

e-Proceeding

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SPACE PLANNING DETERMINANTS TO ACHIEVE ACOUSTICAL COMFORT IN LIBRARIES: A LITERATURE REVIEW

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Abstract

Library spaces nowadays exhibit a wide range of acoustic quality since it provides spaces for 'reading and thinking' as well as spaces for 'communicating and interacting' to be suited with current learning practices, whether in schools, universities or public libraries. Planning a space to cater for various activities in a library will be complex and need a conscientious approach to ensure the occupants experience the acoustical comfort thus achieving quality learning conditions. This paper aims to review the determinants of space planning criteria towards the library's acoustical comfort. The paper presents a discussion on the space planning components, sustainable standard, noise sources and acoustical comfort. The findings provide an insight for researchers interested in acoustic comfort and sustainable space planning for libraries.

Keywords: *acoustical comfort, library, space planning, sustainable environment, noise*

1.0 INTRODUCTION

The elements of indoor environment quality (IEQ) play an important role to ensure the occupants experience comfort in the buildings. Many researches explained that IEQ could cover many issues related to occupant comfort, health, and safety and those who occupy space within it. IEQ is determined by many factors including the functions of space layout and the acoustics comfort (Lee & Kim, 2008). Library is one of the facilities that provide educational sources for supporting the learning process. and today's library acts as a modern and open plan concept and function. The open plan of the library has difficulty in controlling the sound and type of activities. Noise in a library is a constant source of concern for library users and administrators (Lange, Miller-Nesbitt, & Severson, 2016; Heaton and Master, 2007; Both, Heitor, & Medeiros, 2013). Therefore, some opinions said that the library should be prepared towards a peaceful environment to the occupants including among others, thermal, visual and acoustic comfort (Roulet, 2001). Furthermore, the Malaysia Green Building Index also indicates that the acoustic environment needs to ensure that the building is designed to maintain a comfortable acoustic environment for occupants.

A library should be provided with a good physical setting and comfortable environment for users to ensure that the learning needs being fulfilled and the objective of learning being achieved. However, many issues regarding noise pollution have been raised and causing user discomfort, thus affecting the learning process and performance. Furthermore, it also led towards behaviours dissatisfaction (Petty, 2017; Low, Liu, & Oh, 2008; Mattern, 2007) and disturb the quality of life, education performance, environmental awareness and health (Jan, 2014; Gordon-Hickey & Lemley, 2012).

Research regarding noise discomfort revealed that noise sources mostly came from people voice, cell phones, furniture movement and machinery (Oyedum, 2012; Vance, 2018; Cicolani & Cicolani, 2018; Nilsson, Hellström, & Berthelsen, 2008; Markham, 2004).

Consequently, to countermeasure the issues, the design strategies especially on space planning which encompass factors like physical setting, spatial function analysis, space allocation, space flexibility, space shape, space fluidity, etc are recommended to achieve acoustic comfort for library (Xiao & Aletta, 2018; Janet E. Franks and Darla C. Asher, 2014; Yoo-Lee, Lee, & Velez, 2013;). Therefore, this paper attempts to review the literature that focuses on space planning for acoustic comfort. What are the factors or components that could cater the noise pollution issue? Three objectives are formulated to understand the overall scope of study. First, the noise in the library and its source. Second, the acceptable sustainable noise standards for IEQ and third, the concept of space planning components as contributing factors to acoustic comfort.

2.0 METHODOLOGY

A content analysis was conducted to extract the suitable content from scientific journal publications related to keywords of acoustical comfort, library, space planning, sustainable environment and noise. The papers were collected from various fields of Built Environment, Facilities, Library Information, Library Management, Architecture and Building Engineering, Educational Research and Library Administration. Relevant articles have been extracted using qualitative systematic content analysis which all-encompassing review of the available literature on aforementioned keywords. Accordingly, we also investigated publications on space planning and acoustical comfort that were published in 2008 until the end of 2019.

3.0 LIBRARY NOISE AND IEQ STANDARDS

The library's multifunction spaces and modern design come with a large open plan area which has recently expanded its function from only reading books to visiting exhibitions, meeting friends, collaborative meetings, children's activities as well as having lunch. Therefore, sounds of various activities and conversation are difficult to control. Expecting that libraries will maintain their quiet traditional environment is no longer possible. In previous researches conducted, noise distraction in the library came from many causes including sound, footsteps and furniture (Oyedum, 2012), people (Vance, 2018), cell phones (Cicolani & Cicolani, 2018), sound from eating and audio players (Xiao & Aletta, 2016) furniture (Oyedum, 2012), machinery (Markham, 2004) and also speech (Nilsson, Hellstrom, & Berthelsen, 2008). From all listed noise sources, noise from people had a very wide margin and the main acoustic source of disturbance in open plan libraries is usually caused by speech, while 82 percent of the noise complaints identified in the library's quiet and isolated area were caused by machinery. Studies conducted in 1938 had categorized library noise into two, which are, background noise and service noise. When referred to at present time, background noise with a decibel reading that ranges from low 34dB to 70dB is normally caused by main noise as mentioned above. On the other hand, the 'service noise' is the noise that produces very minimal decibel reading of 5db to 16db and sometimes reaches 60dB, but consequently contributing to noise pollution. The list includes shoe clicking, pencil sharpener, scraping of chairs, books drop on table or shelf, flipping magazines or newspaper, closing and opening windows, opening desk drawers, etc. and these noise sources normally increase during the day (McDiarmid & Tatum, 1938). These service noises may seem to not have a big impact but when accumulated, it can be partly responsible for noise disturbance for library users.

Acoustic comfort also is part of the factors that contributes to Indoor Environment Quality (IEQ) which is also a criterion used to rate human health and indoor comfort in a green building. Organizations like Green Building Index (GBI) in Malaysia, are creating green rating tools in order to promote a sustainable and healthier indoor environment, simultaneously improving the quality of life of the occupants. Many countries have set the acoustic comfort reading from the range of 45dB to 60dB as shown in Table 1. From the standard noise level, we can see whether the spaces in the library have achieved acoustic comfort or not.

Table 1: Noise standard comfort in some countries

Selected noise level standards	Noise Level dB
WHO recommended health criteria (noise level guidelines)	45 dB
Malaysia (GREEN BUILDING INDEX)	50 dB
Japan (Ministry of the Environment Government of Japan)	50 dB
Singapore (ANSI Standards)	60 dB

4.0 SPACE PLANNING COMPONENTS CONTRIBUTING TO ACOUSTIC COMFORT

In the aforementioned statements, many researchers have recommended space planning as a design strategy to achieve acoustic comfort. Space planning is one of the crucial elements in the interior design process. The designer or space planner will conduct in-depth analysis of the use of space, its function, activities occur, circulation pattern, how people move through the space and finally, how to decide upon the physical setting of the space by adding furniture elements, equipment, accessories, decoration, etc. until up to acoustic treatment. In the modern library design, the expectation towards the acoustic environment becomes challenging since its use is not limited to individual activities but gradually spreading towards collaborative involvement and social activities. Therefore, space planning in this study context can be defined as *an in-depth analysis space that is used in structures, which considers the purpose of space and who will use them. It helps ensure efficient use of floor space without wasting it.*

In order to associate the space planning with acoustic-comfort-library, analysis on related literature has been conducted and it can be concluded that the space planning for acoustic comfort encompasses six components including: 1) Space Flexibility, 2) Space Fluidity, 3) Space Shape and Barrier, 4) Space Allocation, 5) Space Utilization and 6) Space Function (Chan & Spodick 2014; Mwanzu & Wendo, 2017; Chae, Costello, & Natriello, 2016; Cha & Kim, 2015; Kassim & Md Ajis, 2018). The components have been extracted from the pilot literature review relevant to the study and showed in Table 2. The contribution of space planning components in reducing the noise in library can be elaborated as the following:

- 1) Space Flexibility – refers to flexibility in the use of space such as combining several functions in one space and can be used by different types of people for different types of activities (Goyena, 2019). This space can be transformed with the minimum disruption, simply by rearranging the furniture, shelving and equipment (Mc Donald, 2006).
- 2) Space Fluidity – refers to the circulation and how people will move through space. Heavy flow of space fluidity should be far located from quiet zones and should be creatively designed to reduce towards minimal disruption.
- 3) Space Shape and Barrier – refers to room shape or furniture arrangement to create a new form of space. The room shape and furniture arrangement should suit the diversity of activities users are involved in, so that the noise pollution can be controlled (Choy and Goh, 2016).
- 4) Space Allocation – refers to the structure and zoning of the spaces. Spaces for concentration, collaboration, interaction and focus should be allocated according to its function as public space or private space (Kasim and Md Ajis, 2018), so it can contribute to minimal disruption.
- 5) Space Utilization – refers to the percentage of use of the space. Higher occupation of space will create more noise, therefore the arrangement of furniture, space shape, physical settings will need to be creatively designed to cater the issue.
- 6) Space Function – refers to the purpose and use of space. The noise level will be determined by activities conducted and function of the space.

Table 2: Research of space planning components in library design

Year	Author	Field of Study	Space Planning Components
2006	McDonald	The qualities of good library space	SPACE FLEXIBILITY
2008	Loertscher	Libraries design	SPACE FLEXIBILITY
2009	Ntui	Noise sources and levels at the university library	Available usage (SPACE UTILIZATION)
2012	Jochumsen, H, Rasmussen, CH & Skot-Hansen, D	A new model for the public library	Inspiration space, learning space, meeting space, performative space (SPACE FUNCTION)
2012	Gordon-Hickey & Lemley	Background Noise Acceptance and Personality Factors	Quiet zone (SPACE ALLOCATION)
2012	Rizzo, Jc	Information age library	Active and quiet space
2013	Clugston, V	Library and learning space: projects, trends and ideas	Flexible or multifunctional space (SPACE FLEXIBILITY)
2013	Alterator & Deed	Open learning spaces	Available usage (SPACE UTILIZATION)
2014	Chan & Spodick	Space development	SPACE FLEXIBILITY
2015	Cha & Kim, 2015	Physical library space	SPACE ALLOCATION
2016	Andrews, Wright, & Raskin	Library Learning Spaces	Enclosure (SPACE SHAPE AND BARRIER)
2016	Choy & Goh	A framework for planning academic library spaces	Available usage (SPACE UTILIZATION)
2016	Chae, Costello, & Natriello	A library space to be re-designed by patrons.	SPACE SHAPE AND BARRIER
2016	Choy & Goh	A framework for planning academic library spaces	Diversity (SPACE FUNCTION)
2017	Mwanzu & Wendo	Re-branding libraries to embrace open space and aesthetic reflections	Smoothly (SPACE FLUIDITY)
2018	Noor Ali AL Jorani, & Dr. Shatha Abbass Hassan	Libraries design	Smooth without borders (SPACE FLUIDITY)
2019	Adenipekun, Ajibola, & Oluwunmi	Effective workspace design	Variety activities (SPACE FUNCTION)
2019	Goyena, R	Information Modelling	SPACE FLEXIBILITY
2018	Cicolani & Cicolani	Academic libraries	Furniture rearrangement (SPACE FLEXIBILITY)
2019	Aydođan & Şalgamciođlu	Function of space	FLEXIBILITY

5.0 CONCLUSION

Many strategies have been developed to achieve acoustic comfort in libraries as this facility requires a quiet environment for users to concentrate and focus in their activities. Research regarding acoustic comfort in libraries has mainly concentrated on design approaches that focus on the using acoustic materials to absorb, transmit, diffuse and disseminate sounds in library spaces. However, with modern library design that is more open and diverse, concentrating on this approach only is insufficient. Designers or architects should take into how to deal with behavioural sound, which is the main noise pollution in libraries from the very beginning of the design stage — space planning.

Reviewed articles showed that space planning is the other approach that is noteworthy to lessen noise pollution by tackling user behaviour and activities occurred in the library through investigation of the space planning components. Six space planning components encompassing space flexibility, space fluidity, space shape and barrier, space allocation, space utilization and space function can be worth investigating as the architectural strategies from design perspectives could enhance the user's acoustic comfort in the library.

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