Politecnico di Torino

Honors Thesis

Master's degree Science in Architecture Construction City

Abstract

The New Civic Central Library of Torino: a study of the perceived simulated noise and its effects on cognitive performance

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The present abstract concerns the master's thesis project entitled "The New Civic Central Library of Torino: a study of the perceived simulated noise and its effects on cognitive performance", carried out by the student Ioana Grozeva under the academic supervision of Prof. Arianna Astolfi and Prof. Louena Shtrepi.
As libraries evolve in the recent years into multifunctional environments that support studying, collaboration, and cultural activities, effectively managing their indoor sound environments has become increasingly important. In such settings, noise is not only a potential source of distraction but also a factor that may influence cognitive performance and user's comfort. These challenges are further amplified in heritage buildings, where invasive architectural interventions such as the usage of sound-absorbent materials, are often limited.
This study examines the acoustic environment of the New Civic Central Library of Torino, a historically protected structure with a volume of approximately 160,000 m³ and a reverberation time of around 6 seconds at mid frequencies. Given its future role as a hub for reading, social interaction, and public events, it is essential to assess how background noise affects both user perception and cognitive performance to inform effective planning and sound management.

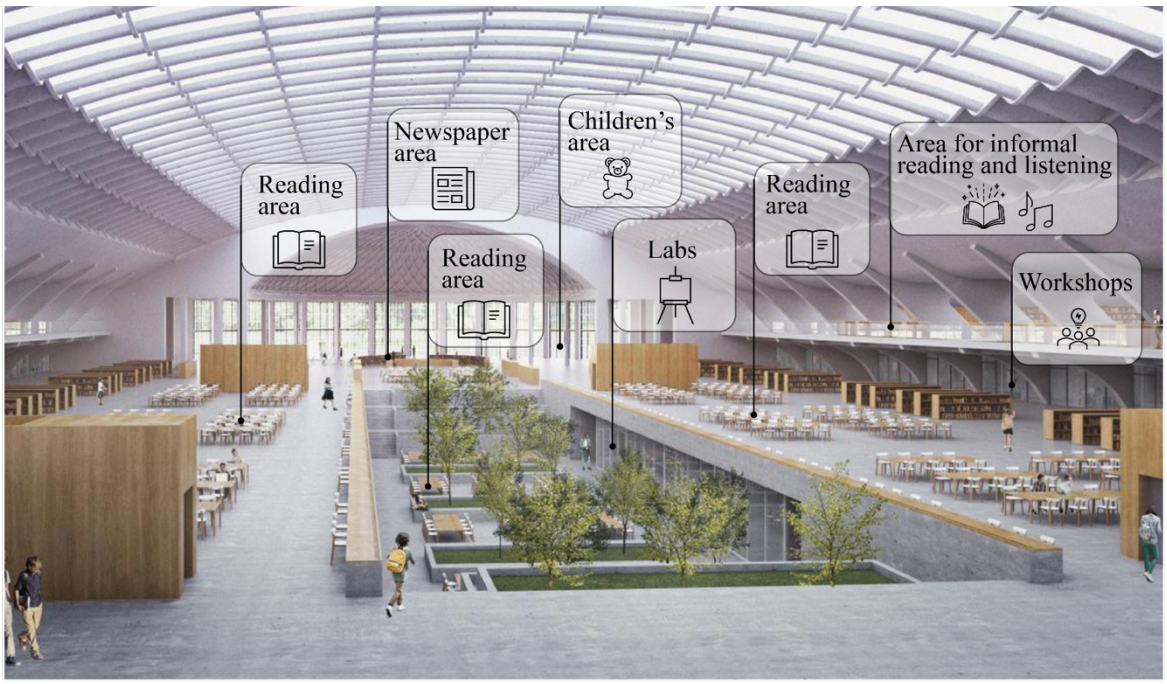

Fig. 1: Render of the main reading room of the New Civic Central Library of Torino with a focus on the multifunctionality of the library.

To simulate the realistic acoustic environment of the place, a detailed three-dimensional modeling was carried out using the acoustic software Odeon 18, with geometrical acoustic simulations performed at five receiver positions corresponding to typical user locations. Simulated sound sources included urban traffic (transmitted through the ceiling), HVAC systems (on the floor and balconies), as well as human-related activity sounds such as unintelligible and intelligible speech as well as

intelligible sentences that were syntactically correct but semantically meaningless, footsteps, page turning, pen clicking. The simulation was based on a highly accurate 3D model of the library, with surface absorption and scattering coefficients carefully assigned to each material to reflect real-world conditions.

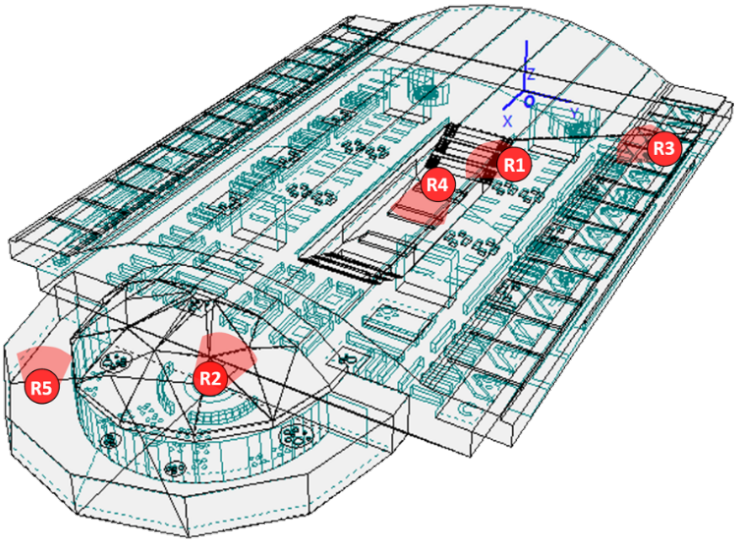

Fig. 2: 3D model of the library created in Odeon with the positioning of the five receivers.

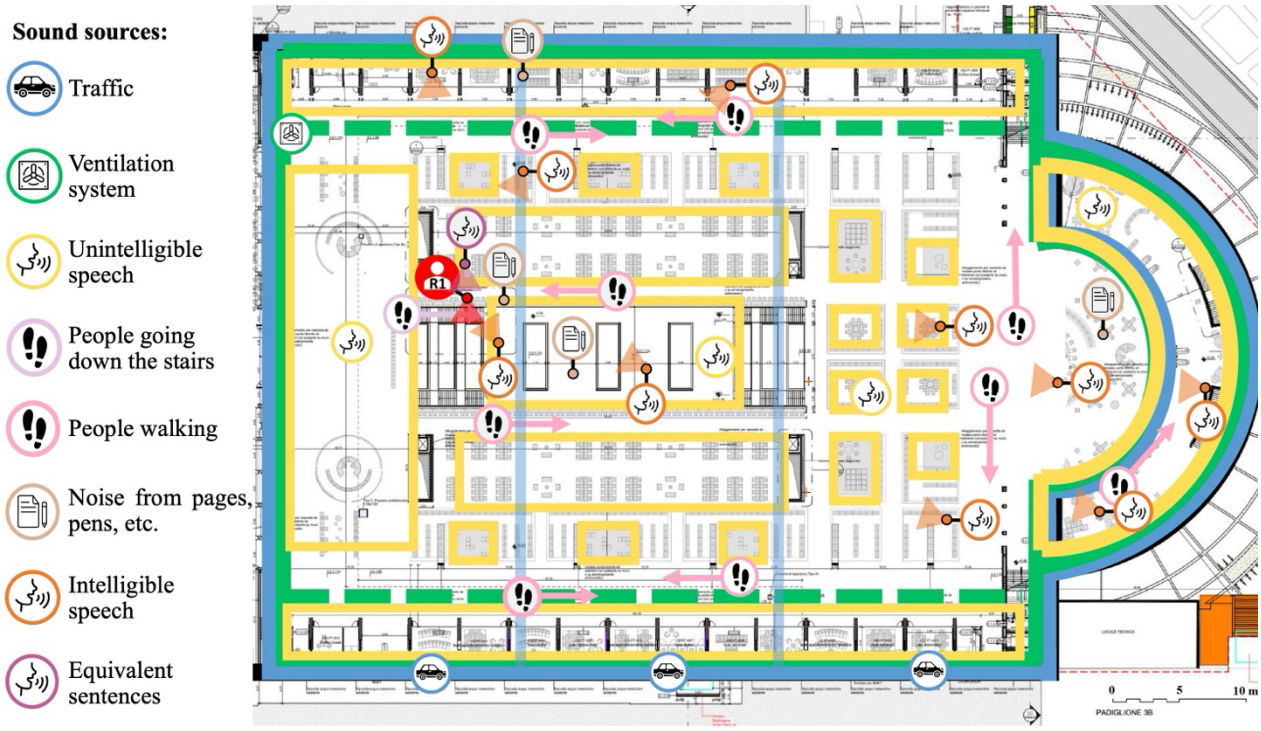

Fig. 3: Plan of the library with the positioning of the different sound sources.

The resulting A-weighted sound pressure levels ranged from 50.2 to 61.8 dB, representing moderate noise levels that may still interfere with concentration in study-oriented settings. To complement the simulation data, an experimental study was conducted involving 50 participants (aged 20–61, all with normal hearing), who completed cognitive tasks under both quiet and noise conditions. Although no statistically significant differences in task performance were observed between the two conditions, subjective reports revealed varying levels of perceived disturbance

and focus. A slight trend toward increased arousal in the presence of background noise was noted, though without clear cognitive detriment.

The findings of this study underline the complexity of assessing auditory comfort in large, multifunctional library spaces, especially when architectural constraints limit physical acoustic treatment. This thesis's work highlights the value of advanced simulation tools in evaluating complex sound environments and proposes a replicable methodology that integrates detailed physical modeling with user-centered perceptual testing. The insights gained are directly applicable to the ongoing development of the New Central Civic Library of Turin, supporting informed design decisions that balance heritage preservation with acoustic functionality.