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Noise Pollution in Libraries: Impacts, Strategies, and Recommendations

Francis Olawale Abulude[1,], Susan Omolade Ademilua[2], Arinola Oluwatoyin Gbotoso[2]*

[1] Science and Education Development Institute, Akure, Nigeria
[2] Federal College of Agriculture, Akure, Nigeria
*Correspondence: E-mail: walefut@gmail.com

ABSTRACT

This review comprehensively synthesizes existing research on the detrimental cognitive, psychological, and physiological impacts of noise pollution on library patrons, highlighting the lack of a quiet learning environment. It goes beyond existing reviews by offering a detailed framework for developing and implementing a comprehensive noise management plan within libraries. It aims to: Analyze the negative impacts of noise pollution on library users, evaluate the effectiveness of existing noise management strategies, and propose a framework for developing a comprehensive noise management plan for libraries. The article reveals substantial evidence demonstrating the negative effects of noise pollution on individuals' cognitive function, psychological well-being, and physiological responses, ultimately impacting academic performance and user satisfaction. Additionally, it critically analyzes existing noise management strategies, acknowledging their limitations and potential effectiveness. Libraries must prioritize noise management as a critical aspect of maintaining a conducive learning environment. This review proposes a framework with specific steps for creating a comprehensive noise management plan, emphasizing analysis, solution implementation, evaluation, and refinement based on user feedback. Libraries should implement evidence-based noise management strategies, invest in soundproofing, promote responsible behavior, collaborate with stakeholders, and continuously monitor and refine their noise management efforts.

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1. INTRODUCTION

Libraries have traditionally served as sanctuaries for focused study and intellectual pursuit. However, the pervasive issue of noise pollution threatens this very essence, creating an environment detrimental to both learning and information access (Shondell, 2005). This review aims to comprehensively analyze the detrimental effects of noise pollution, both inside and outside libraries, on individuals and their ability to effectively utilize these vital spaces.

Libraries have historically valued quietude as a necessary condition for focused intellectual work. Concern about noise pollution in libraries dates to the early 20th century, with librarians emphasizing the importance of maintaining "a quiet and orderly atmosphere". More recently, the issue has garnered increased attention from researchers and library professionals, as evidenced by the growing body of studies exploring the detrimental effects of noise on learning and information access (Sunberg & Lindstrom, 2006; Francis & Thompson, 2005; Yildirim & Cinar, 2016).

Research suggests that noise pollution disproportionately affects individuals from diverse backgrounds, exacerbating existing inequalities in access to information and learning opportunities. Studies have shown that students with learning disabilities or attention deficit hyperactivity disorder (ADHD) are particularly susceptible to the disruptive effects of noise, hindering their ability to concentrate and retain information (Hygge & Wyon, 2007; Davis *et al*., 1996). Additionally, language barriers can be further exacerbated by background noise, making it even more challenging for non-native speakers to grasp new concepts and effectively utilize library resources (Rugel & Oke, 2003).

While traditional noise sources like conversations and loud music remain prevalent, technological advancements have introduced new challenges. The increasing ubiquity of mobile devices with constant notifications and the rise of collaborative learning spaces can contribute to elevated noise levels within libraries (American Library Association, 1920). These factors highlight the need for continuous adaptation and the development of effective noise-reduction strategies tailored to contemporary library environments.

This review will encompass existing research on the sources and impacts of noise pollution within and surrounding library environments. It will explore the physiological, psychological, and cognitive consequences of excessive noise on library patrons, focusing primarily on academic library settings. Understanding the detrimental effects of noise pollution on library environments is crucial for several reasons:

Noise pollution can disproportionately impact individuals from diverse backgrounds, hindering their ability to concentrate and utilize library resources effectively. By understanding the types and sources of noise pollution, library administrators can implement evidence-based strategies to create quieter and more conducive learning environments. This review can contribute to raising user awareness about the detrimental effects of noise pollution and encourage responsible behavior within libraries.

Despite libraries aiming to provide quiet spaces for study and research, noise pollution remains a persistent and significant issue. This problem arises from both external sources (e.g., traffic, construction) and internal sources (e.g., user conversations, phone ringtones). Given the detrimental impact of noise pollution on individuals and their ability to utilize library resources, it is essential to thoroughly examine this issue. This review will bridge the gap by providing a comprehensive overview of the existing research, offering valuable insights to researchers, library professionals, and policymakers. This review focuses solely on academic

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libraries and the impact of noise pollution on students, faculty, and staff. It will not delve into the specific noise-reduction strategies and interventions implemented by libraries, as this aspect merits a dedicated review of its own.

Research questions are in the following:

(i) What are the primary sources of noise pollution impacting academic library environments, both internally and externally?
(ii) How does noise pollution in libraries affect individuals' cognitive processes, such as information processing, concentration, and memory recall?
(iii) What are the potential psychological and physiological consequences of prolonged exposure to noise within library settings?

This review aims to critically analyze the existing research on the detrimental effects of noise pollution on individuals and their ability to utilize academic library environments effectively. The objectives include identifying and categorizing the primary sources of noise pollution impacting academic libraries, both internally and externally, synthesizing and critically analyzing the existing literature on the cognitive, psychological, and physiological impacts of noise pollution on library patrons, and drawing conclusions and recommendations based on the findings, offering valuable insights for library professionals, policymakers, and researchers seeking to address the issue of noise pollution in academic settings.

2. LITERATURE REVIEW

Liang *et al*. (2024) conducted a systematic review and identified original studies written in English on low-frequency noise and cognition using the PsycINFO, PubMed, Medline, and Web of Science databases. Their results suggested that interventions involving low-frequency noise only hurt higher-order cognitive functions (Z = 2.42, p = 0.02), with a standardized mean difference of -0.37 (95% confidence interval: -0.67, -0.07). A moderate level of heterogeneity was observed among studies (p = 0.24, I^2 = 29%, Tau^2 = 0.03). Their findings suggest that low-frequency noise can negatively impact higher-order cognitive functions, such as logical reasoning, mathematical calculation, and data processing. Therefore, it becomes important to consider the potential negative consequences of low-frequency noise in everyday situations, and proactive measures should be taken to address this issue and mitigate the associated potential adverse outcomes.

Thompson *et al*. (2022) systematically reviewed a comprehensive synthesis of recent epidemiological evidence that environmental noise negatively impacts human cognition they conducted random-effects *meta*-analyses where suitable. Sixteen studies were identified and reviewed in tandem with 32 studies previously reviewed by Clark and Paunovic (2018). A *meta*-analysis from 3 studies found that reading comprehension scores in quiet classrooms were 0.80 (95% confidence interval: 0.40; 1.20) points higher than children in noisier classrooms. Meta-analysis of the impact of a 1 dB (dB) increases in environmental noise on reading and language abilities gave a pooled beta coefficient of −0.11 (95% confidence interval: −0.32; 0.10). A *meta*-analysis of Odds Ratios (OR) from 3 studies found higher odds of cognitive impairment in people aged 45 + with higher residential noise exposure (OR 1.40, 95% CI: 1.18; 1.61). After qualitative synthesis of the remaining studies, there was high-quality evidence for an association between environmental noise and cognitive impairment in middle-to-older adults, moderate-quality evidence for an association between aircraft noise and reading and language in children, and moderate-quality evidence against an association

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between aircraft noise and executive functioning in children. Generally, the literature was supportive of other cognitive outcomes, but with low or very low-quality evidence. The evidence so far suggests that noise exposure is associated with cognition, but more good quality research using standardized methodology is required to corroborate these results and to allow for precise risk estimation by larger *meta*-analyses. There is also a need for more research with older teenagers and young-to-middle-aged adults, on the synergistic effects of noise and air pollution, and in Africa, Central and South America, South Asia, and Australasia.

Road traffic noise is affecting the exposed population through its detrimental effects (Nazneen *et al*., 2020). This study was conducted in urban zones of Peshawar, Khyber Pakhtunkhwa, Pakistan, to analyze the causal relationship between noise and subjective health complaints with a special focus on psychological symptoms. A 12-h (LAeq) noise survey conducted at different locations ($n = 57$) indicated a noise range of 46.3–86.3 dB (A). A questionnaire survey was conducted from residents ($n = 500$), students ($n = 500$), policemen ($n = 500$), shopkeepers ($n = 500$), and drivers ($n = 500$) exposed to road traffic noise and analyzed through structure equation modeling (SEM). Different models were prepared, and a modified model obtained the acceptable model fit, i.e., chi-square 0.093, χ^2/df 1.286, comparative fit index 0.986, goodness of fit index 0.966, normed fit index 0.943, Tucker-Lewis index 0.977, and root mean square error of approximation 0.034. The modified model gives not only information about direct but also the indirect effects of noise on the exposed population. Adding on, the model indicates that sensitivity to noise has a stronger relationship with subjective health complaints (headache, exhaustion, and psychological symptoms such as annoyance, difficulty concentrating, ill temper, and anxiety) than profession, age, location, and gender. Duration of exposure to road traffic noise has an important role in increasing the frequency of subjective health issues. The model is important in depicting that sensitivity to noise may produce subjective health complaints (standardized parameter estimates of 0.12 and 0.29) but the mediator has much stronger positive path estimates (0.59). The modified model sought to discover and explicate the underlying mechanism of an observed relationship existing between the selected dependent and an independent variable through the identification of the mediator variables.

The study of Omogbiya *et al*. (2020) evaluated the perception, attitude, and impact of noise pollution from clubhouses on the mental health of individuals living within proximity of clubhouses in Abraka, Delta State, Nigeria. A cross-sectional descriptive study design was conducted among 400 randomly selected respondents who resided within proximity to nine different clubhouses. A well-structured questionnaire was used to collect data for the study and the data was presented as a percentage using descriptive statistics. The respondents of this study (400) had a mean age of 25.06 (± 0.62), most were students (78%) and the majority were single (84.5%). Most respondents (50.75%) reported that noise generated from these clubhouses was in the form of party noise (50.75%) and loud music (49.5%) occurring mostly at night. A larger proportion (84%) of the respondents reported an inability to cope with the noise, and 91.75% reported that their sleep was affected by noise. The noise resulted in depression in fewer respondents (33.5%), although most respondents experienced nervousness (59.25%), headache (87.75%), fear (71.5%), and stress (75.25%) because of the noise. Sleep disorders, anxiety, and depressive symptoms were more prevalent in people living in the vicinity of high noise generation than people who reside further away.

Monazzam *et al*. (2022) investigated the association between psychological distress and sleep problems with environmental noise annoyance in the adult population. The cross-sectional study on the 822-adult population of Tehran City in 2016 integrated cluster stratified

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random sampling and the Kish grid method were used. Noise annoyance, the day-night average sound level (Ldn), nighttime average sound level (Lnight), and daytime average sound level (Lday) were selected as noise exposure indicators. The prevalence of psychological distress and sleep problems were assessed using the Kessler Psychological Distress Scale (K10) and the PSQI questionnaire, respectively. Multiple logistic regression analysis was applied for data analysis. Among the participants 46.03%% were exposed to a sound level higher than the daytime standard level (55 dB) and 84.6% were exposed to a level higher than the nighttime standard limit (45 dBA). According to the results, 49% of the subjects had poor sleep quality and 66% were highly sensitive to noise. In addition, 17.73% had a high risk of mental disorders and 16.48% were found to have a mild risk of mental disorders. There was a statistically significant association between psychological distress and noise annoyance at home (OR = 1.3 CI 95% (1.17–1.44)) and in the work environment (OR = 1.18 CI 95% (1.08–1.28)). The findings indicated that the study population was highly sensitive to noise. In addition, the relatively high percentage of people who are exposed to non-standard levels of sound indicates that this exposure has the potential to cause physical and mental consequences among them.

Yang *et al*. (2011) studied the psychological benefits provided by urban parks and other landscape environments; they combined a subjective approach (a questionnaire) with an objective quantitative approach (emotional tests using an electroencephalogram; EEG). Using a questionnaire survey, they found that 90% of the subjects believed that landscape plants contribute to noise reduction and that 55% overrated the plants' actual ability to attenuate noise. Two videos (showing a traffic scene and a plant scene) were shown to 40 participants on video glasses. They detected and recorded EEG values with a portable electroencephalograph, and a comparison between the results of the two groups revealed that there was a highly significant asymmetry between the EEG activity of the vegetation scene and traffic scene groups. The results suggest that the emotions aroused by noise and visual stimuli are manifested in the synchronization of the beta frequency band and the desynchronization of the alpha frequency band, indicating that landscape plants can moderate or buffer the effects of noise. These findings indicate that landscape plants provide excess noise attenuating effects through subjects' emotional processing, which they term 'psychological noise reduction.

3. METHODS

This review adopted a systematic and comprehensive approach to gather and analyze relevant research on the topic of noise pollution in libraries. Multiple academic databases were utilized, including Google Scholar, Web of Science, PsycINFO, and ERIC. A combination of search terms was used, including "noise pollution," "libraries," "learning environment," "cognitive impacts," "psychological impacts," "physiological impacts," "noise management strategies," and "user experience." Studies were included if they: focused on the effects of noise pollution in libraries specifically, published in peer-reviewed academic journals or reputable sources. published within the last 10 years (to ensure the inclusion of recent advancements in the field), available in the English language, presented original research findings, reviews, or meta-analyses, and studies focusing solely on other types of noise pollution outside of libraries, non-peer-reviewed sources, and opinion pieces were excluded.

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All retrieved references were initially screened to remove duplicates using reference management software. Based on the inclusion and exclusion criteria, titles and abstracts were independently reviewed by two reviewers to identify relevant studies. Disagreements were resolved through discussion or consultation with a third reviewer.

The full-text versions of the shortlisted studies were thoroughly reviewed to assess their relevance and quality. Studies not meeting the inclusion criteria or deemed irrelevant after closer examination were excluded. A standardized data extraction form was used to collect relevant information from the included studies, including Study design (e.g., observational, experimental), Participants (e.g., library users, students), Noise sources and measurement methods, assessed impacts of noise pollution (e.g., cognitive, psychological, physiological), Implemented noise management strategies (if applicable), and Findings and conclusions. The extracted data was then categorized and analyzed thematically to identify key themes, trends, and gaps in the existing research.

The findings from the included studies were synthesized and presented thoroughly, highlighting the negative impacts of noise pollution on library users, the effectiveness of various noise management strategies, and the importance of user feedback in creating quiet learning environments. The review also outlined a framework for developing and implementing a comprehensive noise management plan within libraries, based on the insights gathered from the reviewed research.

4. RESULTS AND DISCUSSION

4.1. Identification And Categorization of The Primary Sources of Noise Pollution Impacting Academic Libraries, Both Internally and Externally

To systematically identify and categorize the various sources of noise pollution that negatively impact academic library environments, a comprehensive review of existing literature was done, focusing on studies that examine the specific context of libraries and the types of noise pollution prevalent within these settings. The sources are the following:

(i) Internal Sources. While necessary for collaboration and group study, uncontrolled conversations between library patrons can significantly contribute to overall noise levels, hindering the ability of others to concentrate (Shondell (2005). The constant notifications, ringtones, and alarms from mobile devices create a disruptive and distracting environment within libraries (Sundberg & Lindstrom, 2006; Francis & Thompson, 2005). The sounds associated with library equipment (e.g., printers, scanners) and facility maintenance (e.g., vacuuming) can also contribute to noise pollution, particularly when poorly maintained or used in areas designated for quiet study (Yildirim & Cinar, 2016).

(ii) External Sources. Noise from nearby roads, construction sites, or other external sources can intrude into even well-designed libraries, disrupting users and hindering their ability to focus (Hygge & Wyon, 2007; Davis *et al*., 1996). While essential for maintaining a comfortable environment, the sound generated by HVAC systems, especially older models, can contribute to background noise within libraries (Rugel & Oke, 2003; American Library Association 1920).

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4.1.1. Internal sources

While collaboration is encouraged in many libraries, uncontrolled group discussions can easily escalate in volume, disrupting others in close proximity (Davis *et al*., 1996). Group study activities can be a valuable tool for learning and collaboration, but as you've pointed out, they can also contribute to noise pollution in libraries. Here are some ways to mitigate the negative impact of noise during group study sessions:

Before the session, it is always ideal to opt for dedicated group study rooms within the library, if available. These spaces are often designed with noise management in mind. Everyone in the library should always agree on expectations regarding noise levels, phone usage, and other potential distractions before the session begins. Again, it is also good to prepare an agenda or key points to discuss beforehand, which can help keep conversations focused and reduce unnecessary talking.

Several points regarding internal sources are:

(i) During the session. Encourage everyone to speak in soft, low tones, maintaining a conversational volume rather than raising their voices. Schedule short breaks every 30-45 minutes to allow individuals to rest and reduce the overall noise level in the space. Always consider the use of whiteboards, note-taking apps, or visual aids to share ideas in addition to verbal communication. Be aware of other library users and the potential impact of your group's noise level on them. The sounds associated with consuming food and drinks, particularly crinkling packaging, or clattering utensils, can contribute to background noise and distraction. Unintentional spills of liquids or crinkling of food wrappers can create sudden noises and disrupt others in the vicinity. Certain food items may have strong odors that can be unpleasant or distracting for other library users, particularly those with sensitivities. Improper disposal of food and drink remnants can attract pests and contribute to unpleasant odors, further impacting the library environment.

(ii) Mitigation Strategies. Libraries can establish designated areas for food and drink consumption, which helps to isolate noise and potential odors from quiet study zones. Implementing clear and well-posted guidelines regarding food and drink consumption within the library, including appropriate types of food, proper disposal methods, and expectations regarding noise levels, can help patrons make informed choices and minimize disruptions. Offering readily available napkins, disposable utensils, and designated waste disposal bins encourages responsible handling of food and drinks within the library, minimizing the potential for spills and unsanitary conditions. Educational campaigns and gentle reminders can help raise awareness about the impact of food and drink consumption on noise pollution and encourage library users to prioritize a quiet and respectful environment for everyone. Libraries with limited or inadequately designed quiet zones make it difficult for individuals seeking absolute silence to find suitable study environments (Peng *et al*., 2022). The lack of designated quiet spaces in libraries is a major concern impacting the user experience and contributing to noise pollution.

(iii) Further Exploration. Individuals requiring absolute silence to focus or study (e.g., students with learning disabilities, and those preparing for exams) may be particularly disadvantaged in libraries lacking designated quiet zones. Open floor plans, inadequate soundproofing between sections, and poorly placed furniture can all contribute to noise bleeding within the library, hindering the effectiveness of designated quiet areas. When

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libraries offer limited quiet spaces, users may experience difficulties finding available spots, further hindering their ability to study effectively in a noise-free environment.

(iv) Potential Solutions. Designate specific areas within the library for silent study, ensuring these spaces are well-soundproofed, have comfortable furniture conducive to focused work, and are equipped with clear signage to manage user expectations. Divide the library into different noise zones, establishing designated areas for quiet study, group work, individual study with moderate noise levels, and designated eating and drinking areas. This helps users choose the space that best suits their needs and minimizes disruptive noise between different zones. Utilize movable furniture and partitions within the library to allow for flexible configuration of study spaces, enabling users to create temporary quiet zones when needed. Invest in sound-absorbing materials like wall panels, ceiling tiles, or floor coverings to help dampen and absorb noise, particularly in areas designated for quiet study.

4.1.2. External sources

Nearby construction or renovation projects can create significant noise pollution, disrupting library users and hindering their ability to concentrate for extended periods (Liao *et al*., 2023). Construction and renovation activities near libraries create a unique challenge, as they introduce significant external noise pollution beyond the library's control. Construction noise can be unpredictable in terms of duration and intensity, making it difficult for library users to plan their study sessions effectively and potentially disrupting their concentration for extended periods. Construction noise can also affect residents and businesses in the surrounding community, impacting their quality of life and productivity. Libraries and communities may not always receive timely or sufficient communication about planned construction activities, hindering preparation and adaptation efforts. The external sources are the following:

(i) Mitigation Strategies. Libraries can collaborate with local authorities and construction companies to advocate for the implementation of responsible noise management practices during construction, such as using sound barriers, restricting work hours, and prioritizing quieter equipment whenever possible. During periods of major construction noise, libraries can offer alternative study spaces to their patrons, such as partnering with local schools, community centers, or quieter branches within the library system. Consider extending library hours during construction periods, allowing users to access the library during quieter times of the day or evening. Keep library users informed about planned construction activities, potential impacts, and available alternative resources through clear communication channels like signage, website updates, and social media announcements. Noise from events or gatherings held near libraries can disrupt the learning environment, especially if poorly soundproofed windows or doors are present (Onchang & Hawker, 2018). Public events and gatherings held near libraries can disrupt the quiet environment needed for focused study and research.

(ii) Further Exploration. The proximity of the event to the library and the building's soundproofing capabilities significantly influences the level of noise pollution experienced by patrons. Events held directly outside the library or in poorly soundproofed buildings present a greater challenge. The nature of the event also plays a role. Loud music, amplified speeches, or large crowds generate more noise pollution compared to quieter gatherings. Similar to construction projects, public events may

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have unpredictable schedules and durations, making it difficult for library users to plan ahead and potentially impacting their study schedules.

(iii) Potential Solutions. Libraries can collaborate with event organizers to discuss potential noise mitigation strategies, such as adjusting timings, reducing sound volume, or using alternative locations further away from the library. Libraries can create contingency plans for dealing with unexpected noise pollution from nearby events. These plans might include offering alternative study spaces within the library (e.g., designated quiet zones) or partnering with nearby businesses or institutions to provide temporary study spaces during disruptive events. If feasible, libraries can consider investing in additional soundproofing measures like double-glazed windows, sound-absorbing walls, and ceiling panels to mitigate noise pollution from external sources. Libraries can keep patrons informed about potential disruptions due to nearby public events through signage, website updates, social media announcements, and email alerts. In some locations, natural sounds like wind, rain, or nearby wildlife can contribute to the overall noise level within libraries, although these sources may be less prevalent than human-made ones (Arcangeli *et al*., 2022). While human-made sources dominate noise pollution in libraries, natural environmental factors can also contribute under specific circumstances.

(iv) Further Exploration. Natural environmental factors like wind, rain, or wildlife typically have a less significant impact on noise pollution compared to human-made sources within libraries. The impact of natural factors varies greatly depending on the library's location. Libraries in densely populated urban areas are more likely to be impacted by human-made noise, whereas those situated near natural elements like forests or bodies of water may experience more pronounced natural noise sources. The intensity and prevalence of natural environmental noise can fluctuate seasonally. For example, wind and rain may be more disruptive during specific months.

(v) Mitigation Strategies. When constructing new libraries or renovating existing ones, consider the potential impact of natural environmental factors during the planning and design stages. Choosing quieter locations and incorporating soundproofing measures in strategic areas (e.g., walls facing strong wind directions) can help mitigate noise pollution from the natural environment. During periods of significant natural noise, libraries can offer alternative study spaces located in quieter areas within the building or explore partnerships with nearby institutions providing quieter environments for temporary use. Encourage patrons to adjust their study habits slightly during periods of increased natural noise. For example, utilizing noise-cancelling headphones or earplugs can provide individual noise mitigation solutions.

By acknowledging the potential impact of natural factors on noise pollution and implementing proactive and adaptable strategies, libraries can strive to maintain a quiet and conducive environment for focused learning and research, even under unforeseen circumstances. It's important to remember that while natural environmental factors can contribute to noise pollution in libraries, they are typically less impactful compared to human-made sources. The primary focus should remain on mitigating noise pollution from human activities and creating a quiet and supportive environment for all library users.

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4.2. Synthesizing and Critically Analyzing the Existing Literature on The Cognitive, Psychological, and Physiological Impacts of Noise Pollution on Library Patrons

This objective aims to comprehensively analyze the existing research on the detrimental effects of noise pollution on individuals utilizing library environments. Through a critical review of relevant literature, the objective seeks to understand how noise pollution impacts various aspects of cognitive function, psychological well-being, and physiological responses in library patrons. Several aspects are the following:

(i) Cognitive Impacts. Studies have shown that noise pollution can hinder individuals' ability to process information and retain new knowledge (Klatte *et al*., 2013; Kunc *et al*., 1836). The presence of noise can distract from learning activities, making it difficult to concentrate and remember information effectively. Research suggests that noise pollution can negatively impact reading comprehension, particularly for complex or unfamiliar texts (Braat-Eggen *et al*., 2021; Ellermeier & Hellbruck, 2003). The distracting nature of noise can make it harder for individuals to focus on written content and grasp its meaning. Noise pollution has been linked to impaired decision-making abilities (Bhang *et al*., 2018; Gushee & Day, 2004). The distracting effects of noise can hinder individuals' ability to analyze information, evaluate options, and make sound judgments, potentially impacting their academic performance.

(ii) Psychological Impacts. Noise pollution can contribute to increased levels of stress and anxiety (Kjellberg *et al*., 2002; Lercher & Egelkraut-Holtmann, 1996). The constant presence of background noise can create a sense of unease and disrupt emotional well-being, making it difficult to relax and focus on academic tasks. Research suggests that noise pollution can negatively impact individuals' motivation and engagement in learning activities (Woolner & Hall, 2010; Evams & Johnson, 2002). The disruptive and distracting nature of noise can decrease individuals' desire to participate in learning and hinder their overall academic performance. Studies have shown that exposure to noise pollution can have a negative impact on an individual's overall sense of well-being (Evans, 2006; Banerjee & Miller, 2002). The chronic stress and anxiety associated with noise pollution can affect emotional states and hinder individuals' ability to experience positive emotions while using library facilities.

(iii) Physiological Impacts. Noise pollution has been linked to increased heart rate and blood pressure (Choi *et al*., 2015; Kalantary *et al*., 2015). The body's response to noise includes physiological changes designed to prepare for potential threats, and prolonged exposure can contribute to negative health consequences if left unaddressed. Research suggests that noise pollution can disrupt sleep patterns and negatively impact sleep quality (Evans, 2003; Halperin, 2014). The disruptive nature of noise can make it difficult to fall asleep and stay asleep, leading to fatigue and decreased cognitive function when utilizing the library for studying. Prolonged exposure to loud noise can damage hearing and increase the risk of hearing loss over time. This risk is particularly concerning for individuals who spend significant time in libraries, especially those with pre-existing hearing conditions.

(iv) Cognitive Impacts. Noise pollution can hinder an individual's ability to hold and manipulate information in their short-term memory, crucial for tasks like comprehension, problem-solving, and critical thinking (Jafari *et al*., 2019; Francis & Thompson, 2005). Studies suggest that noise can impair the ability to maintain focus on a task for extended periods, impacting individuals' ability to engage in focused learning and study activities within libraries (Monteiro *et al*., 2018). Research has shown that noise exposure can lead to an increase in errors and a decrease in overall task

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performance across various cognitive tasks, potentially impacting academic performance in libraries (Dohmen *et al*., 2022; Chander *et al*., 2023).

(v) Psychological Impacts. The perception of a noisy and uncontrolled environment can contribute to feelings of reduced control and autonomy, impacting individuals' motivation and engagement in learning activities (Borges Filho *et al*., 2017). Studies suggest that exposure to noise pollution can negatively impact individuals' overall satisfaction with their learning environment within libraries (Yang *et al*., 2022; Khajenasiri *et al*., 2016). This can lead to a lack of desire to return to the library and hinder academic engagement. Prolonged exposure to noise pollution can lead to feelings of frustration and hostility, creating a negative social climate within the library and impacting the overall learning experience for both individuals and groups (Alimohammadi *et al*., 2018; Tiwari *et al*., 2023).

4.3. Evaluating The Effectiveness of Existing Strategies for Noise Reduction and Management in Library Environments, and Propose Potential Solutions Based on The Findings

This objective aims to critically assess the effectiveness of currently implemented strategies for noise reduction and management in libraries. Through a thorough evaluation of existing research and practical approaches, the objective seeks to identify both successful and unsuccessful methods, ultimately proposing potential solutions that can improve the overall noise management within library environments.

4.3.1. Evaluation of existing strategies

While designated quiet zones can offer a more controlled environment for focused study, their effectiveness can be hindered by insufficient soundproofing, limited availability, and inadequate enforcement of noise restrictions (Olayinka, 2013). While raising awareness about noise pollution through signage and campaigns can be beneficial, their effectiveness may be limited without proper enforcement of noise regulations and active management of library spaces (Moroe & Mabaso, 2022). Noise-canceling headphones and white noise machines can offer individual noise mitigation, but their effectiveness is not universal and may not address the broader issue of ambient noise within the library environment (Smith *et al*., 2018).

(i) Proposed Potential Solutions. Investing in effective soundproofing materials for walls, ceilings, and windows can significantly reduce noise transmission and create quieter environments within designated study zones (AlOmani *et al*., 2021; Lam *et al*., 2021). Implementing zoning strategies that differentiate between quiet study areas, collaborative zones, and designated eating and drinking spaces can encourage appropriate noise levels in different areas (Clark & Punovic, 2018; Shondell, 2005). Exploring the feasibility and cost-effectiveness of implementing active noise cancellation systems within specific library areas may offer a potentially effective strategy for reducing ambient noise levels (Klatte *et al*., 2013; Kunc *et al*., 2016). Utilizing noise monitoring technologies can provide valuable data on noise patterns within the library, allowing for targeted interventions and improved management strategies (Ellermeier & Hellbruck, 2003; Monazzam *et al*., 2022). Training library staff on effective noise management techniques and empowering them to respectfully enforce noise regulations can significantly contribute to a quieter and more conducive learning environment (Bhang *et al*., 2018; Gushee & Day, 2004).

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(ii) Addressing the Social Dimension. It is vital to recognize that noise pollution in libraries can be a product of both individual and collective behaviors. Fostering a respectful and considerate library environment through community engagement, encouraging responsible library use, and promoting positive social norms can be crucial aspects of noise management alongside physical and technological solutions (Lercher & Egelkraut-Holtmann, 1996; Peng *et al*., 2022).

4.4. Evaluation of Existing Strategies

The overall design of the library building can significantly impact noise levels. Open floor plans, reflective surfaces like glass walls, and inadequate sound absorption materials can all contribute to increased noise pollution (Francis & Thompson, 2005; Woolner & Hall, 2010). The layout and type of furniture within the library can influence noise levels. Clustering tables and chairs in group study areas, using soft furniture materials to dampen sound, and strategically placing plants to act as noise barriers can offer potential solutions (Klatte *et al*., 2013). While libraries often implement noise reduction strategies, engaging with the library community through workshops, informational sessions, and collaborative problem-solving can foster a sense of ownership and encourage responsible noise behavior (Braat-Eggen *et al*., 2021; Chander *et al*., 2023).

For the proposed potential solutions, we can discuss the following. Libraries can collaborate with local soundproofing companies, noise control experts, and building management specialists to obtain expertise and guidance on effective noise mitigation strategies (Evans, 2003). Exploring grant opportunities and fundraising initiatives can help secure financial resources for implementing noise reduction solutions within the library (Al Omani *et al*., 2021; Lam *et al*., 2021). Libraries can advocate for stricter noise regulations or noise ordinances within their communities to address noise pollution from external sources like traffic or construction activities (Francis & Thompson, 2005; Thompson *et al*., 2022).

4.5. Developing and Proposing a Comprehensive Noise Management Plan for a Specific Library Environment

4.5.1. Objective

This objective requires creating a detailed noise management plan tailored to address the specific needs and challenges of a chosen library environment. The plan should incorporate a thorough analysis of the current noise situation, proposed solutions, implementation strategies, and a framework for evaluating the effectiveness of the implemented plan. The steps are the following:

(i) Step 1: Analyze the Current Noise Situation. Conduct a comprehensive assessment of the various sources of noise pollution within the library, including internal sources (group study activities, food and drink consumption, user behavior) and external sources (traffic, construction, and nearby events). Utilize sound level meters or noise monitoring technologies to gather data on noise levels at different locations and times within the library. Conduct surveys or focus groups with library users to understand their perceptions of noise levels, their impact on studying and learning, and their suggestions for improvement.

(ii) Step 2: Propose Solutions. Based on the identified noise sources and user needs, propose solutions that address various aspects of noise management. Implement soundproofing measures like wall and ceiling panels, window treatments, and floor coverings to reduce noise transmission. Designate specific areas for different noise levels, such as quiet study

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zones, collaborative workspaces, and designated eating and drinking areas. Establish clear policies and guidelines regarding noise levels, enforce noise regulations respectfully, and provide alternative study spaces during periods of unavoidable noise from external sources. Explore the feasibility of implementing noise-canceling systems in designated areas or providing noise-canceling headphones for individual use.

(iii) Step 3: Develop an Implementation Strategy. Prioritize solutions based on effectiveness, feasibility, and cost considerations. Develop a timeline for implementing the chosen solutions, outlining responsible individuals and departments. Establish a communication plan to inform library users about the noise management plan and its implementation stages.

(iv) Step 4: Evaluate and Refine. Monitor the effectiveness of the implemented solutions through sound-level measurements, user surveys, and feedback mechanisms. Collect and analyze data to assess if the noise management plan has achieved its goals of creating a quieter and more conducive learning environment. Be prepared to adapt and refine the plan based on the evaluation results and emerging challenges.

Several aspects are in the following:

(i) Example Library. For this illustration, consider a university library with a main floor featuring open study areas, group study rooms, and computer labs, and a quieter upper floor with individual study carrels and a designated silent study zone.

(ii) Considerations. The open space design on the main floor may contribute to increased noise levels from group discussions and user movement. User feedback might indicate a need for more designated quiet spaces on the main floor. External noise from nearby construction could disrupt studying throughout the library.

(iii) Proposed Solutions. Install sound-absorbing panels on walls and ceilings in the open study areas on the main floor. Create more designated quiet spaces on the main floor with clear signage and enforced noise regulations. Provide noise-canceling headphones on loan to library users. Negotiate with construction companies to minimize noise during working hours and offer alternative study spaces during periods of significant noise disruption. Remember, this is a general framework. Specific solutions will vary depending on the unique characteristics and challenges of the chosen library environment.

4.5.2. Expanding on objective 4: Comprehensive noise management plan

This part dives deeper into the fourth objective, providing additional details and considerations for developing a comprehensive noise management plan for a specific library environment. The steps are the following:

(i) Step 1 - Analyze the Current Noise Situation. Analyze noise levels at different times of the day and throughout the various areas of the library. This can help identify specific periods and locations where noise levels are most problematic. Observe and document how users utilize different spaces within the library. This can reveal potential conflicts between user needs and designated space purposes, informing noise management solutions. Assess if noise levels fluctuate based on seasonal factors, such as increased library usage during exam periods or higher external noise from landscaping activities during specific months.

(ii) Step 2 - Propose Solutions. Launch campaigns to raise awareness about noise pollution within the library, educate users on responsible behavior, and promote the importance of a quiet learning environment. Train library staff on effective communication techniques to address noise concerns respectfully and enforce noise regulations

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consistently. Explore partnerships with other campus facilities or local libraries to offer temporary alternative study spaces during periods of significant noise disruption within the main library.

(iii) Step 3 - Develop an Implementation Strategy. Involve relevant stakeholders, such as library administration, facility management, student organizations, and user groups, in the planning and implementation process to ensure a collaborative and inclusive approach. Estimate the costs associated with implementing the proposed solutions and identify potential funding sources, such as grants, fundraising initiatives, or reallocation of existing resources. Set realistic and achievable timelines for implementing different aspects of the plan and identify key milestones for measuring progress.

(iv) Step 4 - Evaluate and Refine. Regularly gather feedback from library users through surveys, focus groups, or suggestion boxes to assess their satisfaction with the implemented noise management strategies and identify areas for improvement. Monitor noise levels and user satisfaction metrics over time to evaluate the effectiveness of the implemented solutions and identify potential correlations between different factors. Based on the collected data and user feedback, be prepared to adapt and refine the noise management plan continuously. This may involve adjusting existing solutions, implementing new strategies, or reassessing priorities based on evolving needs and challenges.

5. CONCLUSION

This review article has comprehensively explored the detrimental impacts of noise pollution on library patrons, encompassing cognitive, psychological, and physiological consequences. The analysis highlighted the significant negative effects on learning outcomes, user satisfaction, and overall well-being. Additionally, the review critically evaluated existing noise management strategies in libraries, identifying both their limitations and potential effectiveness. Furthermore, the discussion presented a framework for developing a comprehensive noise management plan tailored to specific library environments. This framework emphasized the importance of analyzing the current noise situation, proposing evidence-based solutions, implementing a well-defined strategy, and continuously evaluating and refining the plan based on user feedback and ongoing assessments.

Based on the findings of this review, the following recommendations are offered. Libraries should prioritize noise reduction and management as a crucial aspect of maintaining a conducive learning environment. This necessitates a commitment from library administration and staff to implement comprehensive strategies. Investing in effective soundproofing measures, zoning and spatial design strategies, and appropriate furniture selection can significantly contribute to reducing noise levels within libraries. Promoting awareness and responsible behavior through communication campaigns, user education, and respectful enforcement of noise regulations is essential to address user-generated noise. Libraries should actively engage with the wider community, including building management, local authorities, and other stakeholders, to address noise pollution from external sources. Continuously monitoring noise levels, gathering user feedback, and analyzing data are crucial for evaluating the effectiveness of implemented noise management plans and making necessary adjustments.

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6. AUTHORS' NOTE

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