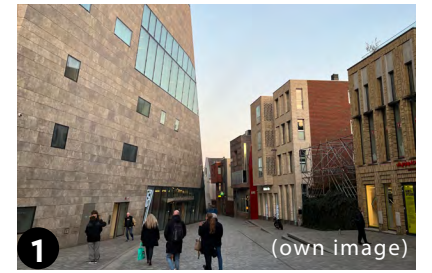


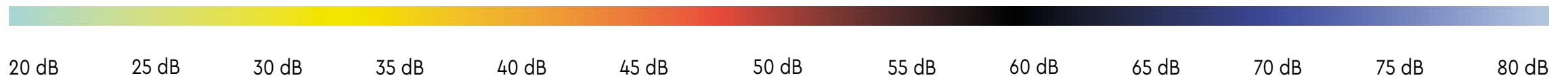
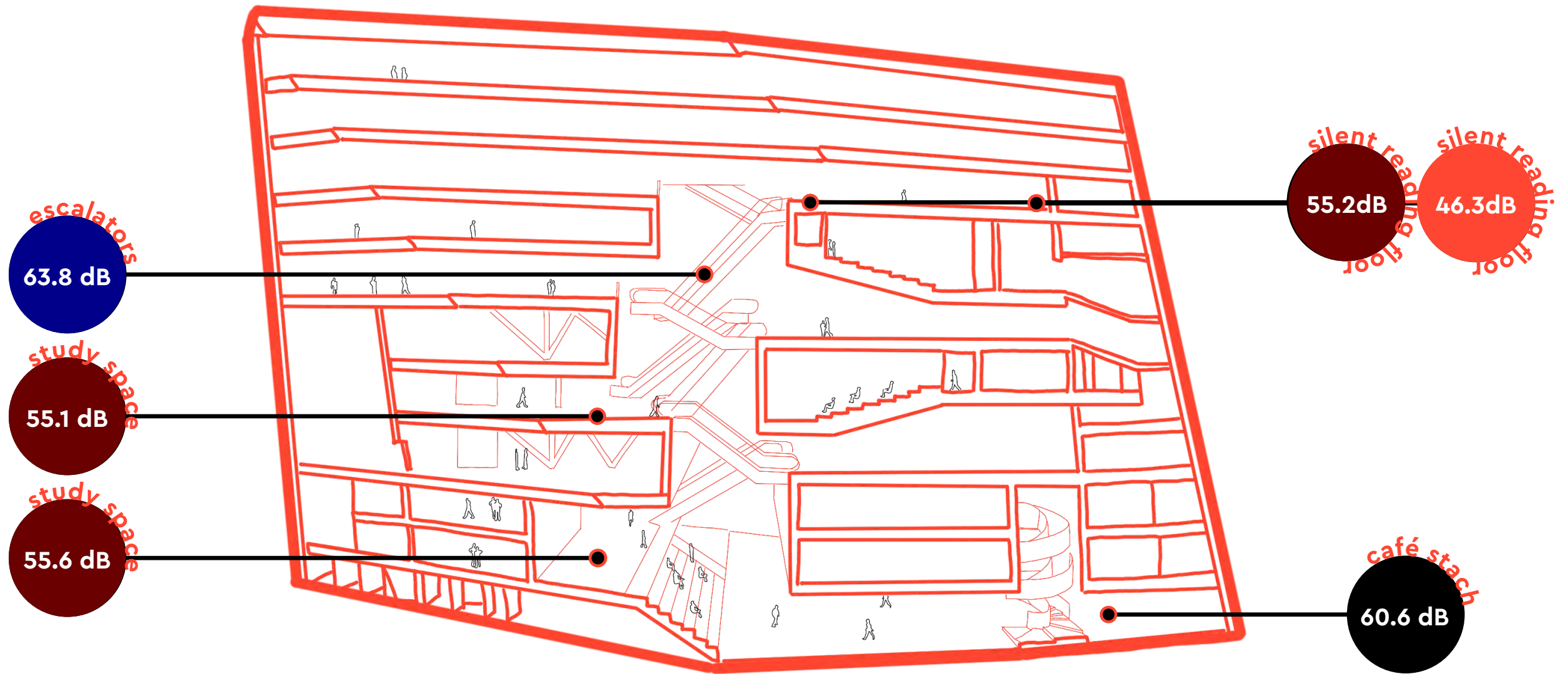
Name	<b>Forum Groningen</b>
Architect(s)	<b>NL Architects deMunnik-deJong-Steinhauser architec- tencollectief</b>
Type	<b>Public Library, Cultural centre</b>
Location	<b>Groningen (City), Netherlands</b>
Building year	<b>2019</b>

### SPATIAL AND AUDITORY OBSERVATIONS

Forum Groningen is situated in the city centre, a predominantly pedestrianized area with limited motorised traffic, where bicycles and foot traffic dominate. As a result, the general sound level in front of the entrance remains relatively low, averaging around 55 dB. However, ongoing urban development in the area has introduced a temporary increase in noise due to a nearby construction site, which serves as the primary source of sound in the external environment. Within the building, escalators contribute a consistent and prominent auditory presence. The highest average sound levels were recorded while standing on the escalators themselves, highlighting their impact on the internal soundscape. In the ground-floor café, a variety of overlapping sound sources were identified, including background jazz music, guest conversations, a vacuum cleaner in use, and the intermittent beeping of security gates as patrons entered with borrowed library materials. Material choices throughout the building appear to be thoughtfully aligned with functional zoning. On floors where reading is the primary activity, large area rugs cover

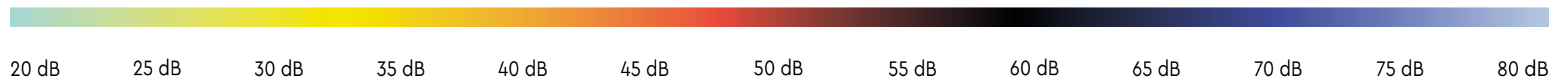
most of the floor surfaces, contributing to a more subdued acoustic environment. The central atrium features consistent use of acoustic wood panels on the ceiling, which likely play a role in managing reverberation across the open vertical space. The café, however, diverges from this material palette. Spatial transitions between zones in Forum Groningen are gradual. The open-plan atrium allows for a continuous flow between floors, avoiding harsh separations between functional areas. It is also important to note that Forum is a multifunctional facility, serving not only as a library but also as a museum, cinema, café, bar, and general public meeting space. On the designated “silent” floor, intended for individual study, external sounds—such as chatter and mechanical noise from the escalators—remain audible, particularly near the edges of the atrium. However, these sounds diminish progressively toward the rear of the floor, where the environment becomes markedly quieter and more conducive to focused work.





	Loudness	Building site	Car	Music	Chatter	Footsteps	Escalators	Wind
1. Forum Entrance	54.9 dB							
2. Café STACH	60.6 dB							
3. Silent floor	55.2 dB front 46.3 dB back							
4. Escalator	63.8 dB							
5. Study floor	55.1 dB							
6. Study floor	55.6 dB							

Measurements done at 14/04/2025 between 09:00-12:00.

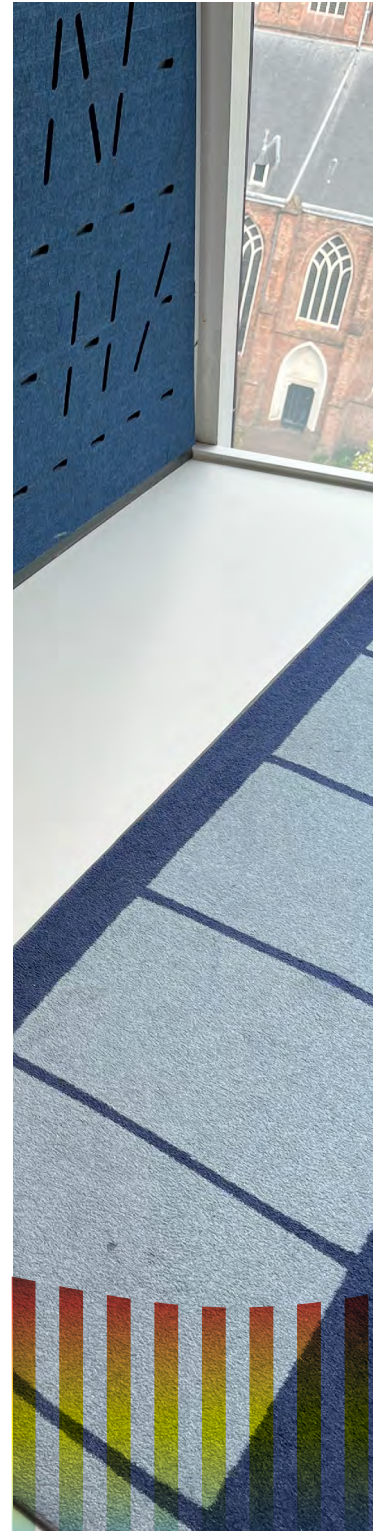




1. Entrance Forum Groningen, natural stone and glass materials (own image)



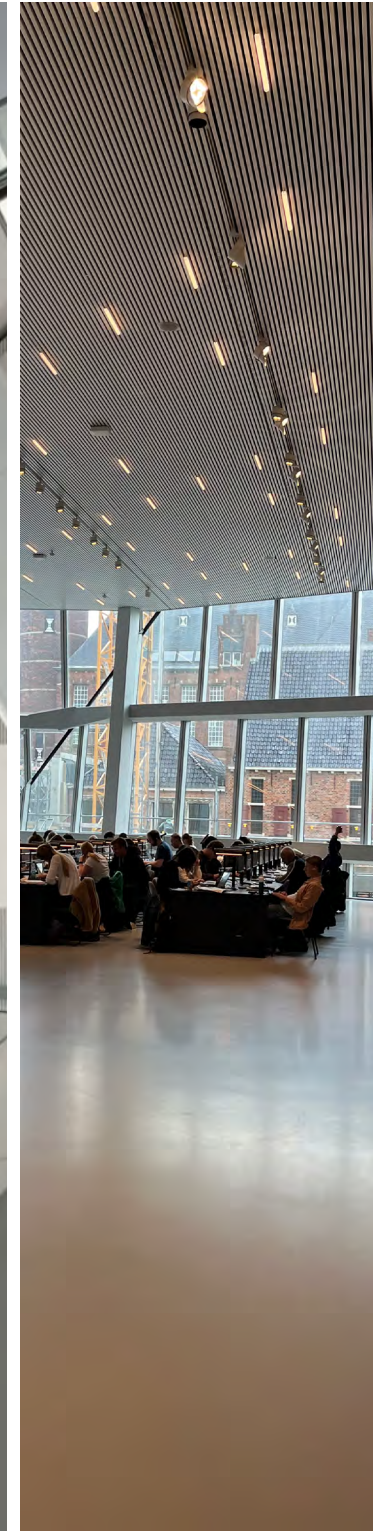
2. Café STACH, marmer stone, smooth wall tiles and wood (own image)



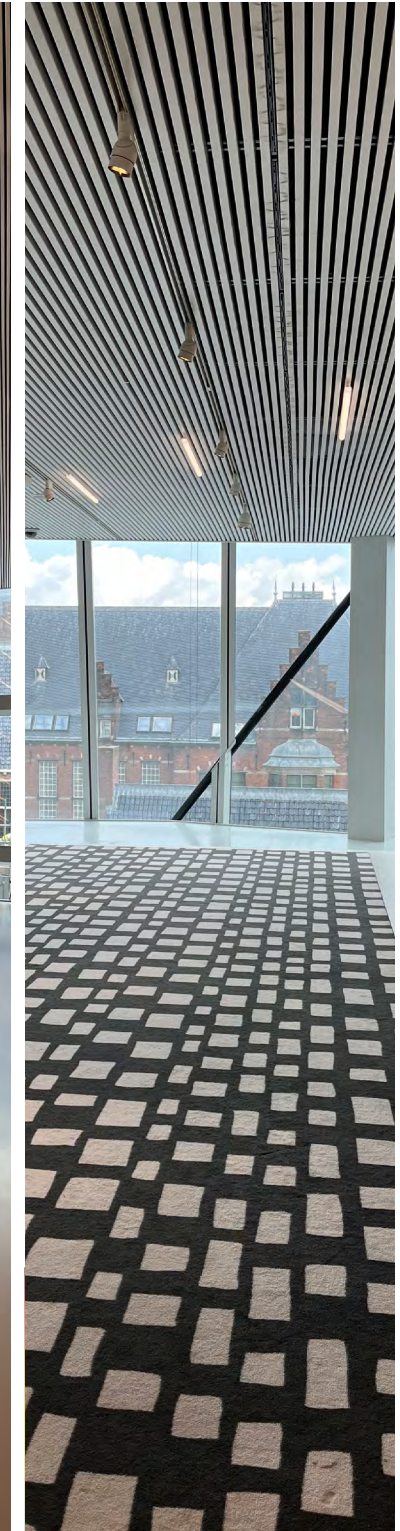
3. Silent floor, cast floor topped with rugs, vilt-like acoustic wall materials (own image)



4. Escalators, stainless steel stairs with glass railings, acoustic ceiling panels (own image)

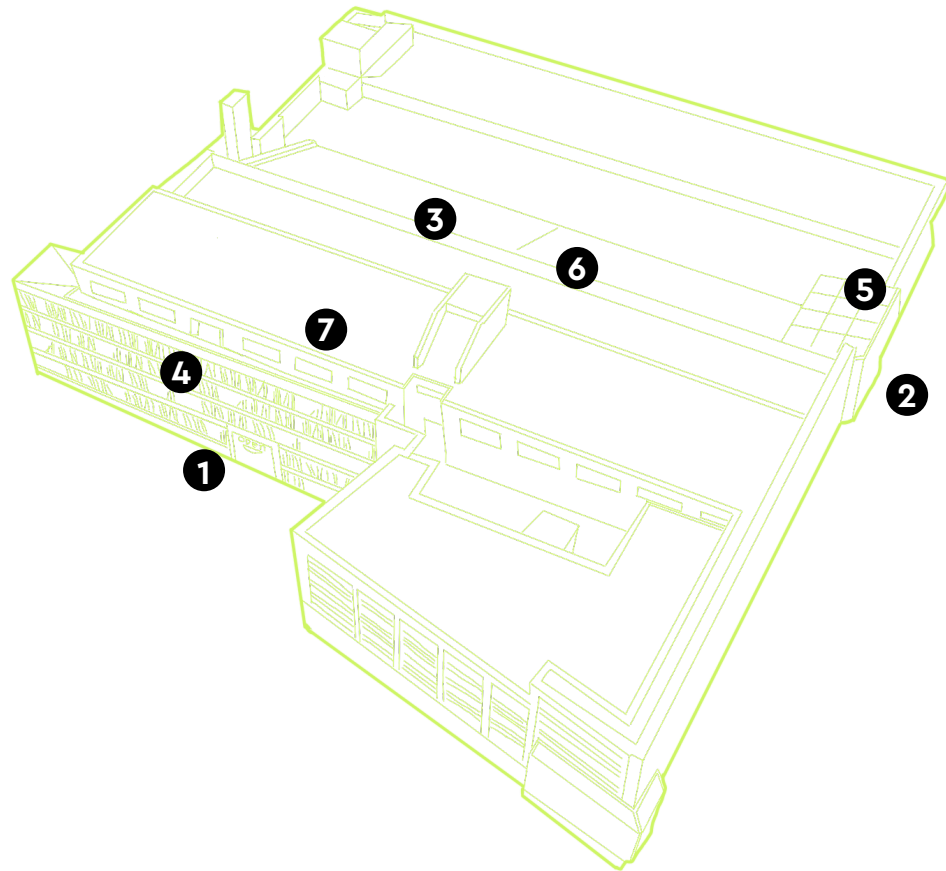


5. Study floor, cast flooring, large glass window and acoustic ceiling panels (own image)



5. Study floor, cast flooring, large glass window, large rug and acoustic ceiling panels (own image)

## 5.2 DOK OPEN



Name	<b>DOK Open</b>
Architect(s)	<b>DOK Architecten</b>
Type	<b>Public Library</b>
Location	<b>Delft, Netherlands</b>
Building year	<b>2007</b>
Area (m <sup>2</sup> )	<b>430</b>

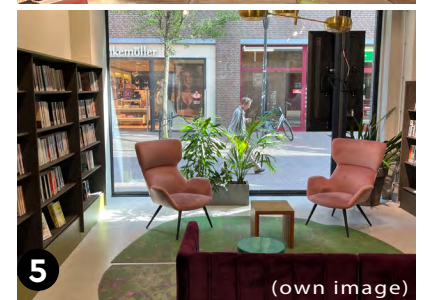
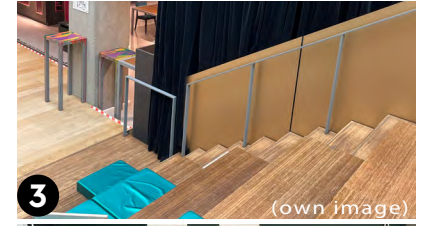
### SPATIAL AND AUDITORY OBSERVATIONS

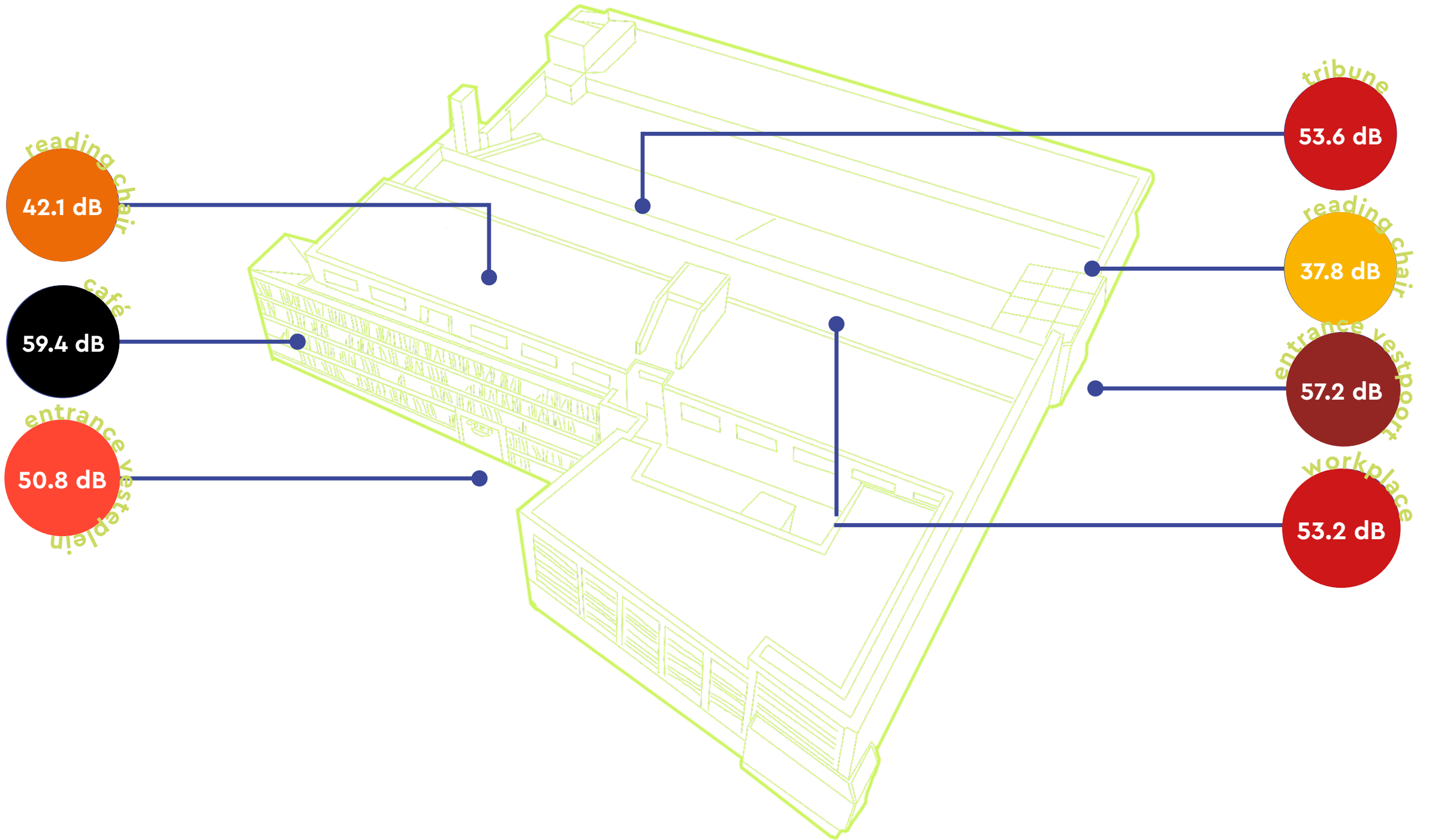
The DOK Open Library, designed by DOK Architects, is a public library that embraces a comprehensive interpretation of the library concept, much like Forum Groningen. Its offerings include traditional library services, a café, workspaces equipped with free Wi-Fi and charging stations for laptops, maker spaces, music studios for workshops, a central stage area, and a multimedia section.

Visitors can enter the library through two distinct entrances. The main entrance is situated at Vestplein, directly across from the theatre De Veste and the Pathé Delft cinema. Upon entering through this way, guests are greeted by a vibrant café, which opens an hour later than the library but quickly fills with visitors. Behind the café lies a theatre area featuring a glass ceiling reminiscent of a conservatory, which fills the heart of the building with natural light. This space is very lively, filled with the sounds

of the café and the chatter of individuals working at nearby tables.

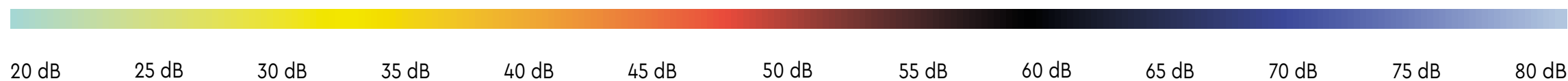
As one moves toward the library's edges, the sound levels decrease. Tables are marked with stickers indicating if they are designated for working with electronic devices or for reading. The workstations, which provide electrical outlets, are primarily situated around the lively central area. Conversely, the outer sections feature an assortment of reading chairs, benches, and nooks. In the library's far corners, the sound from the stage area is largely muffled, likely due to the presence of bookshelves, sound-absorbing rugs, and walls or columns that separate the sound source from the listeners. The quietest corner (place 5) was located near the secondary entrance (which was reportedly closed on the day of assessment), with measured noise levels reaching only 37.8 dB.





	Loudness	Chatter	Footsteps	Moving chair	Coffee machine	Dishes	Slamming door	Creaking stairs
1. Entrance Vesteplein	50.8 dB							
2. Entrance Vestpoort	57.2 dB							
3. Tribune	53.6 dB							
4. Café	59.4 dB							
5. Reading chair ground floor	37.8 dB							
6. Working places first floor	53.2 dB							
7. Reading chair first floor	42.1 dB							

Measurements done at 18/06/2025 between 09:00-11:00

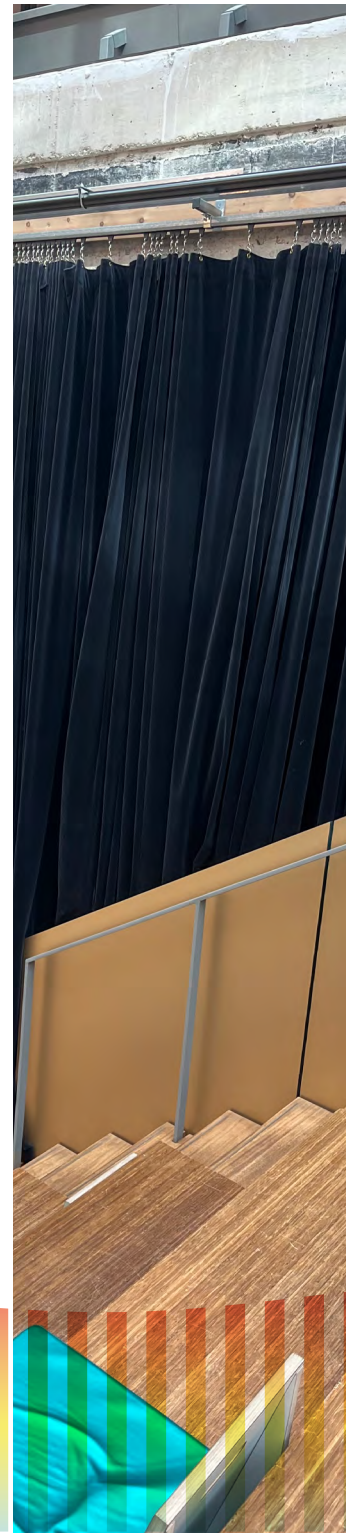




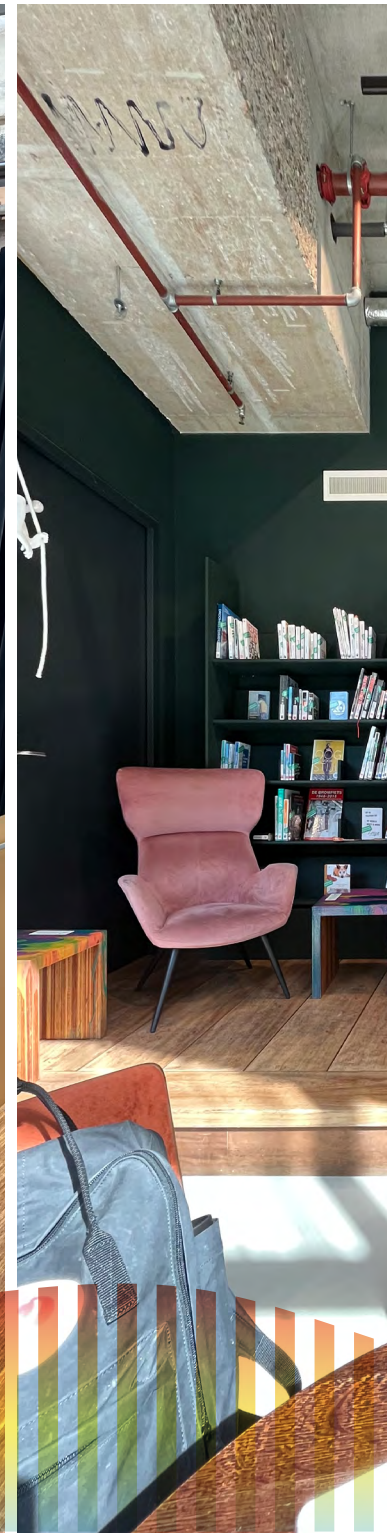
1. Glass facade and stone pavement (own image)



2. Facade consists of masonry and glass windows, similar stone pavement(own image)



3. Tribune made out of wood, curtains of soft, thick fabric, bare concrete structure (own image)



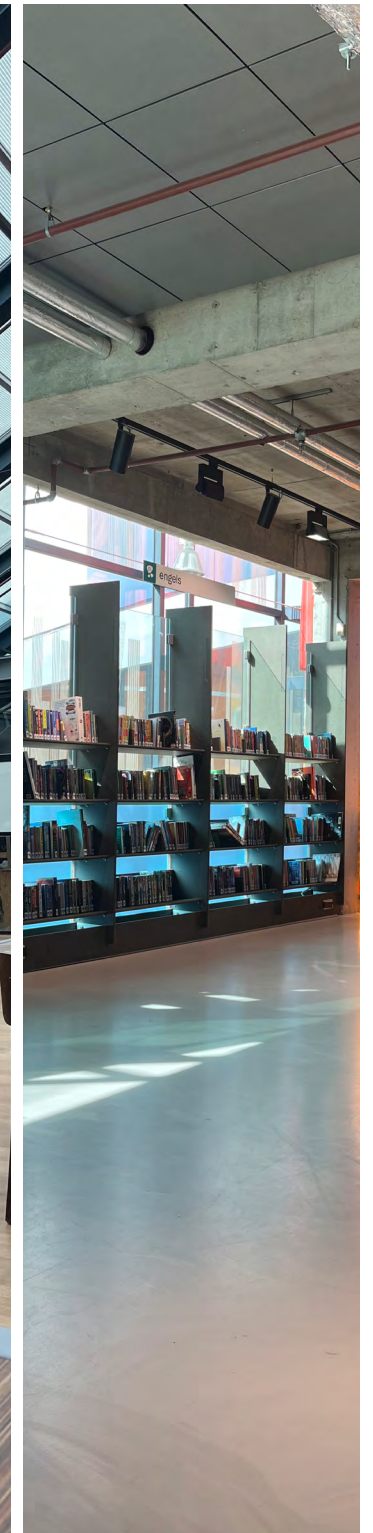
4. Wood and cast flooring, bare concrete ceiling (own image)



5. Cast floor with rug on top, glass facade, concrete ceiling with acoustic panels (own image)

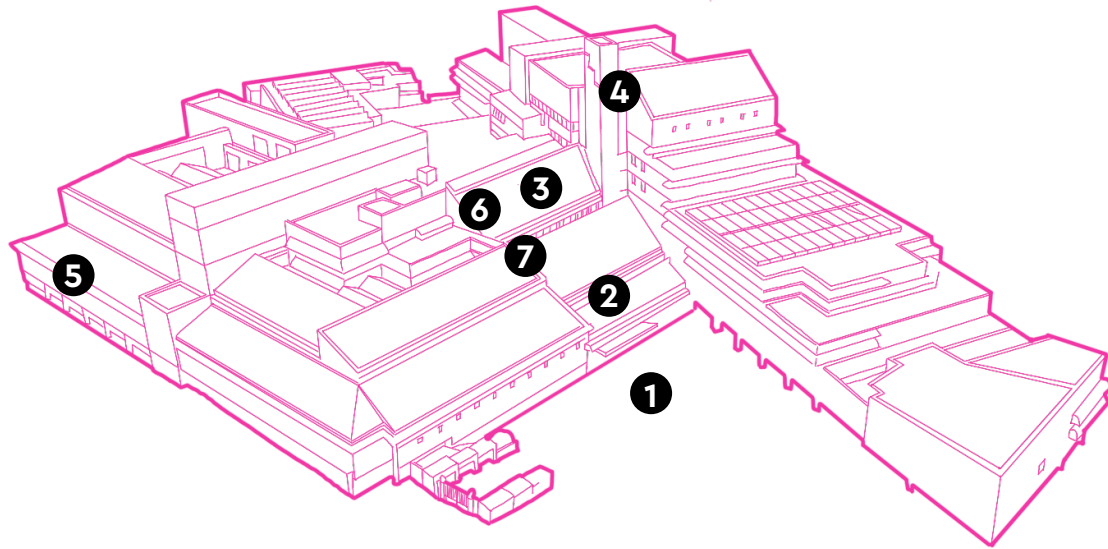


6. Glass ceiling, wooden floor, bare concrete structure (own image)



7. Cast floor, bare concrete ceiling and glass facade (own image)

### 5.3 BRITISH NATIONAL LIBRARY



Name	<b>British National Library</b>
Architect(s)	<b>Sir Colin St John Wilson</b>
Type	<b>National Library</b>
Location	<b>London, England</b>
Building year	<b>1997</b>
Area (m <sup>2</sup> )	<b>120.000</b>

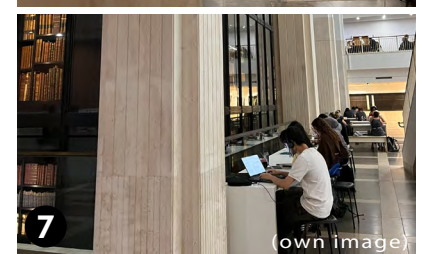
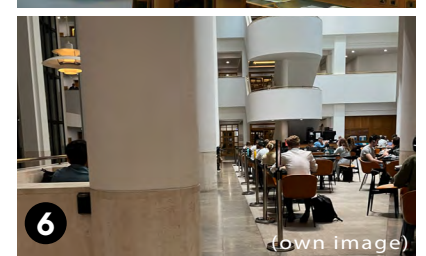
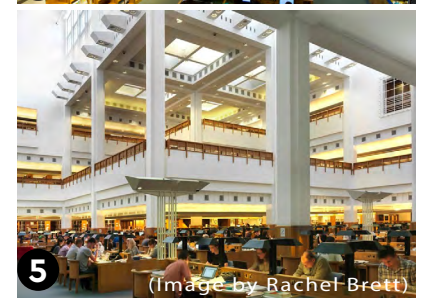
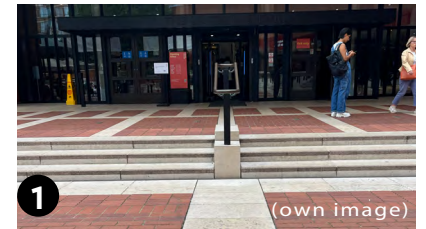
#### SPATIAL AND AUDITORY OBSERVATIONS

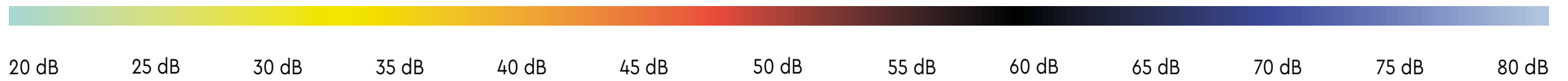
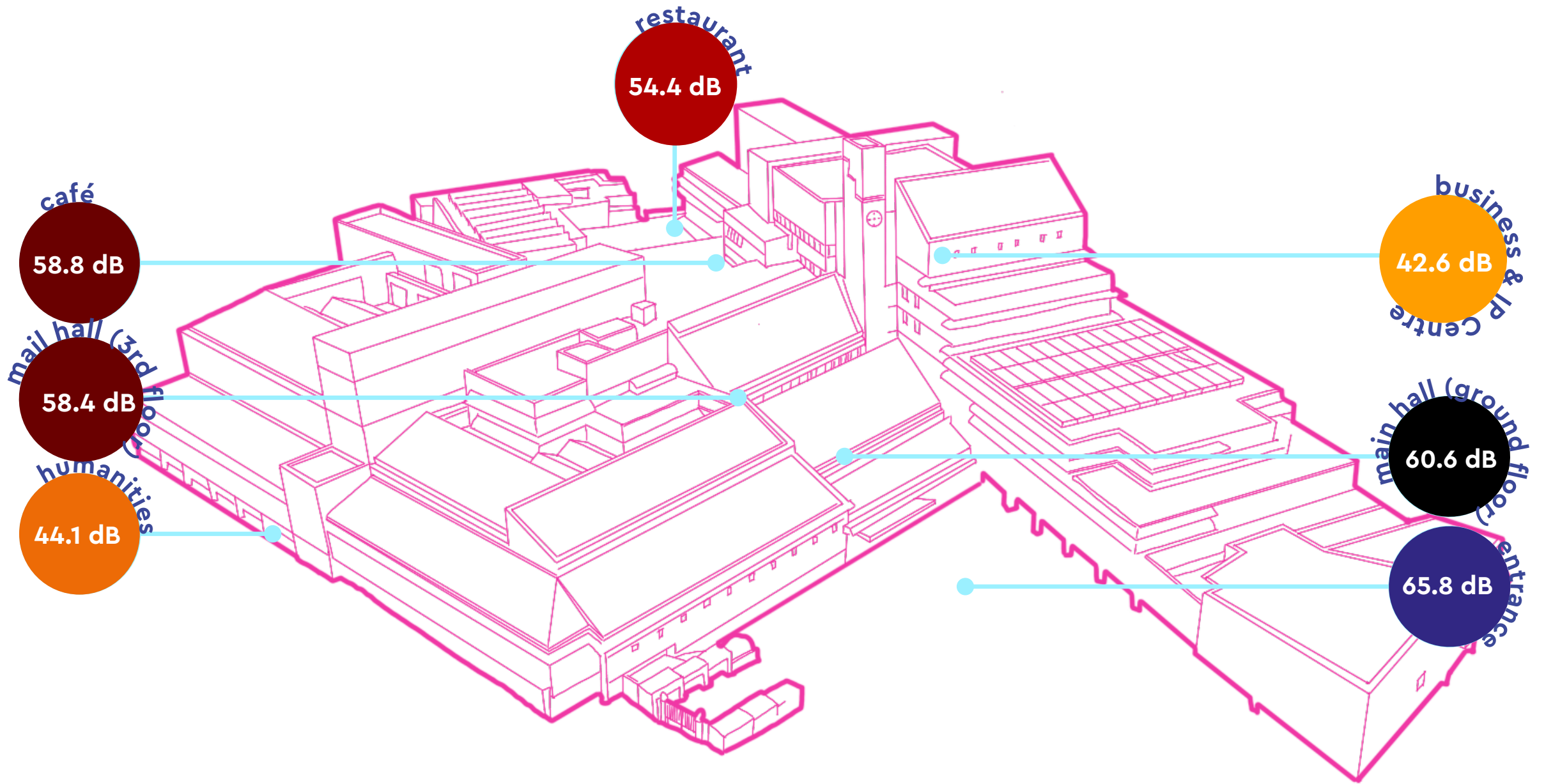
The British Library is divided into two locations: one in West Yorkshire and one at London St Pancras. For this research, the latter was visited. The building is among the youngest ever to be awarded Grade I status in the UK. As in the KB, most of the collection is stored underground in a 24-metre-deep basement (The British Library, n.d.).

The library provides 1,277 desks and 150 open workspaces in the public areas between the reading rooms. Outside, the city is dominated by a sea of traffic noise, but once inside, these sounds are muffled by the façades. Other elements then define the soundscape: conversation, the hum of ventilation, and footsteps on the stone floors. In terms of zoning, the

building is organised into a number of reading rooms designed for silent study. For students and visitors who wish to work together or engage in discussion, the spaces between the reading rooms offer dedicated areas. Noise levels are noticeably higher here, partly due to the materials used on the floors, which reflect sound more strongly.

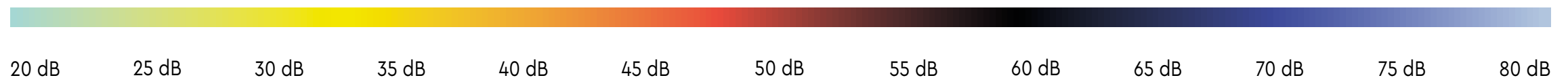
The loudest area of the library is the main atrium at the entrance. This space connects directly to the social working zones as well as the restaurant and café. As a result, it can be difficult to distinguish which tables belong to the café terraces and which are intended for studying or working.





	Loudness	Chatter	Footsteps	Moving chair	Coffee machine	Ventilation	Slamming door	Traffic Noise
1. Entrance	65.8 dB							
2. Main Hall (ground floor)	60.6 dB							
3. Main Hall (3rd floor)	58.4 dB							
4. Business & IP Centre	42.6 dB							
5. Humanities	44.1 dB							
6. Restaurant	54.4 dB							
7. Café	58.8 dB							

Measurements done at 29 July between 14:00-17:00

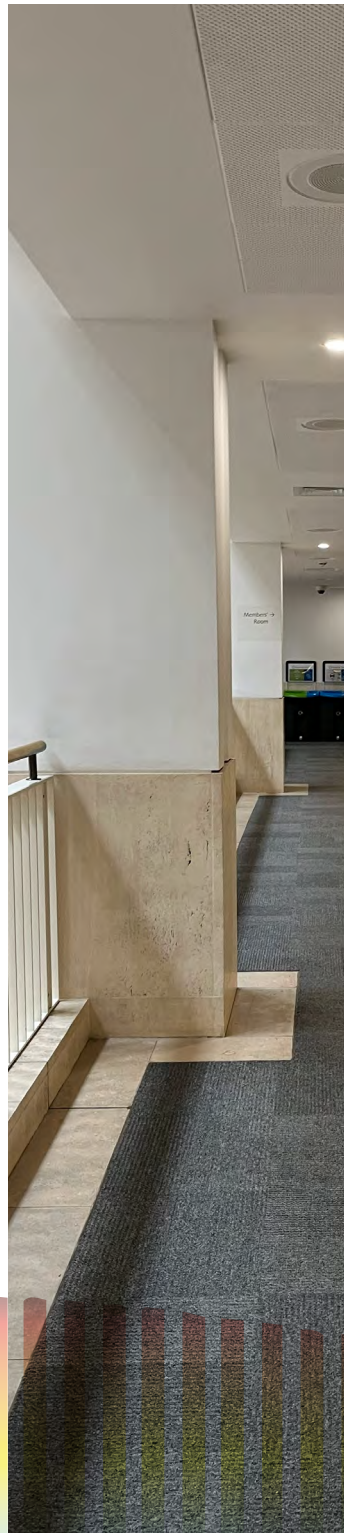




1. Natural stone floortiles, glass and masonry facade (own image)



2. Natural stone flooring, plaster walls, perforated acoustic ceiling panels (own image)



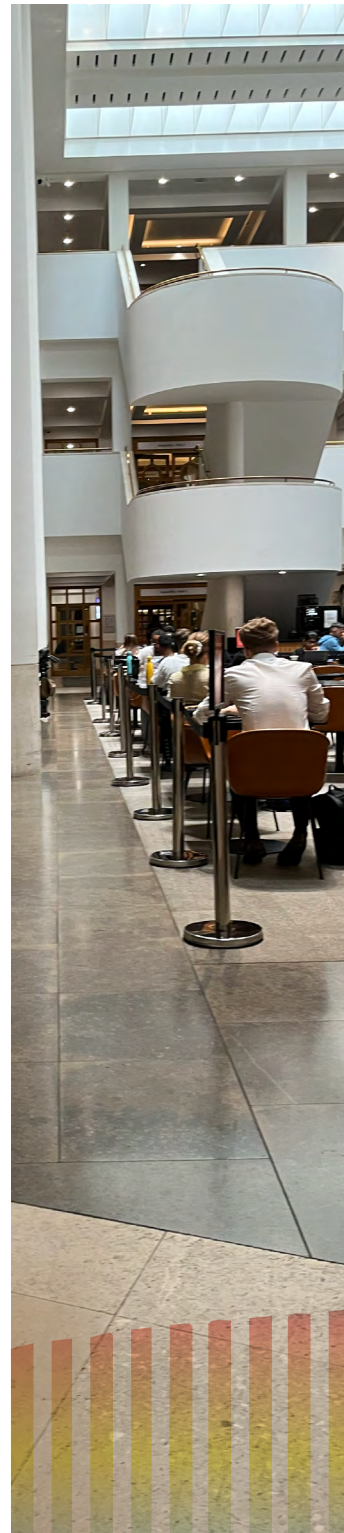
3. Carpet flooring combined with natural stone, metal railings, plaster walls (own image)



4. Carpet flooring, wooden furniture and perforated acoustic ceiling panels (own image)



5. Carpet flooring, wooden furniture and perforated acoustic ceiling panels (own image)

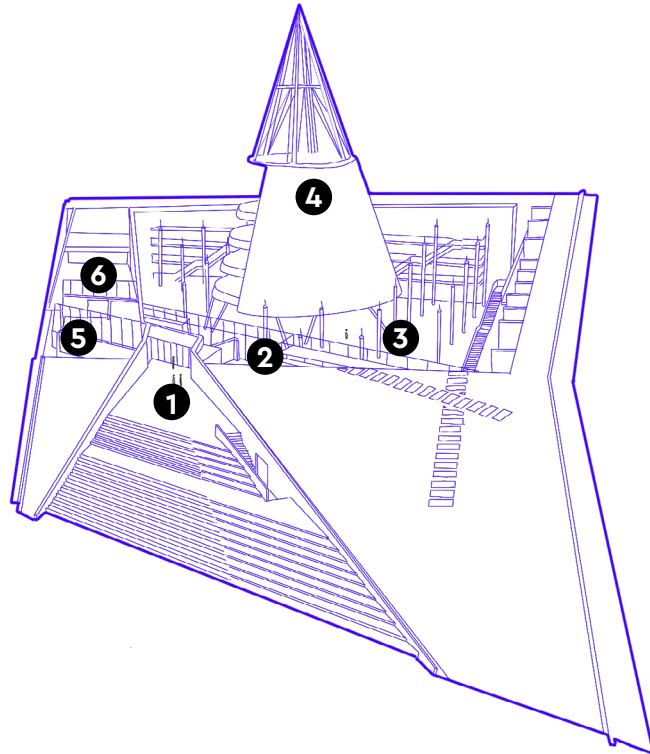


6. Natural stone flooring, plaster and glass walls, perforated acoustic ceiling panels (own image)



7. Natural stone flooring, plaster and glass walls, perforated acoustic ceiling panels (own image)

## 5.4 LIBRARY DELFT UNIVERSITY OF TECHNOLOGY



Name	<b>Library Delft University of Technology</b>
Architect(s)	<b>Mecanoo</b>
Type	<b>Academic Library</b>
Location	<b>Delft, Netherlands</b>
Building year	<b>1998</b>
Area (m <sup>2</sup> )	<b>15.000</b>

### SPATIAL AND AUDITORY OBSERVATIONS

The library of Delft University of Technology is designed by Mecanoo almost thirty years ago. The library is located on the northern edge of the university's campus and seems hidden due to its placement behind the Aula and the architecture of the

building; it is shaped as a grass slope with a white cone sticking out in the middle. Since this library is an academic one, the public is very different to the Forum and DOK Open. In the TU Delft library, there are rarely any kids and most

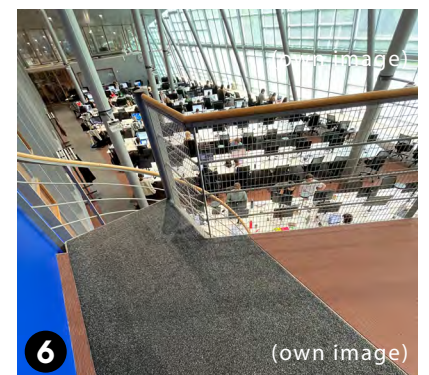
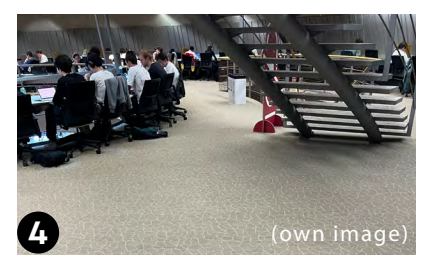
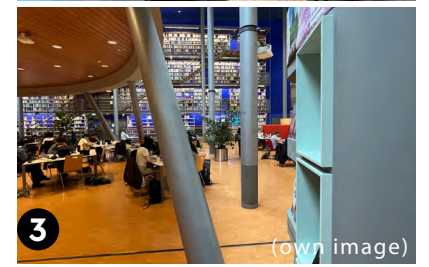
users study at the university. The entrance is formed as a section in the grass slope, where flattened stairs lead to the door of the building. The first space inside is a small vestibule which gives access to the main hall, the coffee corner and the Coffee-

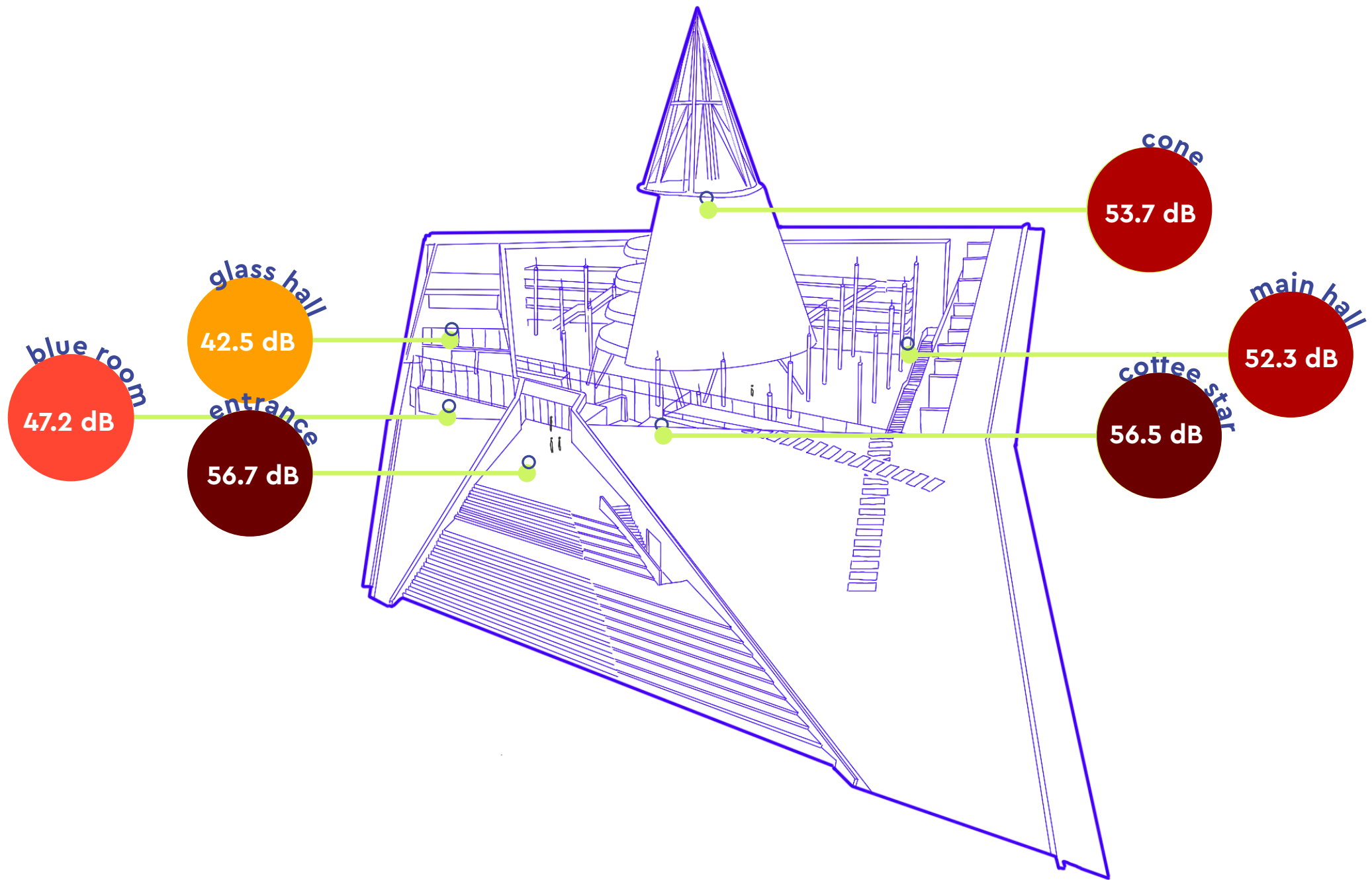
Star café. In the main hall, there is a lively atmosphere. People are walking around, talking, working on one of the tables or drinking their coffee at one of the 'indoor terrace tables' next to the café. Ceilings are very high and the materiality of the hall is largely metallic. In the middle of the hall, there is a spiralling staircase leading into the cone. Here, sounds from the main hall can still be heard well. Users are also not working quietly in this area but talking to each other freely. The staircase shakes when people walk on it, which can be felt and heard throughout the cone structure.

*"The combination of a lack of windows, noise from others and the shaking staircase really makes the cone the least pleasant studyplace in the library."*  
– TU Delft Student

More popular is the glass hall. It is full when the measurements were done. Here, each studyplace comes with a second monitor. The hall is parted from the main hall by a large glass wall. The sound levels are very low in this area. Because of this, smaller sounds are more noticeable, like typing on keyboards, mouse clicking, bags opening or chairs rolling over the carpet. Sounds from the main hall, like laughter and talking, can still be heard but are softened a lot by the partitioning wall. Users respect the aim of quietness in this silent study area and stop talking when they enter the space. One thing to notice is that the floor material is different here than in the main

hall. In this silent study area, the floors are covered in two types of carpet. One of them, the softer type in dark grey, covers the walkways in between the desks. It softens the sounds of footsteps. The other type is laid beneath the desks and chairs, which is a harder type of carpet allowing the chairwheels to roll over it more smoothly. The blue room is situated next to the glass hall. It is similar in material design, although the furnishing is a bit different since this room is also used as a meeting room. It houses no extra screens but only study places. The door can be closed off and locked, in contrast to the glass hall door, which can be easily pushed open to both sides while making minimal noise. The blue room door is thus more present in the soundscape, making squeaking and bashing sounds every time it opens and closes. Lastly, the Coffee-Star café is situated next to the main entrance. It has a similar soundscape to the main hall, although the sounds from the coffee machines and baristas behind the counter are more present here. The materialisation is different in the café, with grey tiling on the floor and white, smaller tiles on the wall. In terms of absorbing materials, there are booths placed in the middle of the café which contain sound absorbing textiles.





20 dB    25 dB    30 dB    35 dB    40 dB    45 dB    50 dB    55 dB    60 dB    65 dB    70 dB    75 dB    80 dB

	Loudness	Door opens/ closes	Bag opens/ closes	Moving chairs	Chatter	Footsteps	Typing & clicking	Wind
<b>1. Entrance</b>	56.7 dB							
<b>2. Coffee Star</b>	56.5 dB							
<b>3. Main Hall</b>	52.3 dB							
<b>4. Cone</b>	53.7 dB							
<b>5. Blue Room</b>	47.2 dB							
<b>6. Glass Hall</b>	42.5 dB							

Measurements done at 03/06/2025 between 15:00-18:00.

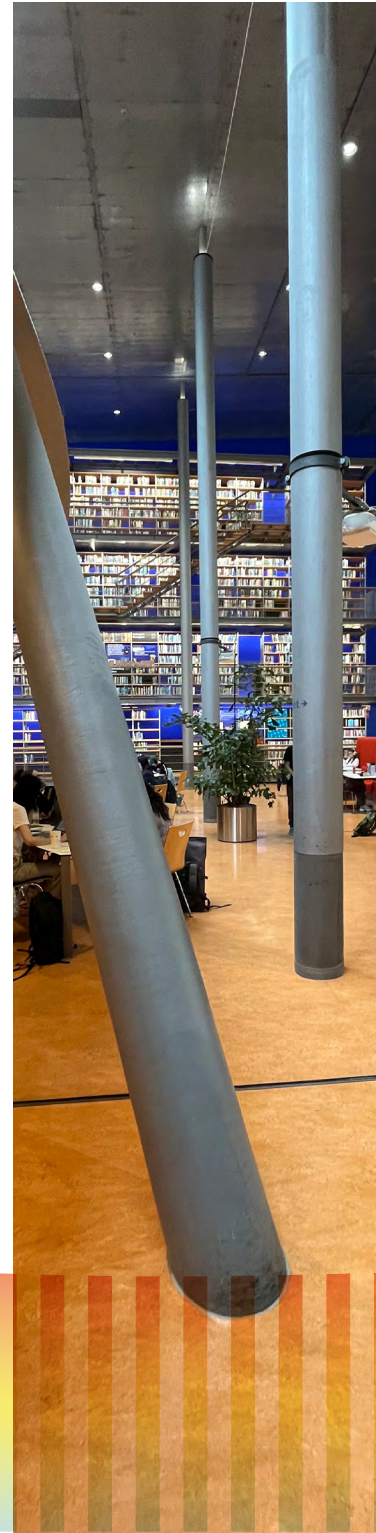




1. Concrete facade and pavement with metal fencing (own image)



2. Grey floor tiles, sound absorbing booths, white wall tiles and wooden furniture (own image)



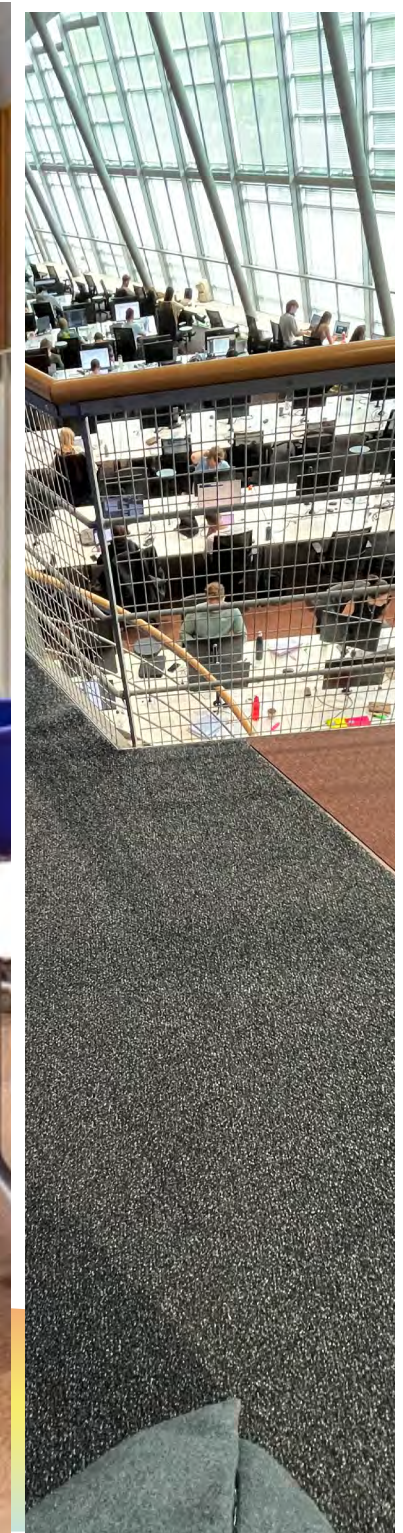
3. Lino floor, steel structural elements and perforated steel ceilings (own image)



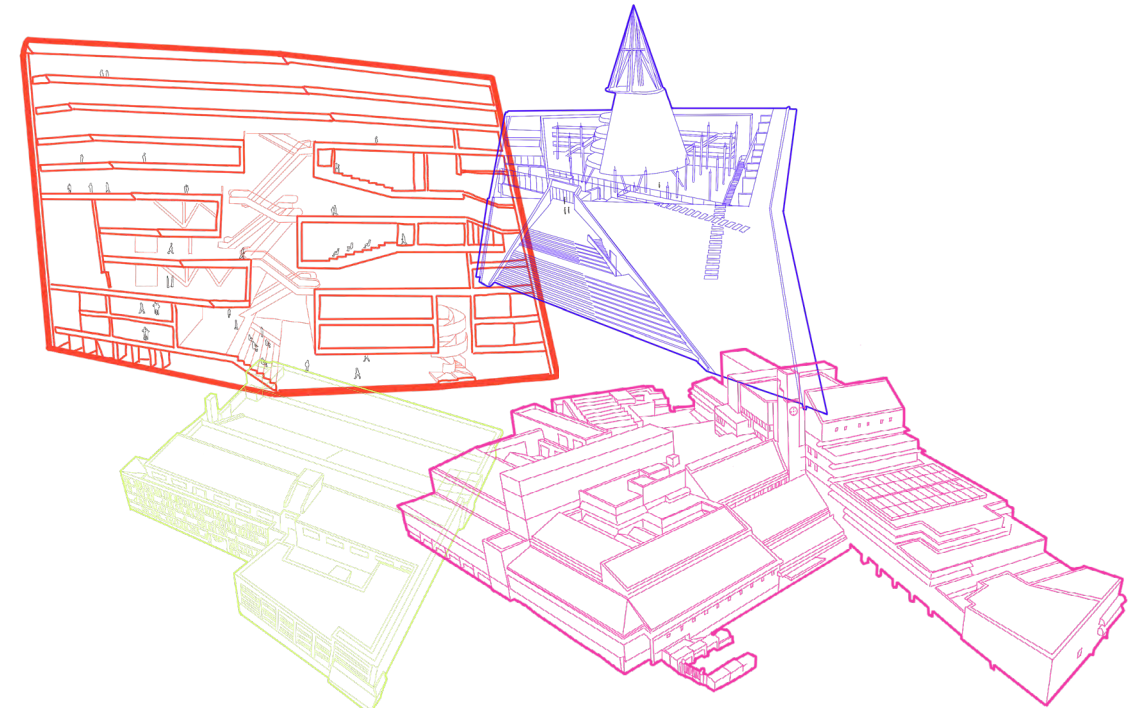
4. Carpet flooring, metal and stone staircase (own image)



5. Hard carpet floor, glass walls and perforated steel ceiling (own image)



5. Both hard and soft carpet floor, glass facade and perforated steel ceiling (own image)



## 5.5 CASE STUDY CONCLUSIONS

All the visited libraries exhibited a range of distinct soundscapes, with measured sound levels spanning from 37.8 dB (DOK OPEN Delft) to 65.8 dB (outside the entrance of the British National Library) and 63.8 dB (inside, at the escalator in Forum Groningen). Notably, the quietest location, the ground-floor reading chair in DOK (measurement point 5), was found in a public library that is not generally considered a “silent” environment. This can be attributed to the careful design of the library’s interior: the existing concrete ceiling structure is clad with sound-absorbing aluminium panels, and numerous bookcases sit between the primary sound source (the café)

and measurement point 5. For the loudest exterior and interior measurements, it is important to highlight that the dominant sound sources were mechanical. At the entrance of the British National Library, most of the noise originated from surrounding traffic, while in Forum Groningen the elevated interior noise levels were generated by the escalators transporting visitors to the upper floors and roof terrace.

*Image: case study libraries (own image)*

## 6 CONCLUSION AND DISCUSSION

### 6.1 CONCLUSION AND DISCUSSION

This research aimed to enhance the auditory library experience in the National Library of the Netherlands by exploring existing soundscape theories, user experiences and reference library soundscapes. The main question to answer in this study was:

*“How can the auditory experience of library users be enhanced through design for different zones in a library’s soundscape?”*

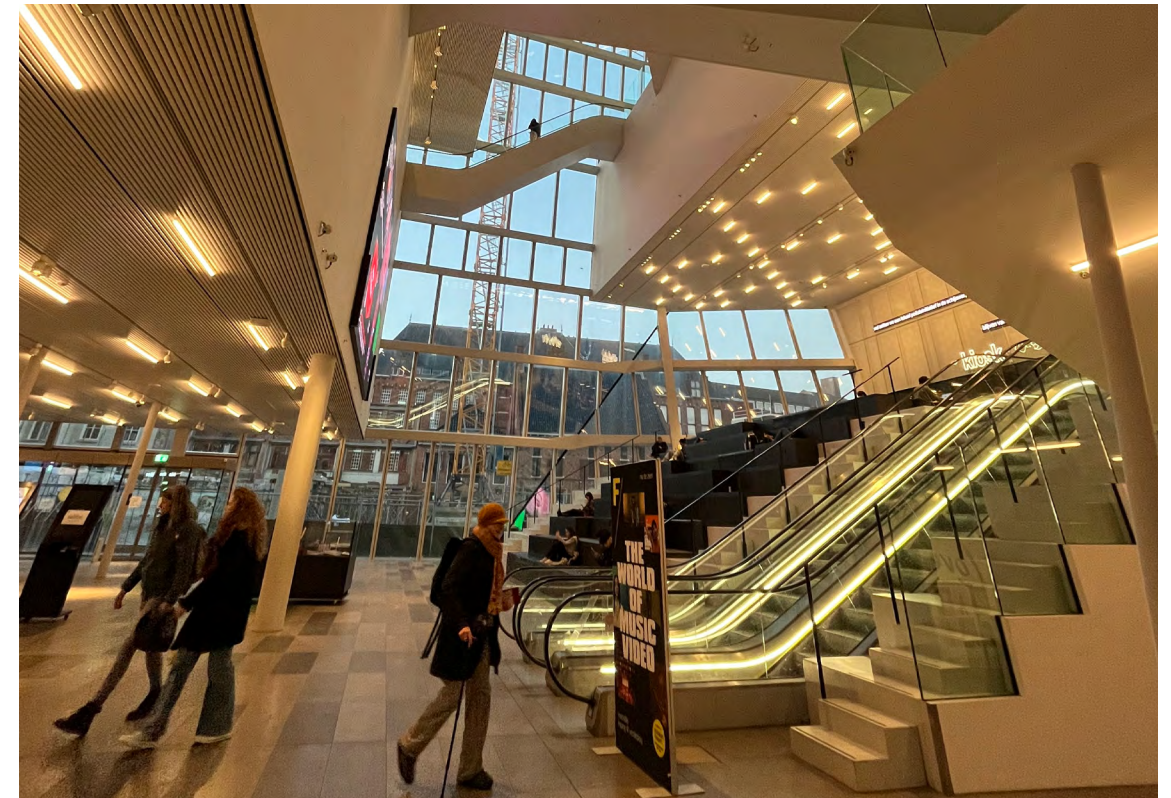
To address this question, the research is structured around three sub-questions:

1. *What should a 21st-century library’s auditory atmosphere be like according to library users?*

2. *What spatial strategies can enhance a library’s soundscape?*

3. *How are these strategies applied in existing libraries to enhance specific soundscapes?*

The literature study on the first question resulted in findings about both wanted and unwanted sounds according to library users. The main opinion was that most sounds were not problematic as long as they were not too loud. Users value having power over their own acoustic experience, which can be achieved through choosing a zone to study in and making sure the overall noise level is not too high, creating the possibility to use noise-canceling headphones when necessary.



In terms of spatial strategies and soundscape theory, Murray Schafer laid a base for this research with his book ‘Soundscape’. His framework for listening formed the shape of the case studies. Other theories helped with recognizing passive and active strategies in acoustic design.

In the case studies, noise levels in four different libraries were put to test. Absorbing materials and spatial design proved to work well to keep the loudness in check in both the British National Library, and TU Delft library as in DOK open. Forum Groningen remained a very noisy library, with its open atrium and large numbers of escalators humming through the space. The case studies in general showed that mechanical sounds were often very present in the soundscape,

as well as sounds produced by other library users (chatter, footsteps). Zoning and the transition between zones played a big role in the experience of a library’s soundscape.

In the literature review it was noted that contemporary acoustic design largely revolves around the incorporation of sound-absorbing materials into a building’s interior. This observation was confirmed by the case studies: all libraries employed a range of acoustic panels, flooring solutions, and ceiling treatments, particularly in areas designated for silent reading. Some libraries, such as the TU Delft Library and the British National Library, used partition walls to demarcate transitions between zones. In contrast, DOK OPEN and Forum Groningen adopted a more

*Image: the atrium of Forum Groningen (own image)*

open spatial approach, allowing areas to blend into one another without strict boundaries. The literature also suggested that quiet zones in libraries remain highly valued by society. Since all case-study libraries showed lively patterns of user activity, both in social zones and in concentration areas, this assumption appears to be accurate.

It was difficult to assess whether users in the case studies valued their ability to adapt their acoustic environment, as no on-site interviews were conducted. However, many visitors (particularly in the TU Delft Library) made frequent use of noise-cancelling headphones, indicating that they were actively managing their own acoustic comfort.

Each of the four case studies offers relevant insights for the redesign of the KB. The British National Library is, unsurprisingly, the closest reference point. In terms of programme and the preservation of valuable materials, it shares many characteristics with the KB. Its comparatively recent building has paid significant attention to providing both social workspaces and focused study areas, offering a useful precedent. Notably, it is the only library among the case studies that combines the custodial function of a national library with a modern, zoned approach to reading and study environments.

Forum Groningen and DOK OPEN are particularly strong examples of libraries as “third places”; environments in which users



feel welcomed and encouraged to linger. Although their spatial forms and soundscapes differ considerably from those of the KB, the way these libraries manage transitions between varying acoustic zones provides valuable insights. Their openness offers an intriguing concept to consider for the KB redesign.

The TU Delft Library illustrates a contrasting approach through its strict zoning strategy. While its glass partitions reduce sound transmission, they do not significantly absorb noise from the main hall and social areas. This may help explain why many students still choose to wear noise-cancelling headphones.

*Image: social workplaces next to the 'Kings Library' in the British National Library (own image)*

## 6.2 RESEARCH TO DESIGN

Concluding the findings of this research, I would like to propose the following steps for the soundscape redesign of KB:

1. Define the zones needed in the library in terms of noise levels and sound types
2. Define the placement of the zones within the building
3. Define the zone transitions and how harsh the shift needs to be to create the desired soundscape
4. Look at the effects of reference library transitions between zones to create the desired soundscape in KB

The reference libraries, both case studies and other projects, provided inspiration in terms of soundscape strategies, as can be seen in the image to the right.

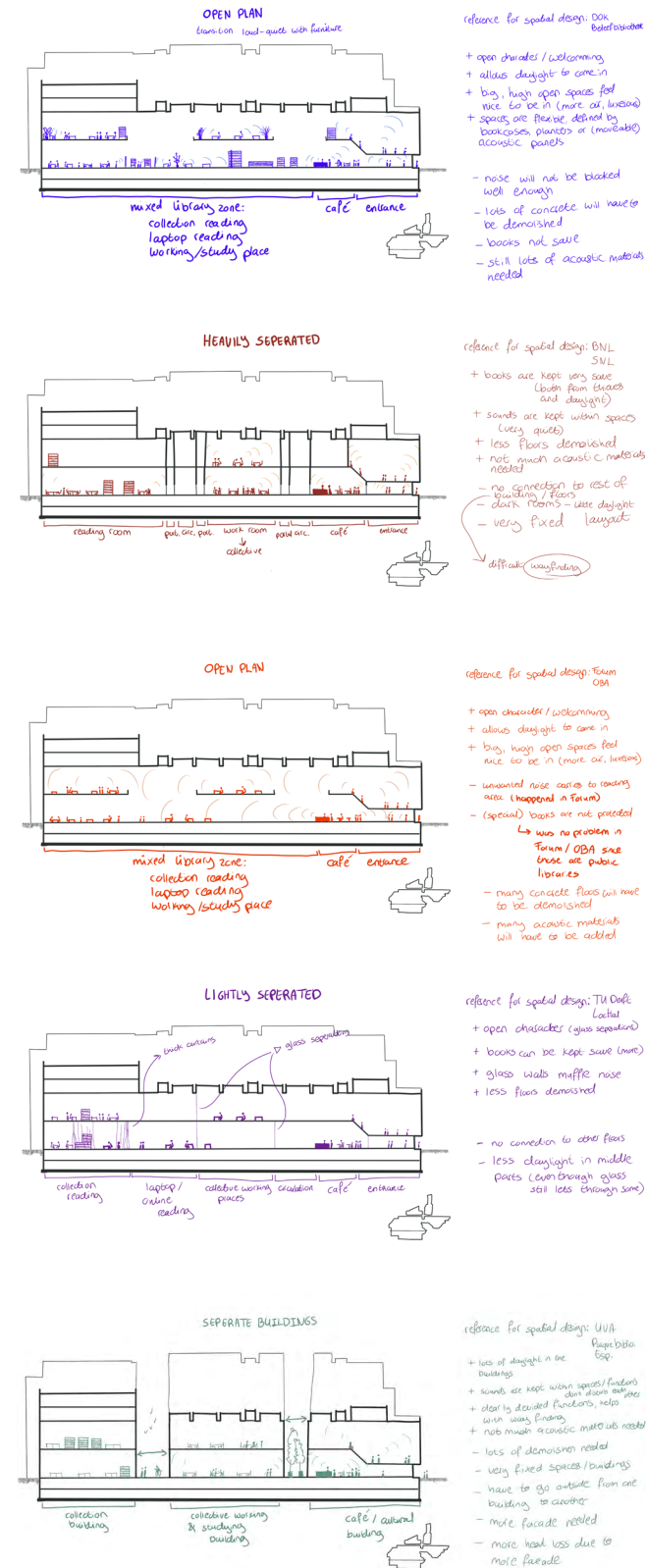
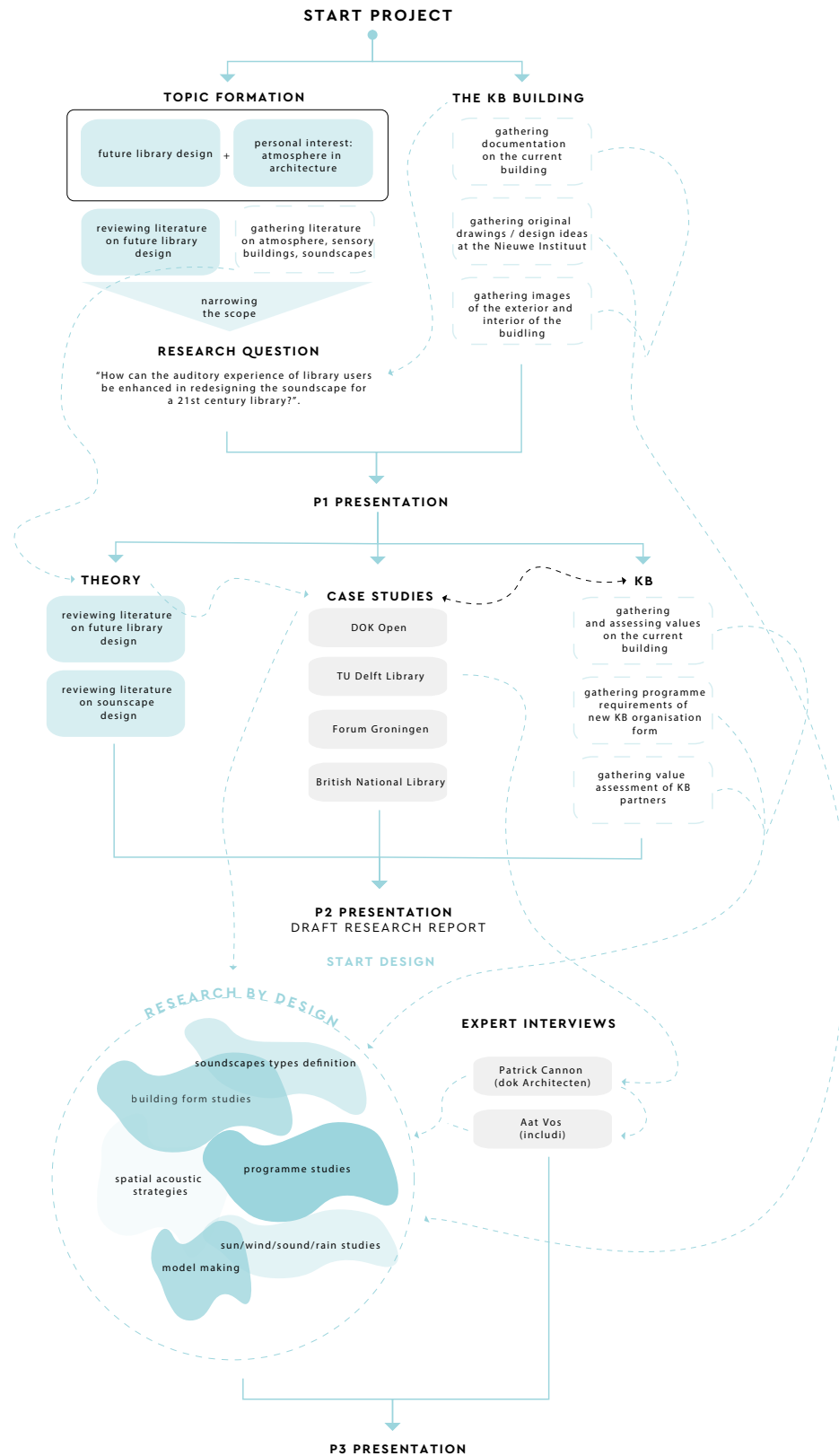


Image: Spatial Sound Strategies found in case study libraries, variations implemented on KB section (own image)



### 6.3 SUGGESTIONS FOR FURTHER RESEARCH

This research contributes to the underdeveloped field of library soundscape design and suggests practical strategies for creating acoustically balanced public spaces.

Limitations of this research are that the findings are based on a limited number of case studies and may not be generalizable to all library types. Also, the user types that were interviewed in reference literature for the literature study were mainly students using academic libraries. Since the results of this study are meant for implementation in a National Library, the user needs might slightly be different.

Further research could explore user responses to specific auditory interventions or do a more in depth examination of one type of library, for instance, public, academic or national libraries.

In conclusion, this research has aimed to bring library design a step closer to being not only visually appealing to users but also offering an enriching auditory experience. As libraries redefine their roles in a digital and overstimulated age, designing with the ear in mind is not just a luxury, but a necessity.

Image: Research and Design Diagram (own image)

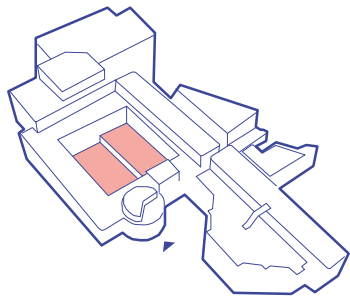
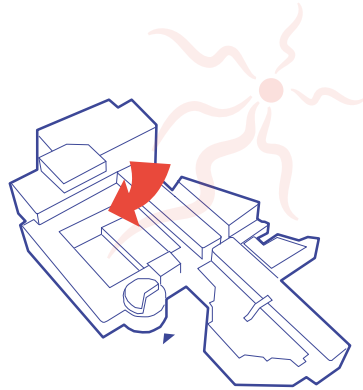
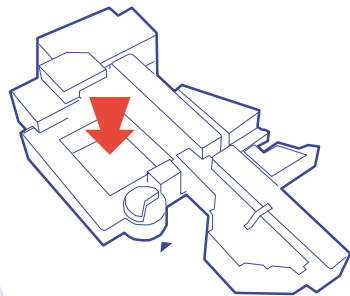
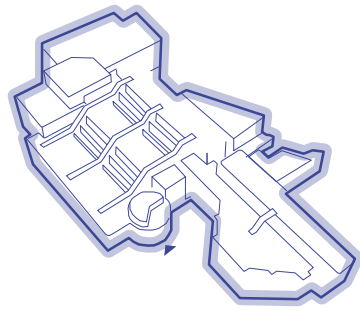
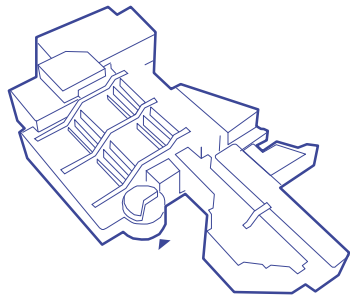


Image: Integration of Heritage and Soundscapes in Design (own image)

## 7 REFERENCES

- Aabø, S., Audunson, R., & Vårheim, A. (2010). How do public libraries function as meeting places? *Library & Information Science Research*, 32(1), 16–26. <https://doi.org/10.1016/j.lisr.2009.07.008>
- Ariffin, H. F., Bibon, M. F., & Abdullah, R. P. S. R. (2012). Restaurant's atmospheric elements: what the customer wants. *Procedia - Social and Behavioural Sciences*, 38, 380–387. <https://doi.org/10.1016/j.sbspro.2012.03.360>
- Awaliyah, D. N., Wei, Z., Niva, M., & Barroso, U. (2024). Architectural taste: shaping aesthetics, embracing multisensory experiences, and navigating cultural influences. *Journal International of Lingua and Technology*, 3(1), 201–216. <https://doi.org/10.55849/jiltech.v3i1.555>
- Baker, J., Grewal, D., & Parasuraman, A. (1994). The influence of store environment on quality inferences and store image. *Journal of the Academy of Marketing Science*, 22(4), 328–339. <https://doi.org/10.1177/0092070394224002>
- Banaei, M., Hatami, J., Yazdanfar, A., & Gramann, K. (2017). Walking through Architectural Spaces: The Impact of Interior Forms on Human Brain Dynamics. *Frontiers in Human Neuroscience*, 11. <https://doi.org/10.3389/fnhum.2017.00477>
- Berman, B., & Evans, J. R. (1995). *Retail Management: A Strategic Approach*. Englewood Cliffs, NJ: Prentice-Hall Inc., 6th ed.
- Blessner, B., & Salter, L. (2006). Spaces speak, are you listening? In *The MIT Press eBooks*. <https://doi.org/10.7551/mitpress/6384.001.0001>
- Bohl, P. (2012). The effects of store atmosphere on shopping behaviour - A literature review. *Corvinus Marketing Tanulmányok*, 2, 1–24. [http://unipub.lib.uni-corvinus.hu/669/1/CMT\\_2012-1.pdf](http://unipub.lib.uni-corvinus.hu/669/1/CMT_2012-1.pdf)
- Borzykowski, B. (2017). Why open offices are bad for us. *BBC January 11th*. <https://www.bbc.com/worklife/article/20170105-open-offices-are-damaging-ourmemories>
- Bossaller, J., Oprean, D., Urban, A., & Riedel, N. (2020). A happy ambience: Incorporating ba and flow in library design. *The Journal of Academic Librarianship*, 46(6), 102228. <https://doi.org/10.1016/j.acalib.2020.102228>
- Bringslimark, T., Hartig, T., & Patil, G. G. (2008). The Psychological Benefits of Indoor Plants: A Critical review of the Experimental literature. *Journal of Environmental Psychology*, 29, 422–433. <https://doi.org/10.1016/j.jenvp.2009.05.001>
- Cal, H. K., Aletta, F., Kang, J., & Clarke, P. (2025). Student Perception of school soundscapes and wellbeing: A mixed methods examination of natural and musical sounds. *Building and Environment*, 112946. <https://doi.org/10.1016/j.buildenv.2025.112946>
- Cambridge Dictionary. (2025). Meaning of soundscape in English. In [dictionary.cambridge.org](https://dictionary.cambridge.org). Retrieved June 3, 2025, from <https://dictionary.cambridge.org/dictionary/english/soundscape>
- Çelik, M., Didiko Glu, A., & Kazanasmaz, T. (n.d.). Optimizing lighting design in educational settings for Enhanced Cognitive performance A literature review. *Energy & Buildings*, 328. <https://www.sciencedirect.com/science/article/pii/S0378778824012969?via%3Dihub>
- Chebat, J., Sirgy, M. J., & Grzeskowiak, S. (2009). How can shopping mall management best capture mall image? *Journal of Business Research*, 63(7), 735–740. <https://doi.org/10.1016/j.jbusres.2009.05.009>
- Chourmouziadou, K., Sakantamis, K., Kang, J., Sakantamis, K., Wang, B., & Hao, Y. (2014). On the sound of Urban Centres: EU COST Action TD0804 “Soundscape of European Cities and Landscapes.” <http://ikee.lib.auth.gr/record/315757>
- Cohen, A. (2025). Library architecture and service programming. In *Elsevier eBooks* (pp. 101–119). <https://doi.org/10.1016/b978-0-443-29176-0.00006-3>
- Cox, A. M. (2019). Learning bodies: Sensory experience in the information commons. *Library & Information Science Research*, 41(1), 58–66. <https://doi.org/10.1016/j.lisr.2019.02.002>
- Dijkstra, K., Pieterse, M., & Pruyn, A. (2008). Stress-reducing effects of indoor plants in the built healthcare environment: The mediating role of perceived attractiveness. *Preventive Medicine*, 47(3), 279–283. <https://doi.org/10.1016/j.ypmed.2008.01.013>
- Donovan, J. M. (2019). Keep the books on the shelves: Library space as intrinsic facilitator of the reading experience. *The Journal of Academic Librarianship*, 46(2), 102104. <https://doi.org/10.1016/j.acalib.2019.102104>
- Donovan, R. J., & Rossiter, J. R. (1982). Store Atmosphere: An Environmental Psychology Approach. *Journal of Retailing*, 58(1), 34–57.
- Du, Y., Li, N., Zhou, L., A, Y., Jiang, Y., & He, Y. (2022). Impact of natural window views on perceptions of indoor environmental quality: An overground experimental study. *Sustainable Cities and Society*, 86, 104133. <https://doi.org/10.1016/j.scs.2022.104133>
- Elsadek, M., Deshun, Z., & Liu, B. (2024). High-rise window views: Evaluating the physiological and psychological impacts of green, blue, and built environments. *Building and Environment*, 262, 111798. <https://doi.org/10.1016/j.buildenv.2024.111798>
- Fanpu, M., Yi, W. S., & Hua, F. (2024). Research on the health lighting scheme of university library Reading room. *Heliyon*, 10(19), e38089. <https://doi.org/10.1016/j.heliyon.2024.e38089>
- Fowler, M. (2015). Sounds in space or space in sounds? Architecture as an auditory construct. *Architectural Research Quarterly*, 19(1), 61–72. <https://doi.org/10.1017/s1359135515000226>
- Francioni, B., Savelli, E., & Cioppi, M. (2018). Store satisfaction and store loyalty: The moderating role of store atmosphere. *Journal of Retailing and Consumer Services*, 43, 333–341. <https://doi.org/10.1016/j.jretconser.2018.05.005>
- Garnar, M., & Tonyan, J. (2021). Library as place: Understanding contradicting user expectations. *The Journal of Academic Librarianship*, 47(5), 102391. <https://doi.org/10.1016/j.acalib.2021.102391>
- Gemeente Den Haag. (2025, April 23). Gemeente Den Haag. Projecten - Den Haag. <https://projecten.denhaag.nl/project/herontwikkeling-koninklijke-bibliotheek/>
- Gentile, N., Dubois, M., Osterhaus, W., Stoffer, S., Amorim, C. N. D., Geisler-Moroder, D., & Jakobiak, R. (2016). A toolbox to evaluate non-residential lighting and daylighting retrofit in practice. *Energy and Buildings*, 123, 151–161. <https://doi.org/10.1016/j.enbuild.2016.04.026>
- Gentile, N., Lee, E. S., Osterhaus, W., Altomonte, S., Amorim, C. N. D., Ciampi, G., Garcia-Hansen, V., Maskarenj, M., Scorpio, M., & Sibilio, S. (2022). Evaluation of integrated daylighting and electric lighting design projects: Lessons learned from international case studies. *Energy and Buildings*, 268, 112191. <https://doi.org/10.1016/j.enbuild.2022.112191>
- Ghisleni, C. (n.d.). Architecture and Memory: The Sense of Smell and Recollection. *ArchDaily*. [https://www.archdaily.com/1002102/architecture-and-memory-the-sense-of-smell-and-recollection?utm\\_source=chatgpt.com](https://www.archdaily.com/1002102/architecture-and-memory-the-sense-of-smell-and-recollection?utm_source=chatgpt.com)
- Gierbienis, M. (2024). Public Facilities in the Context of Sustainable Development: A Multiple-Study of Academic Libraries. *Technical Transactions*, 1(2024), 1–20. <https://doi.org/10.37705/techtrans/e2024008>
- Helmefalk, M., & Hultén, B. (2017). Multi-sensory congruent cues in designing retail store atmosphere: Effects on shoppers' emotions and purchase behavior. *Journal of Retailing and Consumer Services*, 38, 1–11. <https://doi.org/10.1016/j.jretconser.2017.04.007>
- Hourani, M., & Hammad, N. (2011). Impact of daylight quality on architectural space dynamics Case study: City Mall – Amman, Jordan. *Renewable and Sustainable Energy Reviews*, 16. <https://doi.org/10.1016/j.rser.2012.02.074>
- Jung, D., An, J., & Hong, T. (2024). Exploring the relationship between office lighting, cognitive performance, and psychophysiological responses: a multidimensional approach. *Building and Environment*, 263, 111863. <https://doi.org/10.1016/j.buildenv.2024.111863>
- Jung, D., Jung, S., An, J., & Hong, T. (2024). Bio-signals based Occupant-Centric Lighting Control for Cognitive Performance, Visual Fatigue and Energy Consumption. *Building and Environment*, 112424. <https://doi.org/10.1016/j.buildenv.2024.112424>
- Kang, J., Chourmouziadou, K., Sakantamis, K., Wang, B., & Hao, Y. (2013). COST Action TD0804 - Soundscape of European Cities and Landscapes. [PDF]. *Soundscape-COST*. <https://acrobat.adobe.com/id/urn:aaid:sc:EU:3a5b5476-7115-4812-b643->

63e989e0d0d1

- Karabašević, A. (2016). Atmospheric dimensions of architecture. *SAJ - Serbian Architectural Journal*, 8(2), 179–192. <https://doi.org/10.5937/saj1602179k>
- KB. (n.d.-a). A smarter, more skilled and more creative Netherlands. kb.nl. Retrieved March 26, 2025, from <https://www.kb.nl/en/about-us/our-mission>
- KB. (n.d.-b). KB Ons Verhaal. kb.nl. Retrieved May 17, 2025, from <https://www.kb.nl/over-ons/verhaal>
- KB nationale bibliotheek. (2025). Over ons | KB, de nationale bibliotheek van Nederland. KB Nationale Bibliotheek. Retrieved June 23, 2025, from <https://www.kb.nl/over-ons>
- KB-catalogus. (n.d.). KB.nl. Retrieved May 17, 2025, from <https://www.kb.nl/onderzoeken-vinden/uitgelichte-online-bronnen/kb-catalogus>
- Kilic, D. K., & Hasirci, D. (2011). Daylighting concepts for university libraries and their influences on users' satisfaction. *The Journal of Academic Librarianship*, 37(6), 471–479. <https://doi.org/10.1016/j.acalib.2011.07.003>
- Kim, J., Cha, S. H., Koo, C., & Tang, S. (2018). The effects of indoor plants and artificial windows in an underground environment. *Building and Environment*, 138, 53–62. <https://doi.org/10.1016/j.buildenv.2018.04.029>
- Kotler, P. (1972). Atmospherics as a marketing tool. *Journal of Retailing*, 49(4), 48–64.
- Latimer, K. (2018). 2050: a Library Space Odyssey. *Planning the Future Library*. *Legal Information Management*, 18(4), 203–209. <https://doi.org/10.1017/s1472669618000439>
- Lee, K. (2022). The Interior Experience of Architecture: An Emotional Connection between Space and the Body. *Buildings*, 12(3), 326. <https://doi.org/10.3390/buildings12030326>
- Lehmann, S. (2023). Reimagining the Library of the future. from social condenser and community hub to regenerative design. *Public Library Quarterly*, 43(2), 223–259. <https://doi.org/10.1080/01616846.2023.2242626>
- Li, Y., Erjiang, E., & Tian, X. (2024). The user experience of university library: A text mining analysis of a Q&A platform in China. *Library & Information Science Research*, 46(4), 101326. <https://doi.org/10.1016/j.lisr.2024.101326>
- Lushington, N., Rudorf, W., & Wong, L. (2016). *Libraries - a design manual*. Birkhäuser.
- Lyu, J., Krasnikolakis, I., & Vrontis, D. (2022). A systematic literature review of store atmosphere in alternative retail commerce channels. *Journal of Business Research*, 153, 412–427. <https://doi.org/10.1016/j.jbusres.2022.08.050>
- Mady, C., & Hewidy, H. (2024). The public library building as nexus for social interactions: Cases from Helsinki. *City Culture and Society*, 40, 100610. <https://doi.org/10.1016/j.ccs.2024.100610>
- Majidi, V., Khanmohammadi, m. ali, & Mehdizadeh, F. (2023). Explaining the quality of the architectural space in academic libraries based on user preferences. *The Scientific Journal of NAZAR Research Center (Nrc) for Art, Architecture & Urbanism*. <https://doi.org/10.22034/BAGH.2023.351938.5227>
- Manning, P. (1991). Environmental aesthetic design: Identifying and achieving desired environmental effects, particularly “image” and “atmosphere.” *Building and Environment*, 26. <https://www.sciencedirect.com/science/article/pii/036013239190059K>
- Mathspace. (n.d.). Mathspace. mathspace.co. Retrieved June 3, 2025, from <https://mathspace.co/textbooks/syllabuses/Syllabus-1031/topics/Topic-20307/subtopics/Subtopic-266775/?activeTab=theory>
- Meerwein, G., Rodeck, B., & Mahnke, F. H. (n.d.). *Color - Communication in Architectural Space*. Springer.
- MEYERS-LEVY, J., & ZHU, R. (2007). The influence of ceiling height: the effect of priming on the type of processing that people use. *JOURNAL OF CONSUMER RESEARCH*, 34.
- Murray Schafer, R. (1993). *The soundscape: our sonic environment and the tuning of the world*. <http://ci.nii.ac.jp/ncid/>

BA51274040

- Ng, C. F. (2020). Perception and evaluation of buildings: the effects of style and frequency of exposure. *Collabra Psychology*, 6(1). <https://doi.org/10.1525/collabra.324>
- Nieuw boekenmagazijn voor de KB. (2025, January 20). KBPro Website. <https://www.kb.nl/ontdekken-bewonderen/uitgelicht/nieuw-boekenmagazijn-voor-de-kb>
- Owen, D. (2019). Is Noise Pollution the Next Big Public-Health Crisis? *The New Yorker* May 13th. <https://www.newyorker.com/magazine/2019/05/13/is-noise-pollution-the-next-big-public-health-crisis>
- Oxford English Dictionary. (n.d.). <https://www.oed.com/?tl=true>
- Peter, N., Ibisola, A., Oluwatayo, A., Omotosho, V., & Okagbue, H. (2023). Users' perception of the physical work environment in Covenant University. *Materials Today Proceedings*, 105, 148–154. <https://doi.org/10.1016/j.matpr.2023.08.079>
- Peterson, M. (2023). Libraries as felt spaces: Atmospheres, public space and feelings of dis/comfort. *Emotion, Space and Society*, 49, 100986. <https://doi.org/10.1016/j.emospa.2023.100986>
- Peterson, M. (2024). Designing a feminist city: Public libraries as a women's space. *Geoforum*, 150, 103971. <https://doi.org/10.1016/j.geoforum.2024.103971>
- Rhubart, D., Kowalkowski, J., & Pillay, T. (2023). Third places in rural America: Prevalence and disparities in use and meaningful use. *Journal of Rural Studies*, 104, 103153. <https://doi.org/10.1016/j.jrurstud.2023.103153>
- Savchuk, A. (2021, October 14). How loud is 50 decibels | What is 50 decibels. *Decibel Meter App | Best Digital Sound Level Meter for Your Smartphone*. <https://decibelpro.app/blog/what-is-50-decibels/>
- Shishegar, N., & Boubekri, M. (2022). Lighting up living spaces to improve mood and cognitive performance in older adults. *Journal of Environmental Psychology*, 82, 101845. <https://doi.org/10.1016/j.jenvp.2022.101845>
- Spannenburg, Art. (n.d.). ESTRANGED nu ook onderdeel van de KB | Nationale Bibliotheek. [https://www.arjanspannenburg.nl/1204530\\_estranged-nu-ook-onderdeel-van-de-kb-nationale-bibliotheek](https://www.arjanspannenburg.nl/1204530_estranged-nu-ook-onderdeel-van-de-kb-nationale-bibliotheek)
- Spence, C. (2019). Senses of place: architectural design for the multisensory mind. *Cognitive Research: Principles and Implications*, Volume 5, 46.
- Spence, C., & Keller, S. (2019). Medicine's Melodies: On the Costs & Benefits of Music, Soundscapes, & Noise in Healthcare Settings. *Music and Medicine*, 11(4), 211. <https://doi.org/10.47513/mmd.v11i4.699>
- Stanwicks, K. N. (2016). Zoning the Library for Silent, Quiet, and Collaborative Study. *Journal of Library Administration & Management Section (JLAMS)*, 12(2), 4. <https://scholarsarchive.library.albany.edu/cgi/viewcontent.cgi?article=1006&context=jlams>
- Sufar, S., Talib, A., & Hambali, H. (2012). Towards a better design: physical interior environments of public libraries in peninsular Malaysia. *Procedia - Social and Behavioral Sciences*, 42, 131–143. <https://doi.org/10.1016/j.sbspro.2012.04.174>
- Turley, L., & Milliman, R. E. (2000). Atmospheric effects on shopping behavior. *Journal of Business Research*, 49(2), 193–211. [https://doi.org/10.1016/s0148-2963\(99\)00010-7](https://doi.org/10.1016/s0148-2963(99)00010-7)

