Bioscene

Bioscene
Volume- 22 Number- 03
ISSN: 1539-2422 (P) 2055-1583 (O)
www.explorebioscene.com

User Preferences for Indoor Plants in Academic Library Space

[1]Zihadur Rahman; [2]Dil Afroz Bente Aziz; [3]Md. Fujael Ahmed;
[4]Md. Ershadul Haque; [5]Puza Moni Bhattacharyya; [6]Md. Armanul Haque

orcid.org/0000-0002-6143-8917; orcid.org/0000-0002-2263-6590
orcid.org/0009-0005-1514-196X; orcid.org/0000-0001-8786-3105

Corresponding Author: **Zihadur Rahman**

Abstract: As academic libraries evolve into holistic learning environments, there is growing interest in how biophilic elements such as indoor plants can enhance student well-being, academic focus, and comfort. While the psychological benefits of greenery are increasingly acknowledged, empirical studies focusing on student preferences for plant integration in library settings, especially in developing countries, remain limited. This study investigates university students' preferences regarding the type, placement, and perceived impact of indoor plants in academic library spaces. It also explores differences in preferences and concerns across public, private, and national universities in Bangladesh. A quantitative survey was conducted with 274 university students selected through stratified random sampling. Data were collected via structured questionnaires and analyzed using SPSS, with descriptive statistics and non-parametric tests (Kruskal-Wallis H and Dunn's post hoc) used to assess differences across institutional types. Students overwhelmingly supported the presence of indoor plants, citing improved aesthetics, stress reduction, and enhanced concentration. Preferences favored small, low-maintenance plants placed near reading areas. Significant differences were observed across university types: national university students expressed stronger preferences and greater concerns about space, cost, and maintenance. Challenges identified included allergy risks, space limitations, pest issues, and budget constraints. This study contributes new insights to biophilic design theory in educational settings by highlighting how student preferences are shaped by institutional context. It provides actionable recommendations for academic library planners and emphasizes the need for tailored, resource-sensitive greening strategies. The findings are especially relevant for universities in resource-constrained regions seeking to balance well-being with practical design considerations.

Keywords: Indoor Plants, User Preferences, Academic Performance, Academic Libraries, Green Library, Sustainable Library

Introduction

In recent years, libraries, especially academic libraries, have helped users' mental health in addition to offering educational materials (Brewster & Cox, 2023). The intention is not only to provide its readers with resources but also to establish an atmosphere that allows them to focus completely and benefit from the content. Although libraries are helping their users by offering both digital and traditional resources, the use of green library infrastructures attracted the attention of users (Mwanzu et al., 2023). It has been established that exposure to real-life plants is positively related to a healthier mental state (Aydogan and Cerone, 2021). The benefits of indoor plants in lowering stress, improving air quality, and improving a space's aesthetic appeal are becoming more widely acknowledged (Brilli et al., 2018). According to a study by Van den Bogerd et al. (2021), users find an academic study space with potted plants to be more appealing and cozier. Aydogan and Cerone (2021) stated that there are several health and well-being advantages of having indoor plants. The findings of Hami and Abdi (2021) suggest that the physical and psychological advantages of nature, such as stress reduction, a healthier climate, and an all-around more pleasant environment for users, make green study spaces an excellent place for users to relax and study. A study conducted on 544 users by Bossart and Spears (2023) implies that users would rather have a study place with a natural atmosphere featuring plants and neutral colours. The study concluded that an ideal study place would include natural lighting, live plants, natural decor materials, and adjustable lighting elements.

In the context of academic libraries, where users and faculty spend significant amounts of time, such elements can play a pivotal role in shaping the overall user experience. The indoor air quality of eight libraries at Jimma University was discovered that all the libraries exhibit levels of bacterial and fungal contamination ranging from high to very high (Hayleeyesus and Manaye, 2014). Incorporating plants into library spaces aligns with contemporary library design principles, which will not only add aesthetic value but will also help to improve air quality, user comfort, and overall well-being. Indoor plants are increasingly incorporated into academic libraries to enhance aesthetic appeal, reduce stress, and improve indoor air quality. Due to their inherent qualities, green plants possess the ability to purify air as well as have certain sterilizing effects (Bao, 2022). This study seeks to explore users' preferences regarding indoor plants in academic library settings and assess their perceived benefits and challenges. There is no debate about the positive impact of greenery in an enclosed library and work environment; however, data about the particular preferences of library users regarding indoor plants in academic settings is barely available. This study aims to fill that void by closely investigating users' preferences for indoor plants in academic library spaces. The study also aims to establish the direct relationship between green study space and the effect of indoor plants on academic achievement, comfort, and quality of life. The findings

will help libraries to create an atmosphere that resonates most with their users. Understanding their preference will help to reduce any potential concerns or challenges that might arise in the future. Incorporating indoor plants might seem like a small step for a library, but it has a huge impact on the overall satisfaction of the user community. Eventually, the insights will assist in the creation of library spaces that are both functional and therapeutic.

This study aims to research the placement of indoor plants in libraries while exploring users' preferences for them in library settings. Additionally, this research seeks to address a gap in the literature by providing insights into how plants influence users' well-being, academic performance, and comfort, offering valuable information for library administrators and designers. Based on the objective, we formulated four research questions (RQ). Such as;

i. What are users' preferences regarding the types and arrangements of indoor plants in academic libraries? (RQ1).
ii. How do users perceive the impact of indoor plants on their academic performance, comfort, and overall well-being? (RQ2).
iii. What concerns or challenges do users associate with the presence of indoor plants in library environments? (RQ3).
iv. How do users' preferences vary based on the type of university they attend? (RQ4).

Related Literature

Incorporating plants into indoor environments has attracted widespread attention as a potential strategy to enhance human well-being and performance (Liu et al., 2022). Users' preference for indoor plants generally depends on their aesthetic appeal, maintenance requirements, and available amenities. Huang and colleagues' (2022) study found that users prefer typically low-maintenance plants such as succulents, snake plants, and pathos, as they are durable and have air-purifying properties. Similarly, Lee and Kim (2021) noted that users generally prefer plants with bright leaves and soothing colours, such as peace lilies and ferns, which create a visually appealing and relaxing environment. The arrangement of plants also plays an important role; studies have shown that clustered arrangements of plants around study areas are preferable to individually placed plants (Smith et al., 2023). Students face academic stress, which troubles their strength and performance. This reduces their focused devotion, leading to psychological exhaustion. To support them, the physical teaching space atmosphere is being reformed for support. According to the results from van den Bogerd et al. (2020) demonstrated that incorporating indoor nature elements (e.g., potted plants) in educational environments offers potential, yet results are context-dependent. In their multi-level longitudinal field experiments, they found that one class taught in a room with a plant, by itself, could increase students' perceptions of the quality of the environment. In addition, secondary education students indicated that they could pay more

attention and had more positive valuations of the lecture and teacher. But the research revealed no acute or direct effects on symptoms or well-being from such a small dose, indicating that although the exposure had an effect on some of the attention and perceptual measures, nature in indoor settings might require a longer intervention. One encouraging involvement is integrating indoor nature, like potted plants, to increase well-being and safeguard against stress(Van Den Bogerd et al., 2021). Indoor plants caring has been found to enhance mindfulness and mental well-being in adult Chinese, as it brings them closer to nature (Ma, 2022). Nevertheless, very little is known about the workplace effects; laboratory studies have produced positive results, but field studies have produced inconsistent results (Thatcher et al., 2020). According to Browning et al. (2021), indoor plants advocate those indoor plants can provide stress reduction and attention restoration and enhance academic productivity. A research conducted by Diller (2014) showed that students were less anxious and more satisfied with their study area when they had potted plants kept in library. In addition, Sharma et al. (2022) found that trees contribute to air quality, which has an indirect effect on cognitive performance and comfort. These findings align with the biophilia hypothesis, according to which humans have a natural tendency towards nature. Kellert and Wilson (1995) suggested that incorporating natural features such as trees to interior spaces is calming and enhances mental health, especially in high stress environments, like academic libraries.

While indoor plants have advantages such as purifying air and boosting mental wellness, they can be difficult to work with in disparate settings. Kumar et al. (2023) argued that the problems created by the need for frequent watering, trimming, and pest control are all issues for plants care professionals. Poor maintenance can result in plant damage, compromising the visual and air quality of the indoor space (Stein, 2021). Another important thing, is a possibility of allergies. Garcia et al. (2022) determined that flowers or plants producing abundant pollen could cause allergies in certain people, leading to inconvenience and health issues in common spaces. In addition, Moslehian et al. (2023) reported that plants in soil, if not well maintained, can grow mold, and thereby further degrade the indoor air. There also is a practical limitation reshing the widespread use of indoor plants, due to limited space and financial costs. (Mueller et al., 2022) argued that greening requires additional floor space, which is not always feasible in densely populated offices or buildings. In addition, the high upfront cost of purchasing plants and laborious maintenance and replacement costs can be a significant obstacle for budget-strapped organisations (Zhong et al., 2021). Further, unpredictable plants placement will be problematic too. Nguyen and Patel (2023) discovered that plants set inappropriately can prevent access along pathways, impede sight lines, and lead to unnecessary crowding, and this can have negative consequences for work flow and safety in the workplace. Likewise, Carter and Evans (2022) contended that over- or large plant species in open plan office designs can be visually confusing

for employees and decrease staff attentiveness and productivity. These are difficulties food for thought for anyone designing indoor plants for building, offices, and other public locations. It is important for institutions to choose the right tree, site, and care for the plan; and feedback from the users must be collected to generate a reasonable and effective greening plan.

The literatures suggest that indoor plants can also significantly enhance users' academic performance, comfort, and well-being in academic libraries. However, successful implementation requires addressing users' preferences, ensuring proper maintenance, and mitigating potential challenges. Research specifically addressing users' preferences for indoor plants in academic library settings is limited. While there are some studies on greenery in indoor spaces, the majority of them focus primarily on the office environment. Even the minimal existing research on greenery in library spaces primarily concentrates on the practical issue of plant placement and setting, without really exploring the idea of users' preference of such plants.

Methodology

The study employed a quantitative survey research design to explore the perceptions of Bangladeshi university library users, especially students, regarding indoor plants in academic libraries.

Sampling and Data Collection

The study targeted regular users of university libraries across Bangladesh, focusing primarily on students from public, private, and national universities as shown in the figure 1. A stratified random sampling method was employed to ensure balanced representation across these institutional types. Of the 380 individuals initially targeted, 274 valid responses were collected and analyzed, resulting in a satisfactory response rate. Data were gathered over five months, from October 2024 to February 2025, using a structured questionnaire distributed both manually and via Google Forms to maximize reach and participation. The questionnaire primarily featured Likert scale items and was designed to capture user preferences for plant types and arrangements, perceived impacts on academic performance, comfort, and indoor environmental quality, as well as potential concerns or challenges. Among the 274 respondents, 140 (51.1%) were male and 134 (48.9%) were female. The institutional breakdown included 91 participants (33.2%) from public universities, 93 (33.9%) from private universities, and 90 (32.8%) from national universities. Participants also varied in library usage frequency: 102 respondents (37.2%) visited 1–2 days per week, 117 (42.7%) visited 2–4 days, and 56 (20.1%) visited 4–7 days weekly. All participants provided informed consent, and data collection procedures adhered to ethical research standards, ensuring voluntary participation and strict confidentiality of responses.

Data Analysis

Data collected from the survey were analyzed using SPSS and R. The analysis followed a structured process to ensure reliability, clarity in descriptions, and suitable statistical comparisons. To assess the internal consistency of the constructs, Preferences, Perceived Impact, and Challenges, reliability analysis was conducted using Cronbach's Alpha (CA). Cronbach's Alpha is a widely used metric to evaluate the extent to which items within a scale measure the same underlying construct. According to Nunnally and Bernstein (1994), a Cronbach's Alpha value of 0.70 or higher indicates acceptable internal consistency, while values above 0.80 are considered good. In this study, the CA values for Preferences, Perceived Impact, and Challenges were 0.775, 0.735, and 0.720, respectively, indicating satisfactory reliability for all three constructs. Basic descriptive statistics, including frequencies, means, and standard deviations, were computed to summarize user responses across survey items. This allowed for a preliminary understanding of participants' attitudes and perceptions regarding indoor plants in academic library settings. For comparison of preferences and perceptions between different university types (public, private, national), the Kruskal-Wallis H test was used. This is a non-parametric alternative to the one-way analysis of variance and is used when the assumptions of normality and homogeneity of variance are violated (Field, 2013; Gibbons &Chakraborti, 2010). It tests whether ranks are distributed differently between groups.

For those variables in which the Kruskal-Wallis test pointed to statistically significant differences ($p < .05$), with Dunn post hoc test with Bonferroni correction applied to recognize which types of university differed significantly from each other. Dunn's test is especially appropriate for post-hoc analysis within nonparametric comparisons as it corrects for Type I error among many pairwise tests (Dinno, 2015).

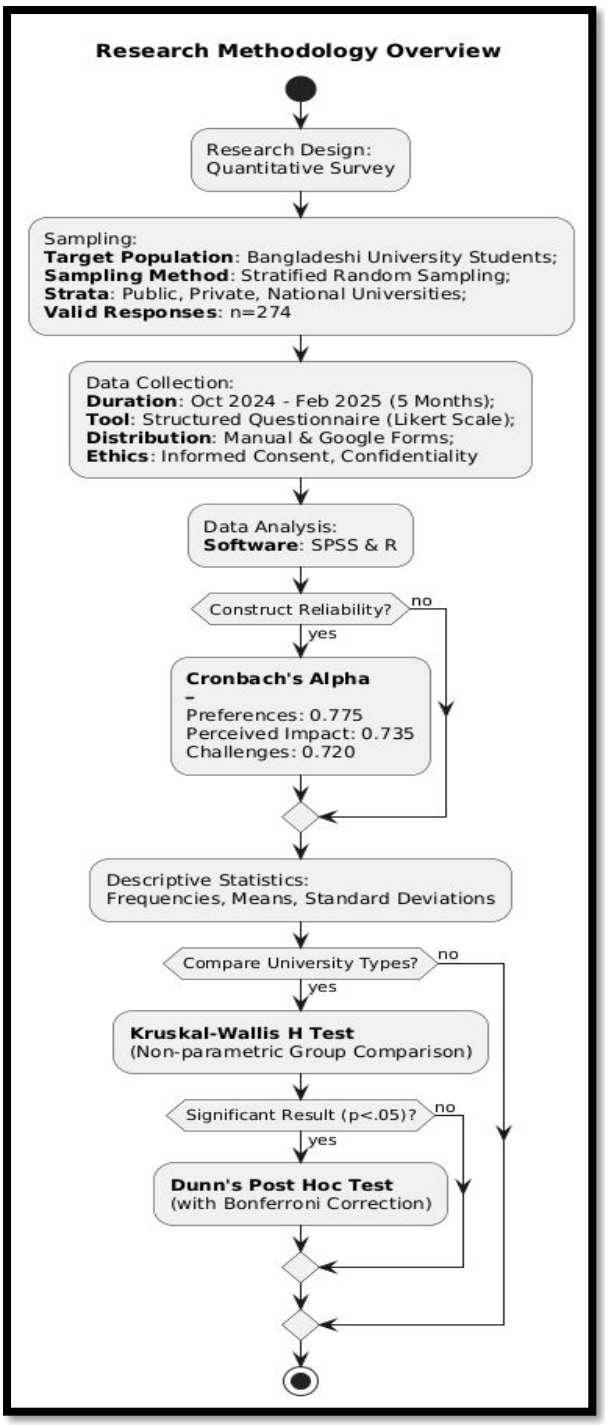

Figure 1: Research Methods flowcharts

Analysis & Findings

The tool for this study was carefully developed by researchers with a known strategy 5-point likert scale, that is commonly used to investig ateco workers' attitudes, perceptions and behavior in social research (Joshi et al., 2015). The Likert scale is a good choice for this study as it permits the participants to express the degree of their agreement or disagreement in the responses and offers the researchers insight of the participants' viewpoint to the issue (Harpe,

2015). A structured questionnaire is useful for maintaining consistency and ensuring data reliability between numerous participants, thus facilitating the statistical analysis and comparison of data (Dillman et al., 2014). Percentages and mean standard deviation (SD) were used for data analysis. Percentages are useful to know the distribution of answers in each category - the frequencies of each answer choice. This is especially useful for attitudes52 or behaviour patterns of participants. (Mohajan, 2020) The mean and standard deviation (SD), however, are statistical tools which can offer valuable details relative to the data. The mean reflects a central tendency and demonstrates the participants' average response toward each question, while the SD reflects how far or near participants' responses were disperse or consistent (Field, 2013). By computing these numbers, the study can tell a little more easily what the average is, and how much agreement or disagreement there is among participants.

Preferences for Indoor Plants

Table 1 indicates that there is in general a positive view of plants in library spaces, although not all items showed unanimity. The mean with the highest value in Table 1 is 4.25, and this represents respondents placing high value on the beauty of indoor plants with low standard deviation of 0.868 which means that the preference is quite uniform among them. Whereas the mean for studying in natural green surroundings is 3.80, this shows a moderate level of agreement, meaning that many people prefer to study in such a space, but this is not as widespread as the appreciation of the aesthetic value of plants. The standard deviation of 0.893 indicates a moderate level of attitude variation, meaning that there are some differing opinions on this preference. The mean of 3.99 indicates that there is a moderate to strong preference for plants that are small and do not take up much space, but the standard deviation of 0.943 indicates that opinions on the size of plants are more diverse. The mean score for a statement about placing plants near study or reading spaces was 4.04, indicating great agreement. This is very consistent, as shown by the low standard deviation of 0.798. The average score for the combination of potted plants and vertical greenery (such as plant walls) is 3.99 with a larger standard deviation of 0.820, indicating a moderate to strong preference. This indicates that participants' opinions on this library design style vary widely. Overall, while there is a clear appreciation for plants in library spaces, the variations in responses suggest different priorities, such as space efficiency and plant placement.

Table 1. Preferences for Indoor Plants

Items	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Mean	SD
I prefer having indoor plants in the library for their aesthetic appeal.	2.2%	3.3%	4.7%	46.0%	43.8%	4.25	0.868

I enjoy studying in spaces that include natural greenery.	1.5%	4.7%	27.7%	43.4%	22.6%	3.80	0.893
I prefer smaller plants that do not occupy significant library space.	1.8%	4.0%	21.5%	38.0%	34.7%	3.99	0.943
I would like to see plants placed near reading/study areas.	8.5%	5.8%	11.7%	45.5%	28.5%	4.04	0.798
I prefer a mix of potted plants and vertical greenery (e.g., plant walls) in library design	0.7%	4.0%	17.2%	50.7%	27.4%	3.99	0.820

Perceived Impact of Indoor Plants

Although opinions differed considerably on the various items, perceptions of the effects of indoor plants (Table 2) in libraries were generally positive. The relatively low standard deviation of 0.794 indicates a high level of agreement among participants, and the statement "The presence of plants in the library helps me reduce stress while studying" received the highest mean score of 4.04, indicating that many respondents strongly felt that plants had a calming effect. Although there was significant variation in the extent to which plants help with concentration, the statement "Plants in the library help me concentrate on my academic work" had a mean score of 3.96, indicating a strong positive response. The standard deviation was slightly higher (0.835). However, the statement "Indoor plants create a more attractive and comfortable library environment" had a standard deviation of 0.985, indicating greater variation in beliefs about the environment created by plants, and a mean of 3.66, indicating moderate agreement. The idea that plants improve indoor air quality showed somewhat variable agreement, although the library had a mean score of 3.91 and a standard deviation of 0.851. Finally, the statement ‘‘The inclusion of plants has a positive impact on my overall library experience’’ with a mean of 3.88 and a standard deviation of 0.820 indicated generally positive but somewhat less enthusiastic opinions, with some disagreement about the overall benefits of plants. While most respondents agreed that indoor plants can help with stress and focus, their perceptions of these benefits varied, particularly regarding the environment and air quality.

Table 2. Perceived Impact of Indoor Plants

Items	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Mean	SD
The presence of plants in the library	0.7%	4.7%	10.2%	57.3%	27.0%	4.04	0.794

helps reduce my stress while studying.							
Indoor plants create a more inviting and comfortable library environment.	1.5%	7.7%	38.7%	27.0%	25.2%	3.66	0.985
Plants in the library improve my ability to focus on academic tasks.	0.7%	3.6%	20.8%	47.1%	27.7%	3.96	0.835
I believe plants contribute to healthier indoor air quality in the library.	.4%	5.8%	20.8%	48.2%	24.8%	3.91	0.851
The inclusion of plants positively affects my overall library experience. (e.g., plant walls) in library design	.7%	5.8%	17.9%	55.1%	20.4%	3.88	0.820

Concerns or Challenges

The data collected on challenges or issues related to indoor plants (Table 3) in libraries indicate several issues, where respondents' levels of concern vary. Most respondents seem to be equally concerned about health issues, such as the statement "I am worried that indoor plants may cause allergies or other health problems" with a high mean score of 3.98 and a relatively low standard deviation of 0.792. The statement "I think plants may take up space that could otherwise be used for sitting or studying" has a mean score of 3.73, indicating moderate concerns about space utilization, and a high standard deviation of 0.975, indicating greater diversity in opinions regarding the allocation of library space. Concerns about plant maintenance, such as watering and pest control, received a score of 3.90 and a standard deviation of 0.877, indicating that respondents are somewhat concerned about how plant maintenance may affect the library environment, but their levels of concern are somewhat varied. Concerns about pests or diseases of plants were reflected in a similar pattern, with a mean score of 3.80 and a standard deviation of 0.876. Finally, the statement ‘‘The cost of maintaining indoor plants may outweigh their benefits to the library environment’’ with a mean of 3.87 and a standard deviation of 0.816 indicates a moderate level of concern regarding the financial costs of maintaining plants. This indicates that opinions regarding cost benefits are somewhat mixed. Overall,

although there are some concerns about health, space, maintenance, pests, and costs, there is a moderate level of concern among respondents, and some variation is seen among respondents regarding these challenges.

Table 3. Concerns or Challenges

Items	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Mean	SD
I am concerned that indoor plants may cause allergies or other health issues.	0.7%	5.5%	10.9%	59.5%	23.4%	3.98	0.792
I believe plants might take up space that could otherwise be used for seating or study areas.	1.8%	6.2%	34.3%	32.1%	25.5%	3.73	0.975
I think the maintenance of indoor plants (e.g., watering and pest control) might disrupt the library environment.	1.1%	5.1%	21.5%	46.4%	25.9%	3.90	0.877
I worry about pests or insects being attracted to plants in the library.	0.7%	6.9%	24.1%	47.1%	21.2%	3.80	0.876
The cost of maintaining indoor plants might outweigh their benefits in a library setting.	0.7%	4.7%	21.5%	51.8%	21.2%	3.87	0.816

Kruskal-Wallis and Dunn's post hoc analysis

To assess whether users from different university types (public, private, national) differed in their attitudes toward indoor plants, a series of Kruskal-Wallis H tests were conducted across three domains: preferences, perceived impact, and concerns or challenges (Table 4). In the preferences category, significant differences were observed in users' enjoyment of natural green study spaces ($H(2) = 6.575$, $p = .037$), preference for smaller, space-efficient plants ($H(2) = 6.398$, $p = .041$), preference for plant placement near study areas ($H(2) = 14.675$, $p = .001$), and preference for mixed plant formats ($H(2) = 9.101$, $p = .011$). However, appreciation for the aesthetic appeal of plants did not significantly differ by university type. Regarding the perceived impact, users from different institutions varied significantly in how they viewed the stress-reducing benefits of plants ($H(2) = 9.588$, $p = .008$), their contribution to a more inviting library environment ($H(2) = 7.248$, $p = .027$), and their role in improving

indoor air quality (H (2) = 29.882, p < .001). No significant differences were found in responses related to improved focus or overall library experience. In the domain of concerns, significant differences were identified in views on plant placement taking up space (H (2) = 17.863, p < .001), worries about pests and insects (H (2) = 17.662, p < .001), and potential maintenance disruptions (H (2) = 8.067, p = .018). Users did not differ significantly in their concerns about allergies (H (2) = 3.640, p = .162) or cost-effectiveness (H (2) = 4.171, p = .124). Overall, the results suggest that users from different university types perceive both the benefits and challenges of indoor plants differently, particularly regarding comfort, logistics, and environmental quality. These insights are critical for tailoring biophilic design strategies in diverse academic contexts.

Table 4. Kruskal-Wallis Test Summary

Variable Group	Item	χ^2 (H)	df	p-value	Significance
Preferences	Prefer indoor plants for aesthetic appeal	0.710	2	0.701	Not significant
	Enjoy studying in spaces with greenery	6.575	2	0.037	Significant (p < .05)
	Prefer smaller plants that do not take up much space	6.398	2	0.041	Significant (p < .05)
	Prefer plants near reading/study areas	14.675	2	0.001	Highly significant (p < .01)
	Prefer mix of potted and vertical greenery	9.101	2	0.011	Significant (p < .05)
Perceived Impact	Plants help reduce stress while studying	9.588	2	0.008	Significant (p < .01)
	Plants create a more inviting library environment	7.248	2	0.027	Significant (p < .05)
	Plants improve focus on academic tasks	4.564	2	0.102	Not significant
	Plants improve indoor air quality	29.882	2	0.000	Highly significant (p < .001)
	Plants positively affect the overall library experience	5.088	2	0.079	Not significant

Concerns/Challenges	Concern about allergies or health risks	3.640	2	0.162	Not significant
	Concern about taking up seating or study space	17.863	2	0.000	Highly significant ($p < .001$)
	Concern about maintenance disruption (watering, pests)	8.067	2	0.018	Borderline (needs post-hoc)
	Concern about pests or insects	17.662	2	0.000	Highly significant ($p < .001$)
	Concern about cost outweighing benefits	4.171	2	0.124	Not significant

Post Hoc Analysis Using Dunn's Test

Following the Kruskal-Wallis H tests, which indicated significant differences among university types (public, private, and national) in several survey items, Dunn's post hoc tests with Bonferroni corrections were conducted to determine specific pairwise group differences (Table 5).

Preferences Domain: For the item "Enjoy studying in spaces with greenery" (χ^2 (2) = 6.575, p = .037), Dunn's test indicated significant differences between private and national universities (p = .033) and public and private universities (p = .041), while no significant difference was found between public and national universities (p = .219). This suggests that users from private universities express a stronger preference for greenery in study environments. For the item "Prefer smaller plants that do not take up much space" (χ^2 (2) = 6.398, p = .041), significant differences were found between public and national universities (p = .021), and between private and national universities (p = .048), with national university users favoring compact plant arrangements more than the other groups. Regarding "Prefer plants near reading/study areas" (χ^2 (2) = 14.675, p = .001), post hoc comparisons showed significant differences across all university pairs, indicating varying attitudes about proximity to greenery.

Perceived Impact Domain: For the item "Plants improve indoor air quality" (χ^2 (2) = 29.882, $p < .001$), Dunn's test revealed statistically significant differences across all pairwise comparisons (public vs. private: p = .002; public vs. national: $p < .001$; private vs. national: p = .045). Users from national universities were more likely to associate plants with air quality improvement. The item "Plants help reduce stress while studying" also showed significant post hoc differences between public and national (p = .017) and private and national (p = .025),

supporting the view that national university users more strongly perceived stress-reducing benefits from greenery.

Concerns Domain: The item "Concern about taking up seating or study space" (χ^2 (2) = 17.863, p < .001) showed significant differences between all three university types, with national university users expressing the greatest concern. Similarly, "Concern about pests or insects" (χ^2 (2) = 17.662, p < .001) and "Concern about maintenance disruption" (χ^2 (2) = 8.067, p = .018) yielded significant pairwise differences, particularly between national and private institutions.

These post hoc findings reinforce that users' perceptions and concerns related to indoor greenery vary meaningfully across institutional contexts, with national university users generally reporting stronger preferences, benefits, and concerns.

Table 5. Significant Dunn's Test Comparisons

Survey Item	Group Comparison	Adjusted p-value	Significant
Enjoy studying in green spaces	Public vs. Private	0.041	Yes
	Public vs. National	0.219	No
	Private vs. National	0.033	Yes
Prefer smaller plants	Public vs. National	0.021	Yes
	Private vs. National	0.048	Yes
Prefer plants near study areas	All pairs	< .05	Yes
Stress-reducing effect	Public vs. National	0.017	Yes
	Private vs. National	0.025	Yes
Improve indoor air quality	All pairs	< .05	Yes
Concern: taking up space	All pairs	< .05	Yes
Concern: pests/insects	All pairs	< .05	Yes

Concern: maintenance disruption	National vs. Private	0.032	Yes

Discussion

The findings of this study are closely aligned with the stated research objectives and questions, providing valuable insights into users' preferences for indoor plants in libraries, their perceptions of their impact on academic performance, comfort, and well-being, and potential concerns related to their identity.

RQ1 It was found that overall, librarians have a clear preference for the inclusion of indoor plants in libraries with respect to type and placement. Respondents place a high premium on how plants look, suggesting that there is an enduring appreciation for aesthetics and design. This is consistent with Lee and Kim (2021) and Bossart and Spears (2023) who reported that users appreciate natural elements that create visually calming, comfortable environments. Also, there was a strong preference for minimal space-occupying small plants, indicative of a space-efficient mindset, akin to (Mueller et al., 2022) that found spatial constraints to hinder greening of shared spaces. The most agreement was of the proximity of plants to study or reading areas, which is similar to Smith et al. (2023) who also revealed the advantages of such clustered plant arrangements in workspaces. Nevertheless, preferences for other combinations, such as potted and vertical greenery, showed the wider variation, indicating differences in design style preferences and the necessity for various plant placement strategies. These results suggest that (while users prefer greenery) user preferences are complex due to aesthetic as well as practical values.

RQ2 According to the findings, indoor plants have a positive impact on users' academic performance, comfort, and well-being. There was the greatest consensus about the assertion that 'plants are useful for reducing stress when studying', supporting the calming influence of the natural world, an assertion thoroughly evidentially grounded by Browning et al. (2021) and Van Den Bogerd et al. (2021). These researchers concluded that there is a considerable association between the presence of 'verdantness' and decreases of stress and increased attentiveness. Additionally, respondents indicated that indoor plants support their concentration while doing academic tasks, matching the results of Brilli et al. (2018), who focus on greenery to enhance indoor air quality and cognitive function. The appraisal of the amount of plants contributing to a pleasant and attractive indoor environment varied more, as also described already by Thatcher et al. (2020) in their in situ study on mixed responses to greenery in indoor spaces. Likewise, the assumption that indoor flowering plants result in improved indoor air quality is supported by the research of Sharma et al. (2022) and Aydogan and Cerone (2021), who deduced detectable environmental benefits from the inclusion of plants. These findings support the principle of

biophilic design, that natural factors can have beneficial impacts on human experience in the built environment (Kellert & Wilson, 1995).

RQ3 Although users tend to agree on having indoor plants, there are somepartially crucialconcerns evidenced from the data. The big concern is allergies or other negative health affects, especially from plants that produce pollen. This is in agreement with the result of Nehr et al. (2023) warned that uncomfortable plant types can be a nuisance in shared spaces. There were even more comments about space usage, and some users were concerned that plants would take up and room for more chairs or work space- similar to what Kanika Design (2025) had talked about regarding visual and spatial disruption in shared office spaces. Maintenance challenges such as watering, pruning, and pest control were emphasized, similar to the problems identified by Kumar et al. (2023) on the operational expenses and the risk due to the wrong maintenance. people also had fear of bug or pest, which is in accordance with Moslehian et al. (2023), who referred to fungal and pest problems associated with neglected house plants. Finally, the costs to maintain were identified as a barrier, similar to that found for of (Zhong et al., 2021) who highlighted budget limitations as an important factor for institutions installing sustainable design features. These issues emphasis that strategic concept, right chosen plants and open-minded exchange are essential to succeed in integrating indoor plants in academic libraries.

RQ4 To answer the research question ‘‘How do users’ preference differ depending on the type of university they are attending? multiple Kruskal-Wallis H tests with Post Hoc Analysis Using Dunn’s Test were used to compare the differences in users’ preference, perceived benefits, and concerns between the three university types public, private, and national when it comes to indoor plants in academic libraries. For the non-parametric comparison of three or more independent groups, Kruskal-Wallis H test with subsequent Dunn's post hoc analysis is essential. Whereas the Kruskal-Wallis test gives an overall impression, Dunn's test reveals which specific groups differ and is especially critical in controlling for comparisons in more than two groups, as not to result in false positives. This double-barreled approach is made even more powerful when assumptions can't be met in a parametric fashion (Lee, 2025; Lee, 2025; Statology, 2020). Users’ preferences and concerns towards indoor plants. These findings suggest that types of university contribute significantly to how users’ perceive indoor plants. All the national university library users tended to assume greater benefits but also more practical problems. These findings are critical to the design of inclusive, biophilic academic environments to suit a range of institutional contexts.

The research aims of the study were meet in a positive manner, indicating that users in general, desire indoor plants in libraries, because of its esthetic value, stress reduces and its ability to increase concentration and sense of well-being. However, preferences, type and arrangement of plants vary and health,

space, maintenance, and cost consideration should be made to ensure successful implementation. These thoughts are helpful for design and management of libraries from library managers, designers and researchers who wishes to design a more aesthetically pleasing and productive indoor plant study environment. Future research might investigate design solutions of concerns, and provide further evidence for the benefits of indoor plants in academic settings.

Conclusion and Recommendation

This research offers insights into the factors related to university users' preferences towards indoor plants in academic library spaces, and the impact of greenery on user experience, academic involvement, as well as well-being. Results in general, survey responses showed a common agreement of the positive impact of indoor plants to the aesthetics of library spaces, aiding in reducing academic stress, increasing focus and overall level of comfort supported by the study of Afacan (2017). These findings provide considerable evidence about the role of biophilic design in academic library design as a means to achieve spaces that are both functionally effective, and psychologically restorative.

Notably, the study documents considerable differences in users' preferences and priorities depending on the type of higher education institution they belong to (public, private, national). At no campus type were plant inclusion preferences lower than the mean, and consistently national university users were most interested in plants, especially when it came to air cleaning, stress reduction, and reading environment enrichment. Despite that, these users also expressed stronger concerns regarding practical constraints (e.g., space, pests, and disruptions) than those without positive experience of sustainability apps. On the opposite end, respondents in the private universities were less distracted by practical limitations with slightly more of a design bias, preferring aesthetically designed green elements (e.g., vertical green and grouped potted plants). Library patrons of public university libraries were more moderate, showing some interest in indoor plant offerings but also being wary of sacrifice of seating and up-keep implications. They highlight the role of institutional infrastructure, resource constraints, and user expectations and attitudes towards greening academic spaces. For example, the national universities in Bangladesh typically have more severe space and budget restraints and this can account for the greater preference for environmental quality improvement and for increased level of concerns with the logistics of plant integration. Such findings suggest that a one-size-fits-all approach is not adequate, and that biophilic interventions should be customized to each university typology's infrastructural and cultural context.

Practically speaking, for indoor plants to be successfully implemented, a strategy needs to be developed, users have to be involved, and design should be flexible. Low-maintenance, hypoallergenic plant varieties that won't invade

students' study space or safety hazard their path of travel should be favored. To be close to reading areas, which increase intimacy and concentration, it is a design priority. Enlisting users in the planning, maintenance or taking in of greenery can drive ownership and continued use.

To address maintenance concerns, cost-effective strategies such as automated wagering systems, the use of soil-free hydroponic setups, and collaboration with plant care organizations can be explored. Furthermore, institutional differences must guide design decisions. For example, national universities may benefit from modular plant installations that can be scaled depending on space availability and budget, while private universities might experiment with more visually striking installations such as living walls. Public institutions could implement phased greening programs that balance aesthetic improvements with pragmatic concerns such as ventilation, cleaning routines, and circulation.

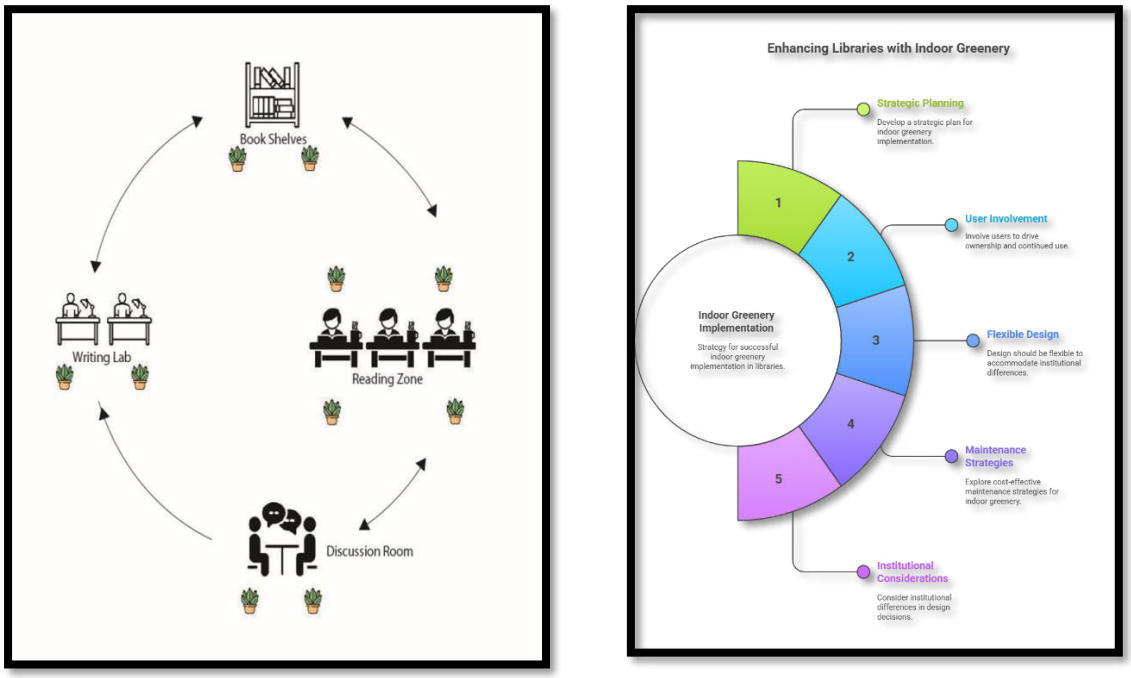

Figure 2. Predictive Layout of Greenery Spaces and strategy (source: authors)

This is a conventional arrangement of library spaces and strategies to incorporate indoor plants, as shown in Figure 2. Including Greenery in a library will only serve to enhance the facility for users and staff. Features of the proposed library plan, such as shelves, reading spaces, mixing rooms and writing laboratories are the places that can be upgraded with green elements. Although this research offers strong support for bringing indoor greenery into academic libraries, it also recognizes limitations in the specific context. The study was carried out in a specific geographical and institutional environment in Bangladesh, and the results might be influenced by climate, cultural norms and budget considerations in the country. More comparative research is necessary across different regional and institutional contexts in order to provide generalizations and better understand how biophilic design might be optimally operationalized.Secondly,

the present study only involved student users, and did not include the opinions of other potential stakeholder groups, such as faculty members, library staff, and administrators, who are important audiences for indoor plant installations, since the authors have a high regard for the various roles they play in the indoor plant installations' construction, funding, and maintenance. Third, despite strong preference for incorporation of green, it might be difficult to materialize, especially at the level of national universities, due to financial and operational issues, which might prevent biophilic features. Finally, the study was cross-sectional in nature and therefore reflects a snapshot of perceptions. This constrains the study of the impact of indoor plants on long-term academic achievement, psychological comfort, and long-term users' satisfaction. Future studies should overcome these limitations including larger sample sizes, institutional and cross-cultural comparisons, and longitudinal assessment of long-term effects.

Conflict of Interest

The authors declare that there is no conflict of interest related to the publication of this research.

Author Address:

[1]Assistant Library Officer, Uttara University, Bangladesh

[2]Information Science and Library Management, University of Rajshahi, Bangladesh

[3]Assistant Library Officer, Uttara University, Bangladesh

[4]Senior Officer, (Library Management), The Institute of Chartered Accountants of Bangladesh, Dhaka, Bangladesh

[5]Senior Officer, (Library Management), The Institute of Chartered Accountants of Bangladesh, Dhaka, Bangladesh

[6]Professor, Information Science and Library Management, University of Rajshahi, Bangladesh

References:

1. Aydogan, A., &Cerone, R. (2021). Review of the effects of plants on indoor environments. Indoor and Built Environment, 30(4), 442–460.
2. Afacan, Y. (2017). Sustainable library buildings: green design needs and interior architecture students' ideas for special collection rooms. The Journal of Academic Librarianship, 43(5), 375-383.
3. Bao, J. (2022). The impact of green plants on the reading environment of college libraries.
4. Bossart, J. L., & Spears, L. (2023, June). What do engineering students want in an academic library space? Paper presented at the 2023 ASEE Annual Conference & Exposition.

5. Brewster, L., & Cox, A. M. (2023). Taking a 'whole-university' approach to student mental health: The contribution of academic libraries. Higher Education Research & Development, 42(1), 33–47.
6. Brilli, F., Fares, S., Ghirardo, A., de Visser, P., Calatayud, V., Muñoz, A., ... &Menghini, F. (2018). Plants for sustainable improvement of indoor air quality. Trends in Plant Science, 23(6), 507–512.
7. Browning, M. H., Rigolon, A., &McAnirlin, O. (2022). Where greenspace matters most: A systematic review of urbanicity, greenspace, and physical health. Landscape and Urban Planning, 217, 104233.
8. Diller, K. (2014). Restorative library study spaces [Doctoral dissertation].
9. Dillman, D. A., Smyth, J. D., & Christian, L. M. (2014). Internet, phone, mail, and mixed-mode surveys: The tailored design method. Wiley.
10. Dinno, A. (2015). Nonparametric pairwise multiple comparisons in independent groups using Dunn's test. The Stata Journal, 15(1), 292-300.
11. Field, A. (2013). Discovering Statistics Using IBM SPSS Statistics (4th ed.). Sage Publications.
12. Field, A. (2024). Discovering statistics using IBM SPSS statistics (6th ed.). Sage Publications.
13. Gibbons, J. D., &Chakraborti, S. (2010). Nonparametric Statistical Inference (5th ed.). CRC Press.
14. Hähn, N., Essah, E., &Blanusa, T. (2021). Biophilic design and office planting: A case study of effects on perceived health, well-being and performance metrics in the workplace. Intelligent Buildings International, 13(4), 241–260.
15. Hami, A., & Abdi, B. (2021). Students' landscaping preferences for open spaces for their campus environment. Indoor and Built Environment, 30(1), 87–98.
16. Harpe, S. E. (2015). How to analyze Likert and other rating scale data.Currents in Pharmacy Teaching and Learning, 7(6), 836–850.
17. Hayleeyesus, S. F., &Manaye, A. M. (2014). Microbiological quality of indoor air in university libraries. Asian Pacific Journal of Tropical Biomedicine, 4, S312–S317.
18. Hung, C. Y., & Han, K. T. (2010). Effect of classroom greenness on students' psycho-physiology, performance, and health at the Shin-Kuang Junior High School, Taichung County. Scientia Agricola, 58, 89–106.
19. Joshi, A., Kale, S., Chandel, S., & Pal, D. (2015). Likert scale: Explored and explained. British Journal of Applied Science & Technology, 7(4), 396–403.
20. Kanika design. (2025, May 6). The Beauty of Indoor Plants In Office Interior Design. Kanika Design.
21. Kaushik, A., Arif, M., Ebohon, O. J., Arsalan, H., Rana, M. Q., & Obi, L. (2023). Effect of indoor environmental quality on visual comfort and productivity in office buildings. Journal of Engineering, Design and Technology, 21(6), 1746–1766.

22. Kumar, P., Singh, A. B., Arora, T., Singh, S., & Singh, R. (2023). Critical review on emerging health effects associated with the indoor air quality and its sustainable management. Science of The Total Environment, 872, 162163.
23. Lee, H. Y., Wu, Y. H., Asri, A. K., Chen, T. H., Pan, W. C., Yu, C. P., ... & Wu, C. D. (2020). Linkage between residential green spaces and allergic rhinitis among Asian children (case study: Taiwan). Landscape and Urban Planning, 202, 103868.
24. Lee, J. K., Kim, D. Y., Park, S. H., Woo, S. Y., Nie, H., & Kim, S. H. (2021). Particulate matter (PM) adsorption and leaf characteristics of ornamental sweet potato (Ipomoea batatas L.) cultivars and two common indoor plants (Hedera helix L. and EpipremnumaureumLindl. & Andre). Horticulturae, 8(1), 26.
25. Liu, F., Yan, L., Meng, X., & Zhang, C. (2022). A review on indoor green plants employed to improve indoor environment. Journal of Building Engineering, 53, 104542.
26. Ma, J. (2022). Interaction with nature indoor: Psychological impacts of houseplants care behaviour on mental well-being and mindfulness in Chinese adults. International Journal of Environmental Research and Public Health, 19(23), 15810.
27. Mohajan, H. K. (2020). Quantitative research: A successful investigation in natural and social sciences. Journal of Economic Development, Environment and People, 9(4), 50–79.
28. Moslehian, A. S., Roös, P. B., Gaekwad, J. S., & Van Galen, L. (2023). Potential risks and beneficial impacts of using indoor plants in the biophilic design of healthcare facilities: A scoping review. Building and Environment, 233, 110057.
29. Mousavi Samimi, P., &Shahhosseini, H. (2021). Evaluation of resident's indoor green space preferences in residential complexes based on plants' characteristics. Indoor and Built Environment, 30(6), 859–868.
30. Mueller, W., Milner, J., Loh, M., Vardoulakis, S., & Wilkinson, P. (2022). Exposure to urban greenspace and pathways to respiratory health: An exploratory systematic review. The Science of the Total Environment, 829, 154447.
31. Mwanzu, A., Bosire-Ogechi, E., &Odero, D. (2023). Green initiatives towards environmental sustainability: Insights from libraries in Kenya. IFLA Journal, 49(2), 298–314.
32. Nehr, S., Duarte, R. M. B. O., Almeida, A. S., Baus, L., & Bergmann, K. (2023). Assessing the relevance of allergenic pollen in indoor environments—current knowledge base and research needs. Allergo Journal International, 32(6), 167–175.
33. Nunnally, J. C., & Bernstein, I. H. (1994). Psychometric Theory (3rd ed.). McGraw-Hill.

34. Sharma, S., Bakht, A., Jahanzaib, M., Lee, H., & Park, D. (2022). Evaluation of the effectiveness of common indoor plants in improving the indoor air quality of studio apartments. Atmosphere, 13(11), 1863.
35. Smith, H. S., Irga, P. J., Fleck, R., &Torpy, F. R. (2023). Portable botanical biofilters to address internal combustion engine exhaust exposure. Building and Environment, 244, 110777.
36. Statology. (2020). Dunn's Test for Multiple Comparisons. Retrieved from www.statology.org
37. Stein, E. W. (2021). The transformative environmental effects large-scale indoor farming may have on air, water, and soil. Air, Soil and Water Research, 14, 11786221219958l9.
38. Thatcher, A., Adamson, K., Bloch, L., &Kalantzis, A. (2020). Do indoor plants improve performance and well-being in offices? Divergent results from laboratory and field studies. Journal of Environmental Psychology, 71, 101487.
39. Van den Bogerd, N., Dijkstra, S. C., Koole, S. L., Seidell, J. C., & Maas, J. (2021). Greening the room: A quasi-experimental study on the presence of potted plants in study rooms on mood, cognitive performance, and perceived environmental quality among university students. Journal of Environmental Psychology, 73, 101557.
40. Van Den Bogerd, N., Dijkstra, S. C., Tanja-Dijkstra, K., De Boer, M. R., Seidell, J. C., Koole, S. L., & Maas, J. (2020). Greening the classroom: Three field experiments on the effects of indoor nature on students' attention, well-being, and perceived environmental quality. Building and Environment, 171, 106675.
41. Zhong, W., Schröder, T., &Bekkering, J. (2021). Biophilic design in architecture and its contributions to health, well-being, and sustainability: A critical review. Frontiers of Architectural Research, 11(1), 114–141.
42. Zuniga, A., Motlagh, N. H., Flores, H., &Nurmi, P. (2022). Smart plants: Low-cost solution for monitoring indoor environments. IEEE Internet of Things Journal, 9(22), 23252–23259.