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RESEARCH ARTICLE

Building Occupant Satisfaction Towards Indoor Environmental Quality of Library

Tuan Nurul Asmaq Tuan Kamaruddin and Norhidayah Abdul*

Faculty of Industrial and Science Technology, Universiti Malaysia Pahang Al-Sultan Abdullah, 26300 Kuantan, Pahang, Malaysia

ABSTRACT - Indoor environment is an important factor to be considered while designing a building. The quality of the indoor environment for buildings that are not in the "non -profit" category is rarely given attention. The quality of a library's indoor environment is crucial to be highlighted as modern people are spending 90% of their time in enclosed spaces. Disruption of the indoor environment can reduce the efficiency and satisfaction of the occupants. Occupants are going to feel insecure making their job in an unhealthful environment. The purpose of this study is to assess the building occupant satisfaction in library regarding indoor environment. A total of 85 questionnaires were distributed to the users of the Kemaman District Library in Terengganu. To investigate occupants' satisfaction, quantitative approaches were applied and evaluated by using the Statistical Package for the Social Sciences. The results of a self-assessed occupant satisfaction survey revealed that the indoor environment quality, as well as the interior design, had a positive correlation and significant effect on occupant satisfaction. Interior design accounted for 39% of occupant satisfaction since the p-value is lower than significant value (β=0.390, p-value=0.000<0.05), whereas the indoor environment quality accounted with the largest beta coefficient (β=0.497, p-value=0.000<0.05) which has explained 49.7% of the variation in occupant satisfaction. When compared to the indoor environment quality, respondents were found to be less satisfied with the interior design. This study contributes to the proposal of interior design solutions to improve and maintain occupant satisfaction in the library.

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1. INTRODUCTION

The concept of a building as a shelter is to shield or protect people against environmental variables within the ecosystem. One of the primary goals of buildings is to provide occupants with a comfortable, safe, and healthy indoor environment. A building's convenience has also resulted in an indoor environment that has negative impacts on occupant activity, comfort, and satisfaction. Attributing to this, indoor environment of the library should be maintained to provide an optimum or at least comfortable environment that can satisfy most of the occupants. Disruption of the indoor environment can reduce the efficiency and satisfaction of the occupants. Occupants are going to feel insecure making their job in an unhealthful environment. The level of satisfaction of building occupant with their indoor environment has recently become a topic of discussion. Good indoor environment quality of library will surely influence the level of occupant productivity, health, and comfort[1]. Commercial buildings, such as various types of office around the world, shopping complexes or other profit-making buildings, are already concerned with the satisfaction of their occupants [2] but buildings that are not in the "non -profit" category is rarely given attention. The level of comfort, wellbeing or dissatisfaction with the physical environment is measured by the occupants' perception [3]. The indicators of indoor environmental quality (IEQ) and occupants' satisfaction are divided into physical and non-physical factors. The physical factors include four components: thermal comfort, indoor air quality (IAQ), lighting and acoustic comfort. All factors are measured using appropriate measurable parameters. Non-physical factors generally refer to indoor quality that cannot be measured with an instrument, including privacy, cleanliness, space layout, facilities, furnishing and view. [4]. Good IEQ should be focused specifically on educational environments [5].

The comfort of the indoor environment is an essential part of increasing the efficiency and satisfaction of the occupants. According to the Sustainable Development Goals (SDGs) number three, which is to ensure healthy lives and promote well-being for all at all ages [6], it is best to have working and learning environments designed to maximize productivity, performance, and satisfaction or to minimize the negative effect on the occupants. Some of the previous studies have shown that a poor indoor environment causes inconvenience and dissatisfaction among the residents. Negative interactions between building operations and these occupants can lead to loss of energy efficiency and poor building performance[7]. Dissatisfaction from occupants is mainly due to temperature, air quality, lighting and noise [8]. On the other hand, they conclude that occupant satisfaction can be used as one of the indoor environmental evaluation criteria. Where there is a poor IEQ condition, it is possible to adjust or control the corresponding IEQ factor based on human feedback. Satisfaction with one physical IEQ metric is highly related to satisfaction with all other IEQ indicators; thus, it is critical to assess all IEQ factors holistically[9]. Other than that, when it comes to creating comfortable

***CORRESPONDING AUTHOR | N. Abdull** | ✉ norhidayahabdull@umpsa.edu.my

daylighting environments, integrating interior layout and furniture design with building designs is critical. Design quality can be measured subjectively, based on the individual opinions, experiences, and preferences of the end-users. According to the American Society of Interior Design (ASID), interior design should be functional to improve the quality of life, work environment, and occupant satisfaction. Therefore, this research is intended to assess occupant satisfaction regarding indoor environment quality and interior design.

Hypothesis

H1: Interior design influences occupant satisfaction in the library.

H2: Occupant satisfaction is affected by the Indoor environmental quality (IEQ) of libraries including indoor air quality, lighting, thermal comfort, and acoustic comfort

H3: There is a significant relationship between indoor environment quality (IEQ) and occupant satisfaction in the library.

2. METHODS AND MATERIAL

Figure 1 shows the overall methodology used in this research. The objective was achieved through the questionnaire survey to analyze occupant satisfaction with the library's indoor environment. In this study, the data were collected from the questionnaire surveys, which have been distributed to 85 patrons and workers at selected libraries via Google Forms. The questionnaire consists of 3 sections where high is the first section (A) is about individual information, the second section (B) is about library information, and the last section (C) is about the indoor environment. It was adapted from Post Occupancy Evaluation (POE) and the previous researcher (Cronbach's Alpha = 0.870 and 0.765) [10].

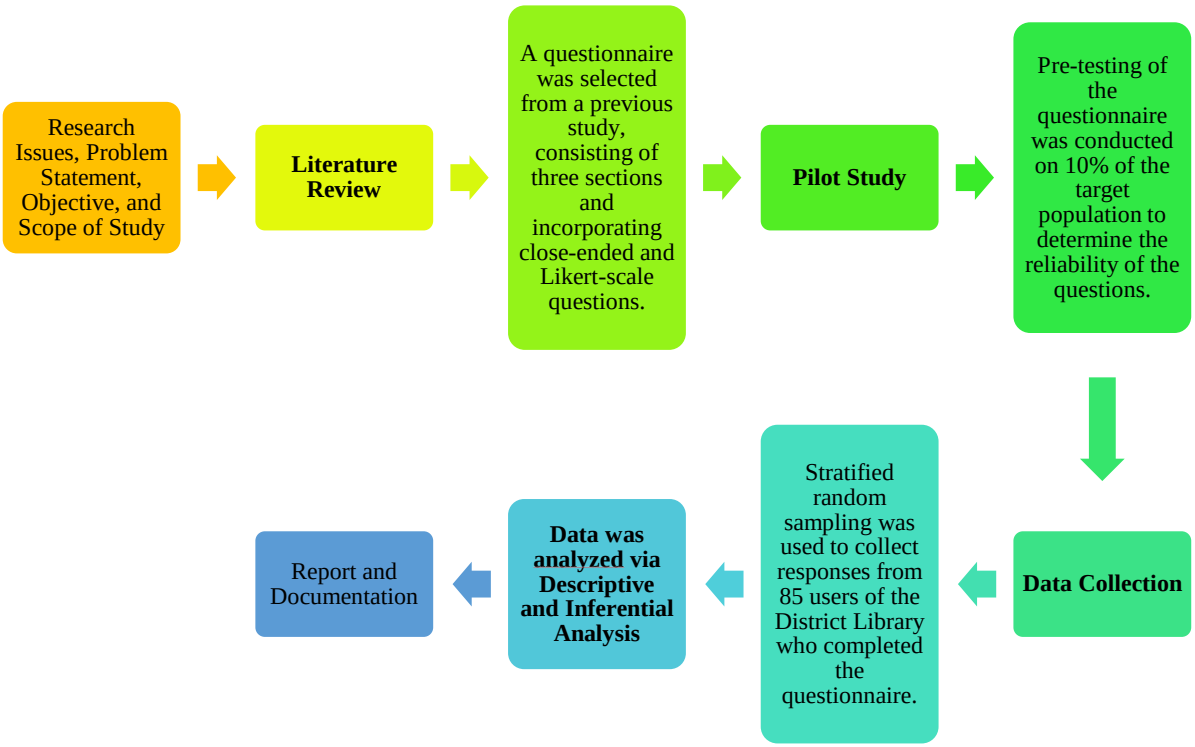

Figure 1. Overview of research flow

According to past studies, there are a few researchers that used the POE method to investigate the occupants' satisfaction, for example [12],[8] and [13]. All the items in Section B until Section C are closed-ended question types with a 5-point numerical Likert scale. 1 as strongly disagree, 2 as disagree, 3 as neutral, 4 as agree, and 5 as strongly agree. After collecting the data obtained from the questionnaire, data analysis was carried out by using the statistical package for the social sciences (SPSS). The data then was analyzed in descriptive analysis and correlation analysis. A Pearson correlation coefficient larger than 0 indicated a positive correlation, whereas a coefficient less than 0 showed a negative correlation.

3. RESULTS AND DISCUSSION

A total of 85 respondents, comprising both visitors and workers, participated in the questionnaire survey to assess occupant satisfaction with the indoor environment of the Kemaman District Library. Of the respondents, 39% were male, while 61% were female.

3.1 Demographic

Based on Table 1, it can be shown 79 respondents, or 92.9%, are visitors/patrons, meanwhile 6 respondents or 7.1%, are workers. The age of the respondent is divided into four classes: 18-24 years old, 25-34 years old, 35-44 years old, and the last one is 45-54 years old. The highest proportion of age comes from 18-24 years old, or 45.9%, with 39 respondents. Moreover, the age 25-34 years old records 30.6% involving 26 respondents. Other than that, 35-44 years old represented a percentage of 20%. For age 45-54 years old showed the lowest percentage with 3.5% involving 6 respondents. Data on the primary reason for using the services of Kemaman district library were collected to determine why people visit the library. The highest percentage of the primary reason that has been recorded was because of education (42.4%), followed by work-related (24.7%) represented by 21 respondents. Meanwhile, 20 respondents voted for leisure as the primary reason for using the library, and 8% of the respondents chose other reasons.

Table 1. Demographic factor

Respondent Profile	Description	Frequency	Percent (%)
Gender	Male	33	39.00%
	Female	52	61.00%
Age	18–24	39	45.90%
	25–34	26	30.60%
	35–44	17	20.00%
	45–54	3	3.50%
Identity	Visitor	79	92.90%
	Worker	6	7.10%
The primary reason for using the services of this Library relates to	Education	36	42.40%
	Leisure	20	23.50%
	Work-related	21	24.70%
	Other	8	9.40%
How many times have you visited this library in a month?	1–5 times	42	49.40%
	6–10 times	21	24.70%
	11–15 times	16	18.80%
	More than 15 times	6	7.10%
Time Spending	1 hour	57	67.10%
	2–5 hours	22	25.90%
	More than 6 hours	6	7.10%

The frequency of visiting Kemaman district library in a month is divided into four classes comprised 1-5 times, 6-10 times, 11-15 times and the last one is more than 15 times. The findings demonstrated that the perceived value of the services supplied to users caused a sense of satisfaction in them, which led to their loyalty to and re-use of library services. It shows that 1-5 times in a month have the highest frequency which is 42 (49.4%), followed by 6-10 times in a month with 21 (24.7%), 11-15 times with 16, and more than 15 times with 6 respondents (7.1%). Finally, is time spent. Table 1 indicates how much time each respondent spent in Kemaman district library. 57 respondents which is the largest percentage among other classes stated that they spend 1 hour. Meanwhile, 22 respondents spend 2 hours to 5 hours in a library, while at least 6 respondents spend more than 6 hours in a library.

3.2 Correlation Analysis

Pearson correlation coefficient was used for the correlation analysis, which analyzed the correlation among interior design, indoor environment quality, and occupant satisfaction. The Pearson correlation coefficient is only used to quantify the linear correlation between the normal distribution's features [14]. The correlation analysis revealed statistically significant positive relationships among the variables ID (possibly representing individual or environmental factors), IEQ (Indoor Environmental Quality), and OS (Occupant Satisfaction). The strongest correlation was observed between IEQ and OS ($r = 0.749$, $p < 0.01r = 0.749$, $p < 0.01r = 0.749$, $p < 0.01$), indicating that improvements in Indoor Environmental Quality are strongly associated with increased Occupant Satisfaction. Similarly, a strong positive relationship was found between ID and OS ($r=0.711$, $p<0.01r = 0.711$, $p < 0.01r=0.711$, $p<0.01$), suggesting that ID factors also play a critical role in influencing satisfaction levels. Meanwhile, the correlation between ID and IEQ ($r=0.647$, $p<0.01r = 0.647$,

$p < 0.01r = 0.647$, $p < 0.01$) was moderately strong, reflecting a significant but slightly less pronounced relationship. All correlations were statistically significant at the 1% level, ensuring that the relationships are unlikely due to chance. These findings underscore the importance of both individual and environmental factors, particularly Indoor Environmental Quality, in shaping Occupant Satisfaction.

Table 2. Pearson correlation coefficient

Correlations				
		ID	IEQ	OS
ID	Pearson Correlation	1	.647**	.711**
	Sig. (2-tailed)		.000	.000
	N	85	85	85
IEQ	Pearson Correlation	.647**	1	.749**
	Sig. (2-tailed)	.000		.000
	N	85	85	85
OS	Pearson Correlation	.711**	.749**	1
	Sig. (2-tailed)	.000	.000	
	N	85	85	85

**. Correlation is significant at the 0.01 level (2-tailed)

3.3 Regression and Hypothesis Testing

The findings presented in Table 3 underscore the significant influence of both IEQ and interior design on occupant satisfaction in libraries. Specifically, IEQ exhibits the most substantial impact, with a beta coefficient of (b = 0.497) and a p-value of (<0.05), indicating a strong relationship that accounts for 49.7% of the variation in occupant satisfaction. This highlights the critical role of factors such as indoor air quality, lighting, thermal comfort, and acoustic comfort in enhancing user experiences. In contrast, interior design also plays a significant role, with a beta coefficient of (b= 0.390) and a p-value of (<0.05), explaining 39% of the variation in satisfaction.

These results align well with previous research that has established a considerable link between spatial layout and workplace satisfaction, reinforcing the idea that thoughtful design can significantly enhance user experiences [15]. For instance, studies have shown that effective workplace layouts contribute to comfort satisfaction across different seasons, further supporting the notion that both design and environmental quality are essential for occupant well-being [16]. Moreover, the analysis confirms that multicollinearity is not an issue, as the collinearity tolerance values exceed 0.2 and the variance inflation factor (VIF) values remain below 10 [17]. This indicates that the independent variables can be treated independently without redundancy, ensuring the reliability of the regression results.

Table 3. Multiple linear regression analysis

Coefficient[a]								
Model		Unstandardized B	Coefficient Std. Error	Standardized Coefficients Beta	t	Sig.	Collinearity Tolerance	Statistics VIF
1	(Constant)	-1.011	.420		-2.407	.018		
	ID	.584	.129	.390	4.539	.000	.581	1.720
	IEQ	.653	.113	.490	5.784	.000	.581	1.720

a. Dependent Variable: OS

The Multiple Linear Regression analysis conducted in this study provides valuable insights into the factors influencing occupant satisfaction in libraries. The results indicate that interior design significantly affects occupant satisfaction, with a beta coefficient of (b = 0.390) and a p-value of (<0.05). This finding suggests that interior design accounts for 39% of the variation in occupant satisfaction, leading to the acceptance of the first hypothesis (H1). In addition, the analysis reveals that indoor environmental quality (IEQ)—which encompasses critical elements such as indoor air quality, lighting, thermal comfort, and acoustic comfort has an even greater impact on occupant satisfaction. With a beta coefficient of (b= 0.497) and a p-value of (<0.05), IEQ explains 49.7% of the variation in occupant satisfaction, thereby supporting the acceptance of the second hypothesis (H2). These findings align with previous research that emphasizes the strong relationship between indoor environmental quality and occupant performance [8], reinforcing the notion that a well-maintained indoor environment is essential for enhancing user satisfaction. Furthermore, the correlation analysis confirms a significant positive relationship between IEQ and occupant satisfaction, with a correlation coefficient of (r = 0.497) and a p-value of (<0.05). This strong correlation indicates that improvements in indoor environmental quality are likely to lead to increased occupant satisfaction, productivity, and overall well-being [18].

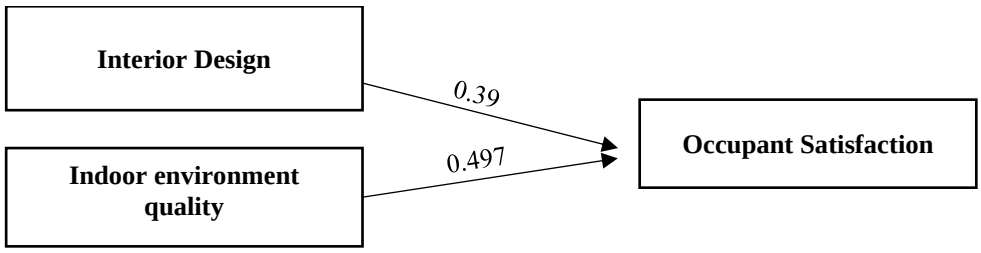

Figure 2. Theoretical model for regression analysis

The study also addresses potential multicollinearity issues, noting that the collinearity tolerance values for both independent variables exceed 0.2, and the variance inflation factor (VIF) values remain below 10. This suggests that the independent variables can be treated independently without redundancy, ensuring the robustness of the regression results. These findings underscore the importance of both interior design and indoor environmental quality in shaping occupant satisfaction in library settings. By prioritizing enhancements in these areas, library administrators can create more conducive environments that not only satisfy users but also promote their productivity and well-being. This comprehensive understanding of the interplay between design and environmental quality is crucial for informing future library design and management strategies.

4. CONCLUSION

Based on the analyses of all the data above, the following conclusion can be drawn:

a) The library's Indoor environment influences occupant satisfaction. According to the Multiple Linear Regression analysis, interior design influenced occupant satisfaction in the library, explaining 39% of the variation in occupant satisfaction, and indoor environmental quality explained 49.7%.

b) Indoor environmental quality and interior design are classified as factors that influence occupant satisfaction. The findings from the correlation statistical analysis indicated that interior design (ID) and indoor environment quality (IEQ) showed a positive and significant correlation coefficient with OS (Occupant satisfaction).

c) There is a substantial positive relationship between the variables. It is found that there is a significant relationship between indoor environment quality and occupant satisfaction in the library since it has a positive and significant correlation coefficient (r=0.497, p-value=0.000).

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CONFLICT OF INTEREST

The authors declare no conflicts of interest.

AUTHORS CONTRIBUTION

Norhidayah Abdul (Conceptualization; Formal analysis; Visualisation; Supervision)

Tuan Nurul Asmaq Tuan Kamaruddin (Methodology; Data curation; Writing - original draft; Resources)

REFERENCES

[1] K. Taylor, A. Post, T. B. Hoshizaki, and M. D. Gilchrist, "The effect of a novel impact management strategy on maximum principal strain for reconstructions of American football concussive events," *Proceedings of the Institution of Mechanical Engineers, Part P: Journal of Sports Engineering and Technology*, vol. 233, no. 4, pp. 503–513, 2019.

[2] H. Tan, L. Qin, Z. Jiang, Y. Wu, and B. Ran, "A hybrid deep learning based traffic flow prediction method and its understanding," *Transportation Research Part C: Emerging Technologies*, vol. 90, pp. 166–180, 2018.

[3] J. B. Caccese, T. A. Buckley, R. T. Tierney, K. B. Arbogast, W. C. Rose, J. J. Glutting, et al., "Head and neck size and neck strength predict linear and rotational acceleration during purposeful soccer heading," *Sports Biomechanics*, vol. 17, no. 4, pp. 462–476, 2018.

[4] S. L. James, D. Abate, K. H. Abate, S. M. Abay, C. Abbafati, N. Abbasi, et al., "Global, regional, and national incidence, prevalence, and years lived with disability for 354 diseases and injuries for 195 countries and territories, 1990–2017: A systematic analysis for the Global Burden of Disease Study 2017," *Lancet*, vol. 392, no. 10159, pp. 1789–1858, 2018.

[5] N. M. Jamaludin, N. Mahyuddin, and F. W. Akashah, "Assessment on indoor environmental quality (IEQ) with the application of potted plants in the classroom: Case of University Malaya," *Journal of Design and Built Environment*, vol. 17, no. 2, pp. 1–15, 2017.

[6] United Nation General Assembly Economic and Social Council, *Progress towards the Sustainable Development Goals Report of the Secretary-General*, A/79/79-E/2024/54, https://unstats.un.org/sdgs/files/report/2024/SG-SDG-Progress-Report-2024-advanced-unedited-version.pdf, accessed 2nd January 2024.

[7] Y. Al Horr, M. Arif, A. Kaushik, A. Mazroei, and E. Elsarrag, "Occupant productivity and indoor environment quality: A case of GSAS," *International Journal of Sustainable Built Environment*, vol. 6, no. 2, pp. 476–490, 2017.

[8] Z. Zhang, "The effect of library indoor environments on occupant satisfaction and performance in Chinese universities using SEMs," *Building and Environment*, vol. 150, pp. 322–329, 2019.

[9] P. Šujanová, M. Rychtáriková, T. S. Mayor, and A. Hyder, "A healthy, energy-efficient and comfortable indoor environment, a review," *Energies*, vol. 12, no. 8, p. 1414, 2019.

[10] Z. Kong, D. M. Utzinger, K. Freihoefer, and T. Steege, "The impact of interior design on visual discomfort reduction: A field study integrating lighting environments with POE survey," *Building and Environment*, vol. 138, pp. 135–148, 2018.

[11] A. L. A. Olanrewaju and Y. S. Chong, "Post occupancy evaluation of green residential buildings, in the Greater Kuala Lumpur, Malaysia," *Journal of Housing and the Built Environment*, vol.36, pp. 825–857, 2021.

[12] J. Park, V. Loftness, and A. Aziz, "Post-occupancy evaluation and IEQ measurements from 64 office buildings: Critical factors and thresholds for user satisfaction on thermal quality," *Buildings*, vol. 8, no. 11, p. 156, 2018.

[13] M. Esfandiari, S. M. Zaid, and M. Azzam Ismail, "Investigating the indoor environment quality parameters and their relationship with occupants' satisfaction in office buildings: A review," *Journal of Design and Built Environment*, vol. 17, pp. 181–193, 2017.

[14] H. Xu and Y. Deng, "Dependent evidence combination based on shearman coefficient and pearson coefficient," *IEEE Access*, vol. 6, pp. 11634–11640, 2017.

[15] S. Altomonte, S. Schiavon, M. G. Kent, and G. Brager, "Indoor environmental quality and occupant satisfaction in green-certified buildings," *Building Research & Information*, vol. 47, no. 3, pp. 255–274, 2019.

[16] P. M. Bluyssen, M. Aries, and P. van Dommelen, "Comfort of workers in office buildings: The European HOPE project," *Building and Environment*, vol. 46, no. 1, pp. 280–288, 2011.

[17] P. Pradhan, "Strengthening MaxEnt modelling through screening of redundant explanatory bioclimatic variables with variance inflation factor analysis," *Researcher*, vol. 8, no. 5, pp. 29–34, 2016.

[18] Y. Geng, W. Ji, Z. Wang, B. Lin, and Y. Zhu, "A review of operating performance in green buildings: Energy use, indoor environmental quality and occupant satisfaction," *Energy and Buildings*, vol. 183, pp. 500–514, 2019.