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Sustainability in the Workplace: Evaluating Indoor Environmental Quality of a Higher Education Building in Riyadh

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Abstract: Sustainable building design has gained global significance as a strategy to address environmental challenges and promote healthier living spaces. This concept is particularly relevant in Saudi Arabia, where there is a growing emphasis on integrating sustainable practices into the design and operation of buildings, especially in educational settings. Amidst the global push for sustainability in workplaces, this study's core lies in assessing and comparing the satisfaction levels with the indoor environmental quality (IEQ) of a Saudi Arabian higher education building against those in international green buildings, considering factors that comprise thermal comfort, air quality, lighting, acoustic quality, office arrangement, furnishings, cleanliness, and maintenance. Employing the Center for the Built Environment (CBE) IEQ survey tool, a comprehensive study was conducted among the building's occupants. A literature review and benchmarking studies complemented this to gather data on international green buildings. This study aims to assess and compare the satisfaction levels with the IEQ of a Saudi Arabian higher education building against international green buildings. The comparative analysis aims to expose the commonalities and differences in satisfaction levels, exploring how various factors influence overall satisfaction with the IEQ. The research found that there is overall satisfaction with the IEQ parameters of the building under investigation, except with two parameters: acoustics and thermal comfort. The building is generally in alignment with the IEQ of international buildings. This research is presumed to contribute significantly to sustainability initiatives in educational buildings, fostering a healthier and more sustainable workplace environment.

Keywords: sustainability; indoor environmental quality; higher education building; green building standards; occupant satisfaction

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1. Introduction

Promoting sustainability in workplaces, particularly educational settings, has become a global imperative in recent years. This focus on creating environmentally responsible and occupant-centric spaces has led to the emergence of the IEQ as a critical aspect of sustainable building design, affecting occupant well-being, productivity, and overall satisfaction [1]. The importance of studying the IEQ of education buildings lies in the fact that poor IEQ can lead to discomfort, respiratory problems, allergies, and other health issues; also, poor IEQ can affect the student's academic performance, retention, and attendance [2]. IEQ encompasses thermal comfort, air quality, lighting, acoustic quality, office layout, furnishings, cleanliness, and maintenance, each significantly impacting occupants' perceptions of their environment [3]. In Saudi Arabia, where higher education buildings perform a significant role in the built environment, assessing and benchmarking occupants' satisfaction with the

IEQ against international green building standards is crucial for advancing sustainability practices [4,5].

Recent studies have indicated the following:

- Elements such as temperature, air movement, and CO_2 concentration in educational buildings often meet acceptable levels, while other factors like relative humidity, sound, and lighting frequently fall below set standards [1,6].
- There is a deficiency in comprehensive studies examining the influence of the building environment on employee performance and satisfaction in such settings.
- Studies have verified that these IEQ parameters strongly influence overall satisfaction in educational buildings [6]. Alshuwaikhat et al. [7] identified environmental characteristics like acoustic quality and thermal comfort as crucial influencers of occupants' satisfaction in office buildings.
- Another study comparing an Italian office building's IEQ with LEED-certified buildings found differences in the satisfaction levels across various categories, including acoustic quality, thermal comfort, cleanliness, maintenance, office layout, and lighting [8].

This research proposes to fill the gap between the building environment on employee performance and their satisfaction in Saudi Arabia, where the concept of sustainability in educational buildings is still emerging, by studying the satisfaction levels of occupants with the IEQ of a higher education building in Saudi Arabia. It seeks to benchmark these satisfaction levels against those reported in international green buildings, providing a comparative perspective. A comprehensive survey using the Center for the Built Environment (CBE) IEQ survey tool was conducted among the occupants of a designated higher education building in Saudi Arabia. This approach aligns with efforts to develop new educational frameworks for green building design in the region [7]. The survey data and data from international buildings will be analyzed and compared using statistical techniques to identify commonalities and differences in the occupants' satisfaction with each IEQ factor. This suggests the importance of a holistic approach to IEQ that addresses all aspects of the indoor environment [9].

Furthermore, the research will explore the effects of various factors on general satisfaction with the IEQ. The conclusions drawn from this study will be invaluable for building managers, administrators, and policymakers striving to enhance the IEQ and sustainability practices in higher education buildings in Saudi Arabia. By leveraging insights from global best practices and aligning with Saudi Vision 2030 [10], which stresses improving the quality of living and well-being, this research aims to inspire sustainability initiatives in the chosen building and similar academic institutions in the region. It provides actionable insights for enhancing the region's educational infrastructure quality (see Figure 1).

Figure 1 demonstrates a suggested approach to developing a new educational framework for green building design. It addresses aspects of the quality of the indoor environment and leverages insights from global best practices.

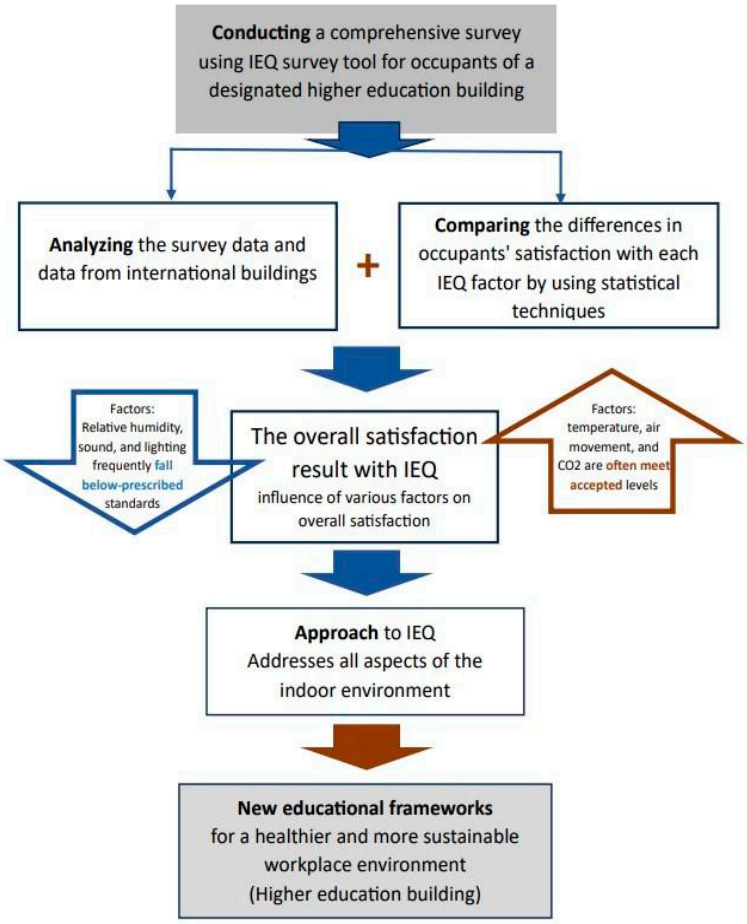


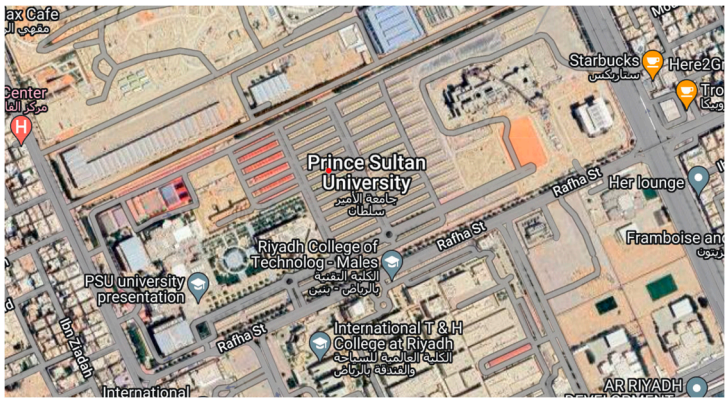
Figure 1. Diagram for the approach to sustainable workplace environments in educational buildings. Source: developed by authors.

2. Theoretical Background

2.1. Geographical Location

Riyadh, Saudi Arabia's capital and main financial center, is located in the country's geographic center and the center of the Arabian Peninsula. As shown in Figure 2a–c, the building under investigation is in Riyadh City.

a. Location of Riyadh city



b. Direct location of Prince Sultan University

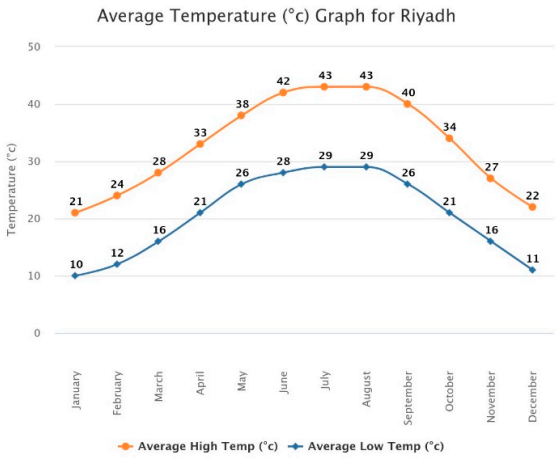
Figure 2. *Cont.*

c. University building under investigation, building facing northeast

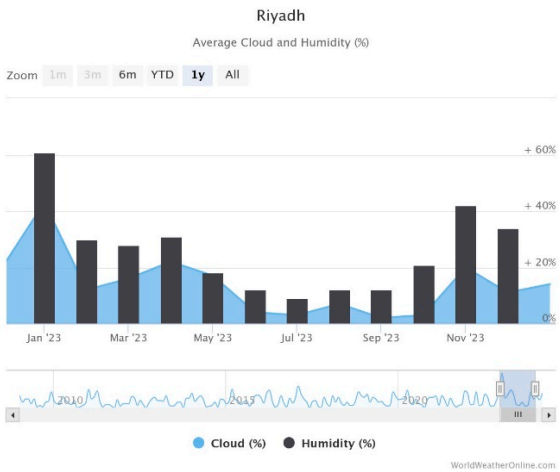
Figure 2. (**a**–**c**) Geographical location of the university building. Source [11].

2.2. Weather Conditions in Riyadh

Riyadh experiences long, hot, and dry summers, while its winters are mild and arid (Figure 3a). It is generally characterized by clear skies throughout the year. While temperamental in the winter, warm days often turn into frigid nights, and summers are extreme, with temperatures peaking at 47 °C. However, low humidity offers some comfort (see Figure 3b). The average annual temperature of Riyadh is 29 °C, with a yearly precipitation of approximately 60 mm (see Figure 3c). Riyadh consistently has wet days throughout the year, with no significant seasonal change. In Riyadh, April experiences the most rainfall, with an average precipitation of 0.3 inches. Riyadh's average hourly wind speed exhibits moderate seasonal fluctuations throughout the year (see Figure 3d). The period with stronger winds spans 2.9 months, starting on 22 May and ending on 17 August. Conversely, the period with less wind lasts 9.1 months, beginning on 17 August and concluding on 22 May.

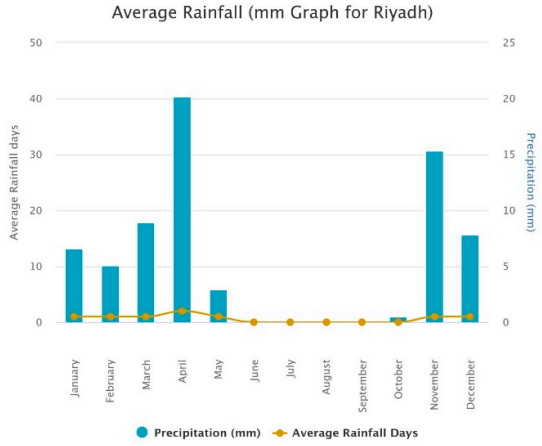


a. Average Temperature

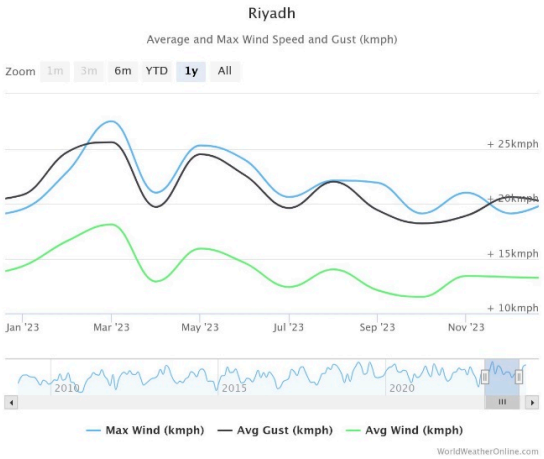


b. Annual Cloud and Humidity Averages

Figure 3. *Cont.*



c. Rainfall Averages



d. Annual Wind Speed and Wind Gust Averages

Figure 3. Riyadh's annual weather averages. Source: [12].

2.3. Introduction to Indoor Environmental Quality (IEQ) and Its Importance

IEQ: 'Indoor Environmental Quality" represents a domain with diverse sub-domains that affect human life in buildings; these include the indoor air quality (IAQ), lighting, acoustics, thermal comfort, drinking water, electromagnetic radiation, ergonomics, and many related factors. Niza et al. [13] highlighted the association between IEQ and sustainable development goals, stressing the need for enhanced technologies to foster healthy and efficient environments. This connection indicates the broader implications of IEQ in achieving sustainability targets and improving the overall quality of life. In educational buildings, specific parameters like thermal quality, indoor air quality (IAQ), and lighting quality have been shown to influence the healing processes of patients in hospital wards [14], further underscoring the broader implications of IEQ. Additionally, the design and metrological characterization of devices for monitoring IEQ conditions [15] have contributed significantly to maintaining and improving the IEQ standards in educational settings. Given the diverse factors influencing IEQ and their varied impacts, there is a growing consensus on integrating IEQ considerations into the design and management of academic buildings. This integration is essential for fostering environments conducive to learning and teaching while aligning with global sustainability and wellness goals.

2.4. IEQ Parameters and Their Influence on Occupants

Indoor environmental quality (IEQ) is a critical element in the design and operation of educational buildings, significantly impacting occupant satisfaction, well-being, and working efficiency. Several research findings have explored the influence of different IEQ factors within educational settings, such as thermal comfort, air quality, lighting, and acoustic quality (see Figure 4). Thermal comfort is a critical factor affecting the well-being and productivity of occupants. According to Park et al. [16], key elements influencing thermal satisfaction include the air temperature, size of thermal zones, window quality, and level of temperature control. The study emphasizes the importance of radiant temperature unevenness with building elevation, highlighting the need for careful design considerations to maintain optimal thermal conditions [16]. The air quality within educational buildings also plays a vital role in occupant satisfaction. Research by Faraji et al. [17] indicates that maintaining good air quality is essential for promoting a healthy and productive learning environment. This study underscores the need for efficient ventilation systems and regular air quality monitoring [17]. Lighting quality is another critical IEQ parameter. Studies like that of Kostiainen et al. [18] demonstrate that lighting affects visual comfort and psychologically impacts occupants. The research suggests that appropriate lighting design can enhance one's mood and cognitive performance, increasing overall satisfaction

and productivity [18]. Acoustic quality, too, has been identified as a significant factor influencing IEQ satisfaction. Sakellaris et al. [19] found that noise levels were highly associated with overall comfort in office buildings, including educational settings. The research highlights the need for sound insulation and acoustic design to minimize noise disruptions and enhance occupant comfort [19]. These IEQ factors collectively create an optimal learning and working environment in educational buildings. With the increasing recognition of their importance, there is a growing emphasis on integrating these elements into the layout and operation of educational buildings to ensure healthful, comfortable, and productive conditions for occupants.

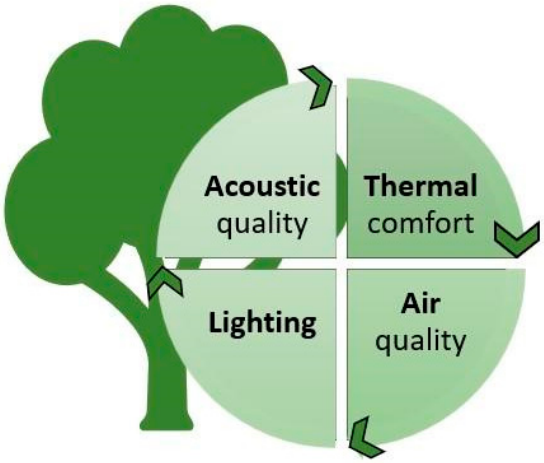


Figure 4. IEQ factors for design and operation of educational facilities to guarantee a healthy, comfortable, and productive environment for occupants. Source: developed by authors.

2.5. Sustainability in Building Design with a Focus on Saudi Arabia

Additionally, Khoshbakht et al. [20] discussed the benefits of executing green building initiatives in higher education campuses, proposing frameworks and policy implications to enhance the efficacy of these initiatives. They identified essential campus-wide energy policies, such as energy dashboards and operational energy performance certification, which are crucial for promoting sustainability in educational buildings [20]. Furthermore, public perception plays a significant role in adopting sustainable practices. A study by Alqahtany [21] in Riyadh found a high public awareness and positive perception of green roofs, with 94% of the respondents agreeing that green roofs enhance building aesthetics and control the air quality. However, the main challenge identified was the climate, which 91% of the respondents saw as a barrier to implementing green roofs [21]. In conclusion, Saudi Arabia is making significant strides in incorporating sustainable building design, particularly in higher education settings. These efforts are supported by research, policy frameworks, and public perception, which are crucial for advancing sustainable practices in the region.

2.6. Comparative Analysis of IEQ in Saudi Arabian and International Green Buildings

The comparative analysis of indoor environmental quality (IEQ) in green constructions, particularly between Saudi Arabian structures and those adhering to international standards like Leadership in Energy and Environmental Design (LEED), offers insightful perspectives on global sustainable building practices. IEQ, a critical aspect of green buildings, encompasses air quality, lighting, thermal comfort, and acoustic performance and is essential for occupant health and productivity. Alzaed et al. [22] highlighted the importance of daily energy savings and water resources in considering sustainability in Saudi Arabian buildings, underscoring the regional emphasis on resource efficiency in green building practices. Internationally, of LEED and Green Globes, an emerging system, the Living, Mustadam in Saudi Arabia, Singapore, South Africa, Spain, Switzerland, and the United States, and the International Green Construction Code (IGCC)/Energy Star in Turkey, Thai-

land, Vietnam, and the Czech Republic, LEED is the prominent benchmark for sustainable building design, with specific IEQ criteria including parameters like air ventilation, the use of low-emitting materials, and indoor lighting and thermal comfort. These standards are designed to ensure a healthy and productive indoor environment, reducing the ecological footprint of buildings. A study by Lee and Kim found that LEED-certified buildings in the United States exhibited higher occupant satisfaction with the office furnishing quality, indoor air quality (IAQ), and cleanliness and maintenance quality compared to non-LEED-certified buildings [23]. In Saudi Arabia, sustainable building practices are emerging, with a growing emphasis on aligning with global standards. For instance, the King Abdullah University of Science and Technology (KAUST) is a LEED-certified project representing the country's strides in sustainable architecture. Jamoussi et al. [24] critically examined and assessed the present state of sustainable building certification techniques in Saudi Arabia, addressing sustainability strategies and the updated Saudi Building Code. This review underscores the need for a certification system that considers new trends and the local context. A study by Al-Surf et al. [25] examines the level of understanding and utilization of green building rating systems among stakeholders in Saudi Arabia, mainly focusing on the LEED and Mostadam systems. This research investigates which rating system is more effective in addressing energy preservation and water utilization in the Saudi construction market [25]. In conclusion, while Saudi Arabian green buildings, particularly in the higher education sector, progressively incorporate sustainable practices, a comparative analysis with international benchmarks like LEED reveals distinct differences in the application and realization of IEQ standards. These differences underscore the importance of considering local environmental, cultural, and technological factors in developing and implementing sustainable building practices.

The global report of UNESCO, "Culture and Urban Future", presented a series of analyses and recommendations for fostering the role of culture in sustainable development and emphasized the importance of considering these local environmental, cultural, and technological factors in the context of Saudi Arabian green buildings.

2.7. Challenges in Saudi Arabia Concerning IEQ

Enhancing the indoor environmental quality (IEQ) in Saudi Arabian educational buildings presents unique challenges and opportunities influenced by the country's distinct climatic conditions and cultural factors (Figure 5). Understanding and addressing these challenges is crucial for improving the learning environment and ensuring the well-being of occupants. Saudi Arabia's harsh climatic conditions, characterized by extreme temperatures and low humidity, pose significant challenges to maintaining optimal IEQ in educational buildings. Alwetaishi's study [26] published in "Energy and Buildings" highlighted the difficulty in achieving thermal comfort in such an environment, which can significantly affect students' concentration and learning outcomes. Additionally, while culturally significant, the traditional architectural designs often do not align with modern IEQ standards, as Adenle and Alshuwaikhat [27] noted in their examination of sustainable practices in Saudi architecture. Air quality within educational buildings is another challenge, exacerbated by the reliance on air conditioning systems to combat the heat. A study by Adenle and Alshuwaikhat [27] discussed the influence of air conditioning on the indoor air quality in Saudi schools, noting the prevalence of pollutants and inadequate ventilation as critical concerns.

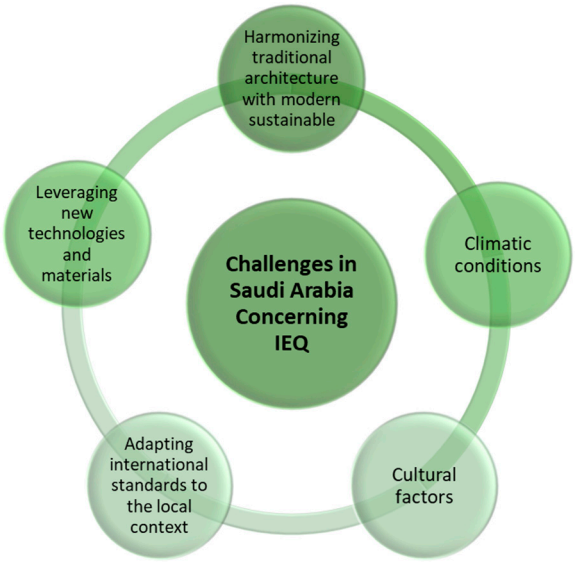


Figure 5. Significant challenges in enhancing IEQ in Saudi Arabia for green educational buildings and the well-being of occupants. Source: developed by authors.

2.8. Opportunities for Improvement and Adaptation

The indoor environmental quality (IEQ) plays a fundamental role in the health, comfort, and productivity of students and teachers in educational buildings, a fact emphasized by its designation as a critical measurement category by the United States Green Building Council's LEED [1]. Studies have established a positive association between the IEQ and enhancing students' learning quality and short-term academic achievements [28,29]. Developing indoor air quality regulations for residential and educational buildings in Saudi Arabia is advocated to improve energy management [30]. The country has seen a growing emphasis on environmental health promotion, spurred by a heightened recognition of physical environmental stressors [31]. The Saudi Arabian government's push for green building construction aims to mitigate environmental impacts and enhance societal well-being through improved indoor air quality and reduced energy and water usage [25]. However, the dependence on air conditioning, a significant consumer of household electricity in Saudi Arabia, presents a challenge [32]. In response, the Resilience and Environmental Sustainability Assessment Framework (RESAF) was introduced for family buildings to address these concerns [33]. Achieving a high IEQ is a principal goal across all nation-building assessment methodologies [34]. The determinants of IEQ in educational facilities include the indoor air quality, thermal comfort, ventilation flow, lighting, and background noise, each impacting occupant performance [35]. Efforts to create frameworks for evaluating and enhancing the IEQ in educational settings have incorporated Building Information Modeling (BIM) strategies [36]. Additionally, the impact of ventilation rates and indoor temperatures on students' cognitive performances has been investigated [32], highlighting the significant influence of the IEQ on the productivity and comfort of those within educational environments. The significance of indoor air quality in these buildings is linked to its potential effects on health and efficiency in work or study. At the same time, thermal comfort has been shown to significantly affect productivity in office settings.

3. Materials and Methods

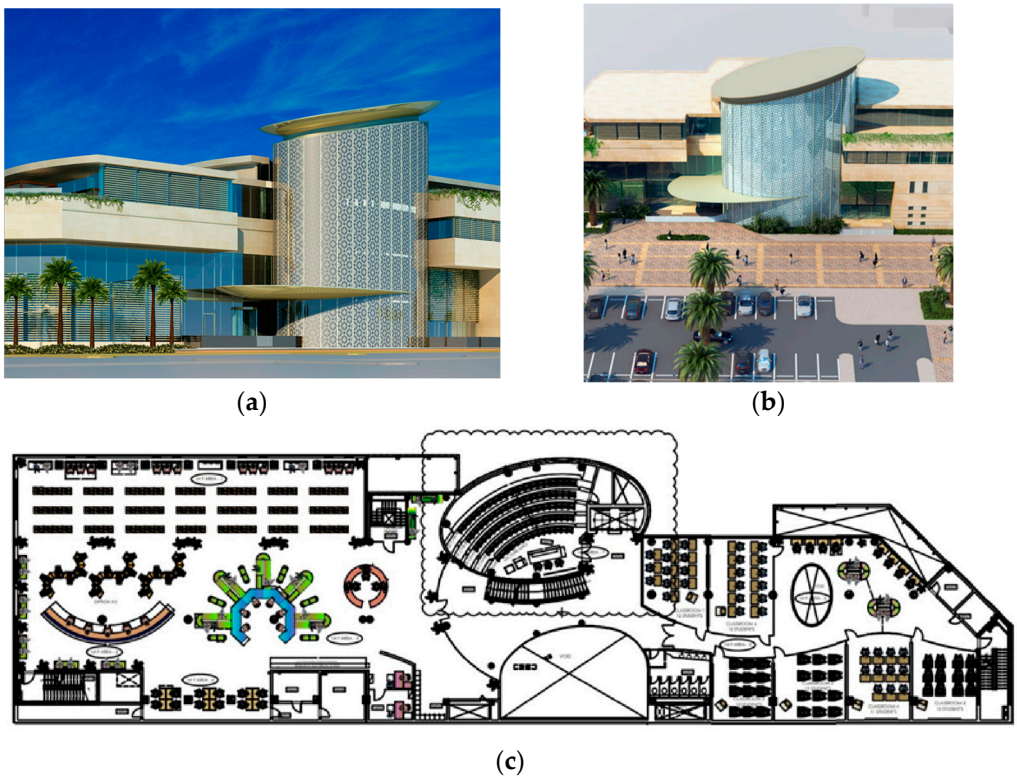
3.1. Research Objective

The research objective was to assess occupant satisfaction with the indoor environmental quality (IEQ) within a green university using the Center for the Built Environment (CBE) web-based survey tool and compare it to international buildings examined using the same web-based CBE survey. This tool evaluates various aspects of IEQ, such as thermal

comfort, air quality, lighting, acoustic quality, and overall satisfaction. Another objective is to benchmark the building IEQ performance compared to international data.

3.2. Study Design

A cross-sectional survey was performed. The web-based approach allowed for efficient data collection and a broader reach, ensuring diverse participation across departments and occupant categories. The building under investigation is a green building on a private university campus in Riyadh City (Figure 6a–c: Building's external views and second-floor plan). The building has many sustainable features, such as green walls, shading devices, and enhanced natural lighting.



(**a**) (**b**)

(**c**)

Figure 6. (**a**–**c**) Building's exterior view and plan layout. (**a**) Exterior view of the building showing shading elements on elevation. (**b**) Exterior view of the building showing exterior pedestrian and car parking on elevation. (**c**) The second-floor plan for the university building shows the classrooms on the right side and the main library on the left side.

The Center for the Built Environment at the University of California, USA, developed the indoor environmental quality (IEQ) survey of occupants' satisfaction. This web-based resource helps determine how well a building performs from the point of view of its occupants. Designers, planners, and facility professionals have considered the survey helpful with every implementation. With its diagnostic branching queries, the core survey is specifically useful for identifying and resolving issues and rating the building's performance. The core parameters tackled by the survey are thermal comfort, air quality, lighting, acoustic quality, office arrangement, furnishings, cleanliness, and maintenance.

3.3. Survey Instrument

The CBE Occupant Survey was originally created in 2000. Since then, it has continuously developed as a research instrument at the Center for the Built Environment at the University of California, Berkeley, CA, USA. It is extensively employed for gathering input from occupants. This online application anonymously assesses indoor environmental quality based on people's perspectives using the space in question. Specifically, individuals

supply subjective evaluations of their contentment, such as their personal workspace, layout, visual privacy, furniture, air quality, lighting and views, cleanliness and maintenance, thermal comfort, and acoustics. The instrument was the web-based survey of the Center for the Built Environment (CBE) at California University in the United States. This tool is renowned for its rigorous and thorough evaluation of indoor environmental quality (IEQ) factors. This tool consisted of a set of organized questions that were evaluated using a Likert scale and spaces, allowing participants to provide open-ended responses.

The survey framework allows for the application of optional modules and custom surveys for specific topics (safety and effectiveness of courtrooms) and users (such as operations, maintenance, and design personnel). In addition, the survey can be coordinated easily with the physical measurements taken at the building. These allow for assembling various detailed images of a building's output, which is especially useful for the field.

3.4. Participant Recruitment

Participants were recruited from a target population (total of 376) of staff that used the building regularly, including students (323), faculty (42), and staff (11). Recruitment methods involved email invitations and website announcements. The number of respondents was 195 (52%), and 63 completed the questionnaire (32%), which comprises 17% of the population. This response rate complies with the minimum requirements.

In the context of occupant satisfaction surveys, studies have reported response rates ranging from 14% to 40.2% for web-based surveys [37,38]. These response rates indicate a moderate level of engagement from survey participants, allowing for meaningful insights to be gathered regarding occupant satisfaction with various aspects of their environment. According to Leadership in Energy and Environmental Design (LEED), there is a credit for conducting an occupant satisfaction survey for the building occupants on their satisfaction with the environment in the building. The responses must be collected from a representative sample of building occupants comprising at least 30% [39].

3.5. Inclusion Criteria

The participants must be regular occupants of the building to ensure familiarity with the building's IEQ.

3.6. Data Collection

The web-based survey instrument starts with a consent statement and then gives section-by-section instructions on how to complete the survey. For survey administration purposes, it was hosted on the CBE online platform. The participants received an email with a link to the survey, instructions, and information about the study's purpose and confidentiality rights. Reminders were sent periodically to encourage participation and enhance the response rate. The survey period was three months to ensure the number of participants was sufficient.

3.7. Data Analysis

To launch the survey, a general announcement was emailed to faculty, staff, and students. Reminders were also sent frequently to encourage building occupants to complete the web-based survey.

The gathered data was analyzed using SPSS Statistics 29 software. Descriptive statistics provided an overview of the IEQ satisfaction levels, and inferential statistics explored relationships between different IEQ factors and occupant satisfaction.

3.8. Ethical Considerations

The study adhered to ethical standards, including obtaining institutional ethical approval and ensuring informed consent, where participants were made aware of the investigation's purpose, their voluntary participation, and the confidentiality of their responses. Data privacy was maintained, with responses anonymized during analysis.

3.9. Limitations

As with any survey-based research, potential limitations include self-reported data biases and the possibility of a non-response bias. Efforts are made to mitigate these through effective participant engagement strategies and thorough analysis.

3.10. Expected Outcomes

The research aimed to provide comprehensive insights into the occupants' perceptions of the IEQ of the targeted environment, with the potential to significantly enhance the IEQ and occupant well-being through data-driven decisions.

This research methodology ensured a systematic and ethical approach to gathering and analyzing data on IEQ satisfaction, leveraging the strength and efficiency of the web-based CBE survey tool.

4. Results

The Results offer a detailed analysis of a survey on the indoor environmental quality (IEQ) of a higher education building in Riyadh City structured for varying levels of detail. It begins with an overview of occupant demographics and experiences, providing essential context for interpreting the data. Subsequent sections include visualizations comparing the building's IEQ to the broader CBE database, snapshots of occupant satisfaction and dissatisfaction, and detailed distributions of responses for each category. The Results also highlight occupant priorities and delve into specific areas of dissatisfaction, identifying challenges within the space. This comprehensive approach allows for a nuanced understanding and targeted improvements in the building's IEQ.

4.1. General Demographics

Figure 7 below shows basic information about the 63 occupants who completed the survey. Table 1 shows the occupants' age grouping. Regarding gender, the number of female respondents is 98%, as the building is on a female campus. About age, most of the building users are students, which is reflected in a percentage of 82%. The remaining 18% are faculty and employees teaching in the building or having offices there.

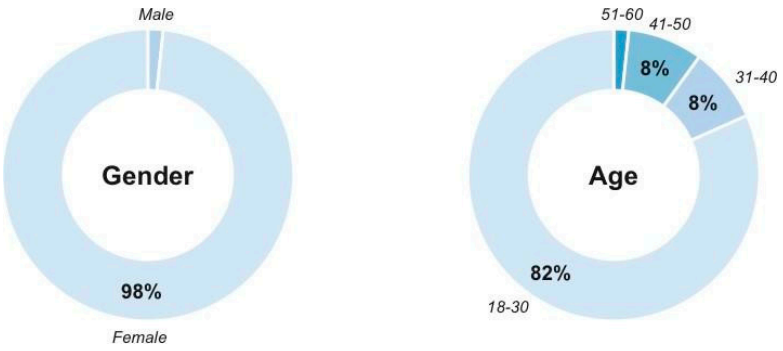


Figure 7. Gender distribution and age groups of building occupants.

Table 1. Occupant age groups.

#	Age Group	Number	Percentage
1	18–30	52	82%
2	31–40	5	8%
3	41–50	5	8%
4	51–60	1	2%

Figure 8 below presents an overview of the occupants' broad experiences with the space regarding the years working in the building and daily time spent. A total of 54% of occupants stayed in the building for more than two years, which was enough time to assess their level of satisfaction with the building.

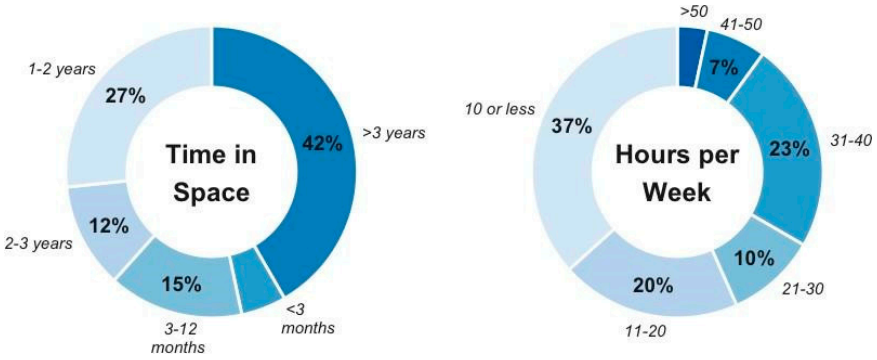


Figure 8. Overview of occupants' broad experiences and time spent in the building. Source: survey analysis.

The next set of plots in Figure 9 shows the analysis of survey responses by floor, location, and space type. Of the 63 occupants who responded to the survey, 82% reported that they were near a window, and 86% reported being near an exterior wall. A total of 58% of survey responses were from Floor 1, and 42% reported they did not know their location. A total of 70% of the space type is classrooms, and 30% are personal spaces.

Figure 9. Demonstration of occupants' floor, location, and space type.

4.2. Benchmarking the Building with International Data

Figure 10 demonstrates that the university building is within the range of the international data across most parameters, especially furnishings and acoustical quality, like international buildings. However, the CBE stated that spaces typically struggle with acoustical satisfaction and thermal comfort. On evaluating the general level of satisfaction over the eight parameters, occupants were relatively optimistic about the IEQ except in terms of thermal comfort.

4.3. Satisfaction with the Space

Figure 11 depicts building occupants' overall satisfaction across various categories, from the highest- to the lowest-performing categories. The figure illustrates this with bars, where red numbers on the left indicate the percentage of dissatisfied occupants, and green numbers on the right show the percentage of satisfied occupants. The survey measured thermal comfort, air quality, lighting, acoustics, cleanliness, visual privacy, and ease of interaction. The most satisfaction was observed in the electric lighting category, with 73% of occupants satisfied, while the temperature category saw the least satisfaction, with only 36% content. This figure serves as a straightforward and practical summary for building managers and designers to identify areas for improvement and observe changes in occupant satisfaction over time.

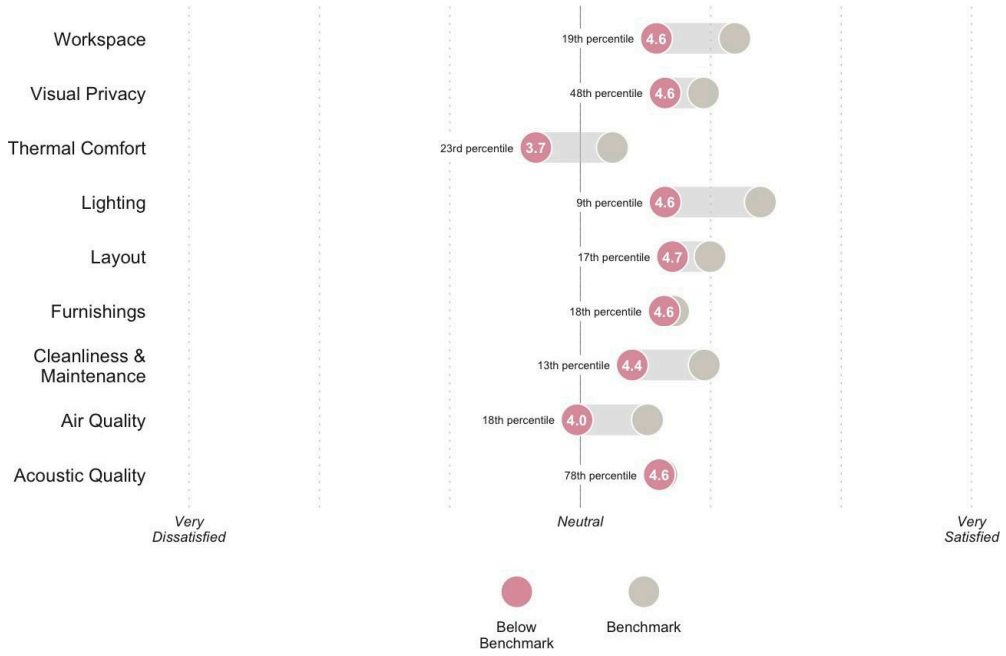


Figure 10. Comparison of the university building to the broader CBE Record.

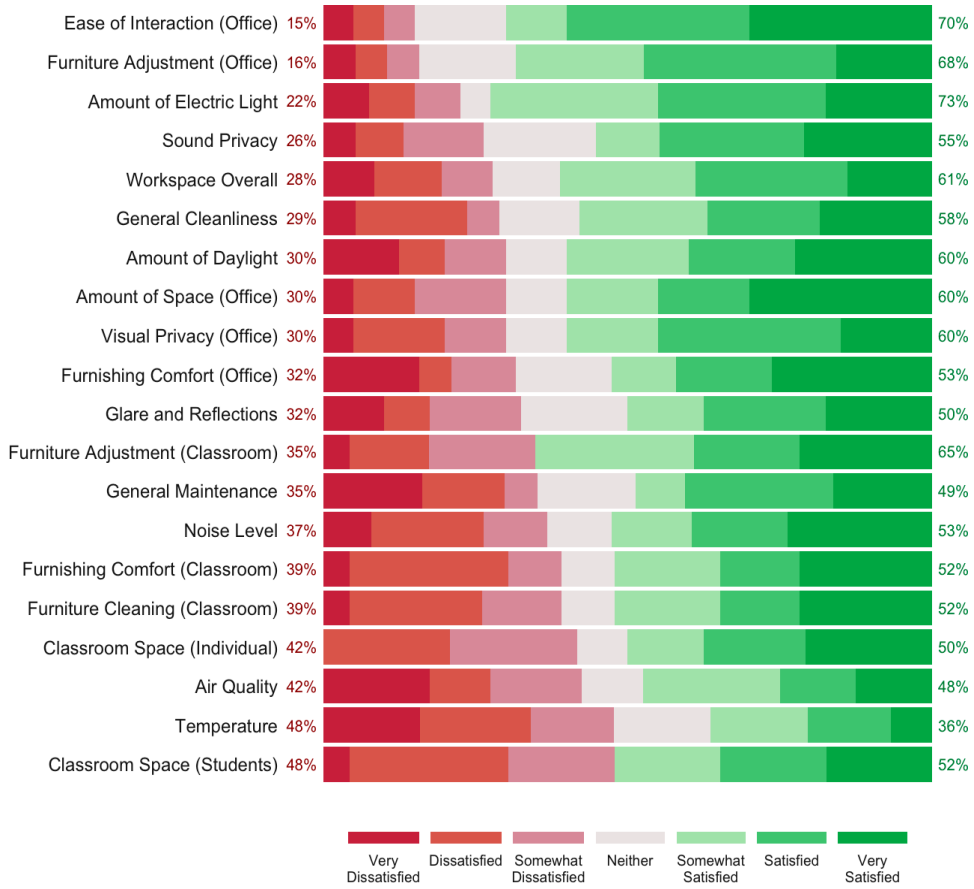


Figure 11. Summary of the occupants' satisfaction levels with the 17 items in the Center for the Built Environment (CBE) Occupant Survey.

Figure 12 below illustrates the satisfaction ratings of all 63 survey respondents. Each column represents the occupants, while the rows correspond to the satisfaction question they answered. The occupants are organized so that those with less satisfaction are posi-

tioned towards the left, while those with higher satisfaction are positioned towards the right. By examining the rows, the reader can promptly identify problem areas related to environmental quality, and by reviewing the columns, the reader can observe how each tenant has indicated their level of satisfaction.

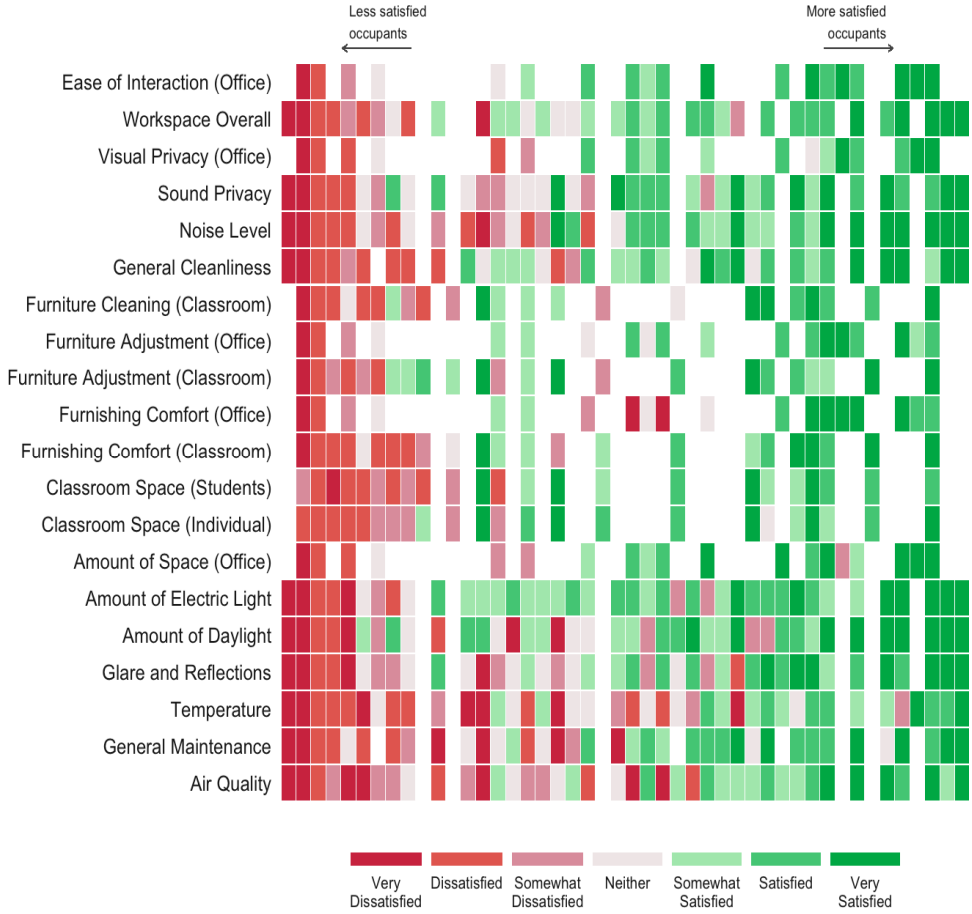


Figure 12. All individual satisfaction votes for every occupant who completed the survey.

4.3.1. Layout

The section explores occupants' perceptions of the layout within classrooms or office workspaces, shedding light on their satisfaction levels with the space provided. The results summarized in Figures 13–15 reveal that 50% of occupants were content with the space accessible for individual work and storage, while 42% expressed dissatisfaction. In contrast, 52% of occupants were satisfied with the space allocated for student work and storage, with 48% needing more space. Furthermore, 70% indicated satisfaction with the facilitated interaction with co-workers, while 15% reported dissatisfaction.

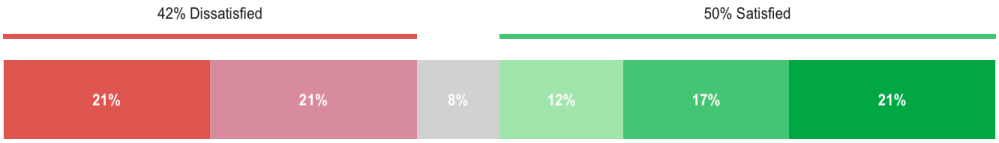


Figure 13. Percentage of satisfaction with the amount of space available for student work and storage.

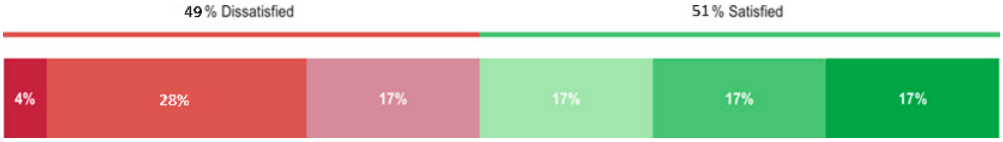


Figure 14. Percentage of satisfaction with the amount of space available for individual work and storage.

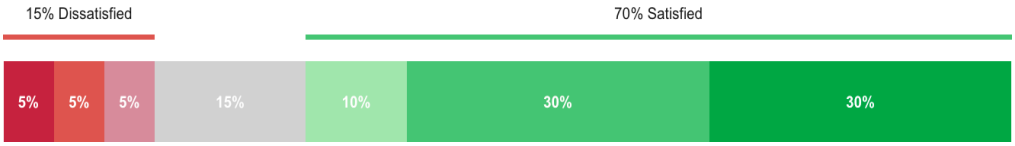


Figure 15. Percentage of satisfaction with the ease of interaction with co-workers.

These results suggest a general trend towards open office layouts among the respondents. However, the high number of neutral responses may indicate a large number of respondents who do not have a personal workspace, use multiple types of workspaces, or did not find the available options applicable to their situation.

In general, the majority of those who responded found the ability to personalize their workspace to be of varying degrees of importance. These results indicate a diverse range of usage patterns, workspace locations, and workspace types among the respondents. However, the high number of neutral responses in each case may indicate the need for additional data collection methods or more tailored survey questions to ensure that the responses more accurately capture the respondents' experiences and preferences.

4.3.2. Visual Privacy

Though definitely related to how one experiences a space's layout, the survey benchmarks "visual privacy" as its characteristic. The study has shown that this aspect of environmental quality is central and unique and should be assessed independently. Here, the occupants perceive this characteristic within the space. Figure 16 displays that 60% of the occupants are satisfied with the level of visual privacy, while 30% are not.

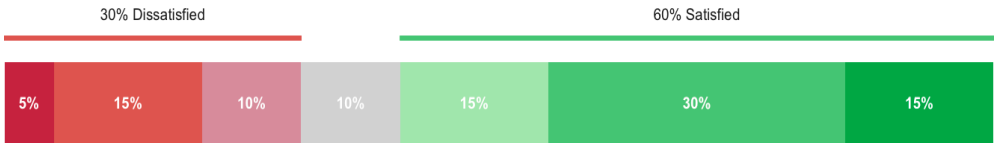


Figure 16. Percentage of satisfaction with the level of visual privacy.

This demonstrates that the aesthetic appeal of a workspace holds significant value for many respondents. The ability to control one's environment appears to be of fair importance to the respondents. This also suggests that a small portion of respondents might be unhappy with their lack of control over this aspect.

4.3.3. Furnishings

The survey results on occupants' perceptions of comfort and flexibility in terms of furniture layout in classrooms and office workspaces reveal exciting insights, as demonstrated in Figures 17–21. In classrooms, 52% of occupants are satisfied with the comfort of their furnishings, while 39% are not. Regarding adjustability, 65% are content with their ability to adjust furniture to meet their needs, with 35% expressing dissatisfaction. Similarly, 52% are comfortable cleaning classroom furniture, while 39% are not. Notably, all participants indicated satisfaction with their ability to adjust furniture. A total of 53% are satisfied with the furnishings' comfort in office workspaces, and 32% are not. Moreover, 68% of office occupants are content with their ability to adjust furniture, while 16% are not.

Classroom

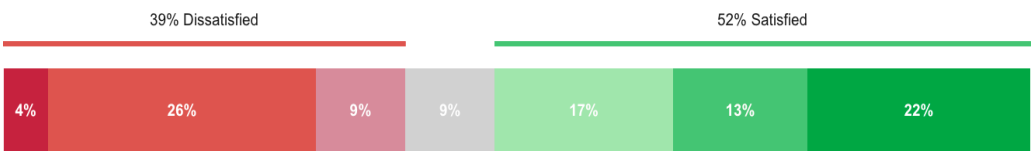


Figure 17. Percentage of satisfaction with the level of comfort regarding the classroom furnishings.

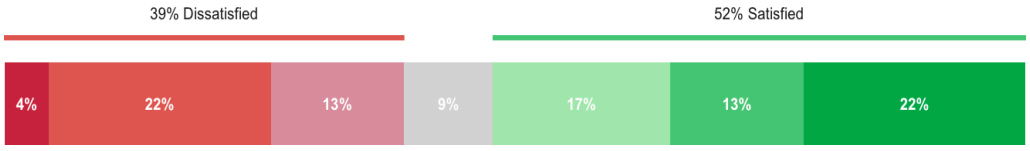


Figure 18. Percentage of satisfaction with their ability to adjust furniture to meet their needs.

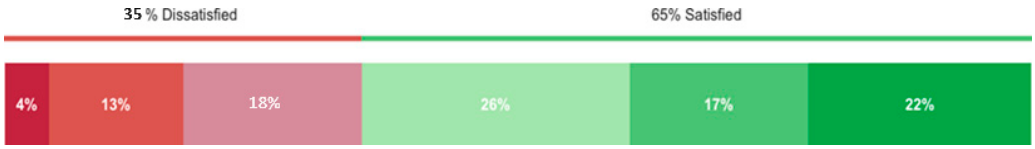


Figure 19. Percentage of satisfaction with the ease of cleaning the classroom furniture.

Office Workspaces

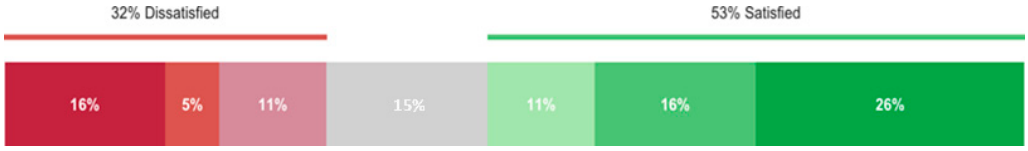


Figure 20. Percentage of satisfaction of office workspace occupants with furnishing comfort.

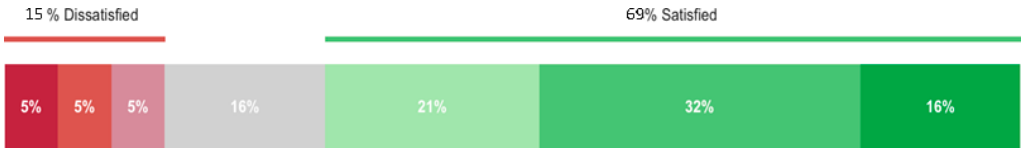


Figure 21. Percentage of satisfaction of office workspace occupants' ability to adjust the furniture to meet their needs.

4.3.4. Thermal Comfort

Next, the survey data analysis features occupants' thermal experiences within the space. Firstly, it examines how satisfied the occupants are with their thermal comfort. As demonstrated in Figure 22, the research has shown that 37% of occupants were satisfied with the temperature of their space, while 48% were not satisfied. While the majority of respondents did not express a preference, the rest were largely spread across the spectrum of satisfaction, with slightly more "dissatisfied" responses than "very satisfied". This indicates a mixed feeling among respondents about their ability to control the temperature.

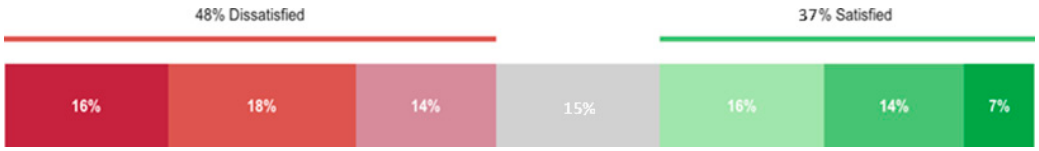


Figure 22. Percentage of satisfaction of occupants with their thermal comfort.

4.3.5. Indoor Air Quality

The following section examines how occupants perceive the space's indoor air quality (see Figure 23). It examines things like stuffy or stale air, cleanliness, and smells. A total of 46% were satisfied with the air quality in their space, while 43% were not. Again, the majority of the respondents did not provide a satisfaction level. However, the respondents who were "very satisfied" outweighed those who were "very dissatisfied." This implies a moderate level of satisfaction among those who did express an opinion.

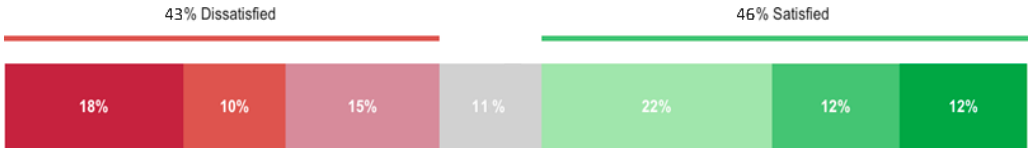


Figure 23. Percentage of satisfaction of occupants with the air quality in space.

4.3.6. Lighting and Views

Occupants' perceptions of lighting and views within a space play a crucial role in their satisfaction and comfort levels. According to the findings shown in Figures 24 and 25, a significant portion of occupants were satisfied with the lighting conditions in their space, with 74% expressing satisfaction with the amount of electric light available. However, a notable 24% were unsatisfied with the lighting levels. Moreover, when it comes to glare and reflections on screens and surfaces, 60% of occupants reported satisfaction, while 30% were not satisfied. The highest proportion suggests that a slightly higher number of respondents are satisfied with their control over lighting than are dissatisfied.

Figure 24. Percentage of satisfaction of occupants with the amount of electric light in their space.

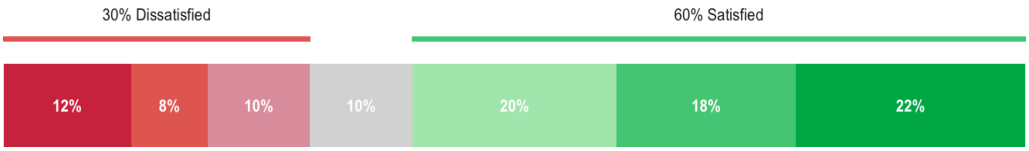


Figure 25. Percentage of satisfaction of occupants with glare and reflections on screens and surfaces.

4.3.7. Acoustic Quality

This section explores how occupants experience the acoustics in a space, as shown in Figures 26 and 27. Specifically, occupants were satisfied with the overall noise level and sound privacy. A total of 56% were satisfied with the noise level of their space, while 26% were not. A total of 53% of occupants were confident with their ability to communicate without their neighbor overhearing and vice versa, while 37% were not. This suggests a moderate level of satisfaction among respondents with their ability to control the acoustics.

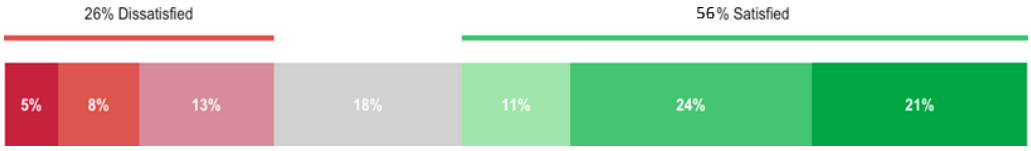


Figure 26. Percentage of satisfaction of occupants with the noise level of the space.

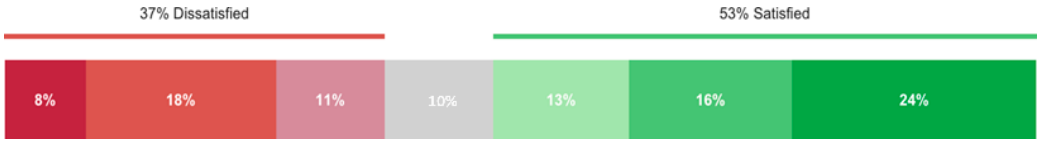


Figure 27. Percentage of occupants' satisfaction with their ability to communicate without their neighbor overhearing and vice versa.

4.3.8. Cleanliness and Maintenance

According to the results shown in Figures 28 and 29, 57% of occupants were satisfied with the building's general cleanliness, while 28% were not. Similarly, 48% of occupants

were satisfied with the building's general maintenance, with 35% expressing dissatisfaction. This indicates that among those who did express an opinion, the respondents were generally more satisfied with their ability to control cleanliness and maintenance.

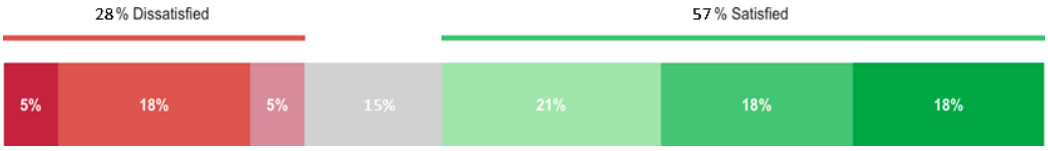


Figure 28. Percentage of satisfaction of occupants with the cleanliness and maintenance of the space.

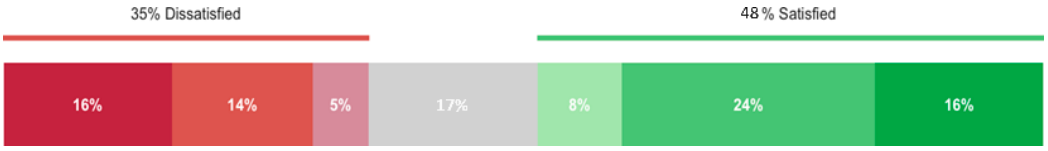


Figure 29. Percentage of satisfaction of occupants with the building's general maintenance of the space.

5. Discussion

Occupants' satisfaction with the indoor environmental quality of a higher education building in Saudi Arabia has been studied through a comprehensive survey. The respondents were asked about their feelings towards their ability to control various environmental parameters. The distribution of responses across the categories of "very dissatisfied", "dissatisfied", "neither satisfied nor dissatisfied", "satisfied", "somewhat satisfied", "very satisfied", and "valid" gave an overview of the satisfaction levels. However, the large proportion of "valid" responses (those who did not express a preference) could be explored further in future research.

By analyzing the frequencies and percentages of satisfaction levels across various environmental parameters, we have identified those with higher satisfaction and those with low satisfaction. For instance, the parameter "cleanliness" had the highest proportion of "very satisfied" responses, suggesting it is an area of high satisfaction. Conversely, the "views" parameter had higher proportions of "dissatisfied" and "very dissatisfied" responses, indicating that it as an area of lower satisfaction. This analysis allows for a better understanding of the specific areas of the indoor environment that contribute to occupant satisfaction.

The general pattern emerging from these results is a high number of neutral responses, which could indicate that the respondents did not find these issues important or relevant or were indifferent. Among those who responded, satisfaction and comfort with the furnishings and equipment vary significantly, indicating a lack of consensus on these aspects. This could imply that each individual's comfort and satisfaction with the physical aspects of their environment can be highly personalized and may not be directly influenced by a general characteristic of the classroom or equipment.

The findings show the areas of least satisfaction, such as "views" and "acoustics", which have a higher proportion of dissatisfied and very dissatisfied responses. With these identified, appropriate measures for improvement can be taken. For example, the management could review their policies and take corrective actions on aspects such as adjusting window views or reducing noise pollution.

Although the effectiveness of workplace indoor environmental parameters and their impact on the occupants' performance was not directly assessed in these statistics, one can infer that areas where higher satisfaction levels are observed might contribute positively to the occupants' performance. Future research should collect more direct measures of occupant performance and correlate these with satisfaction measures to understand the impact of indoor environmental parameters on performance better.

While these statistics provide valuable insights into occupants' satisfaction with indoor environmental quality, benchmarking against national and international LEED-rated

buildings would require comparative data from those buildings. If such data are made available through the shared platform of the Centre for Built Environment (University of Berkley, Berkley, CA, USA), this objective could be achieved. Nevertheless, the current results establish a solid foundation for the comparison and will aid in identifying gaps and areas of improvement for the higher education building in Saudi Arabia.

5.1. General Satisfaction with The Space

This distribution suggests a fairly even spread across the building, with slightly more workspaces in the north area. The relatively high percentage of respondents who did not know their workspace location could suggest a lack of orientation cues in the building or a lack of importance placed on this knowledge by the respondents [40,41].

The findings are associated with previous research emphasizing the significance of indoor environmental quality (IEQ) factors in affecting occupants' satisfaction. Studies have shown that factors like the view, influence over the indoor environment, privacy, layout, size, cleanliness, aesthetics, and furniture are crucial in determining occupants' satisfaction [42]. Additionally, the measure of space, noise levels, and visual privacy are key factors affecting overall satisfaction [43]. Furthermore, the broader environmental satisfaction domain encompasses various elements such as interaction, personal control, cleanliness, and space layout, all contributing to occupants' overall satisfaction [44]. Moreover, the impact of IEQ on occupant productivity and health has been extensively studied, highlighting the interconnected nature of factors like thermal conditions, acoustics, aesthetics, indoor air quality, and lighting on occupant satisfaction [45]. Green-certified buildings have been a research focus, with discussions on creating more comfortable, high-performing, healthier-built environments [46]. The role of IEQ in determining occupants' productivity underscores the importance of considering a holistic approach that integrates physical, attitudinal, social, and demographic components [47]. The depiction of occupants' satisfaction levels in Figure 5 highlights the critical role of various IEQ factors in shaping occupants' experiences within buildings. By understanding and addressing these factors, building professionals can enhance occupant satisfaction, well-being, and productivity in indoor environments.

5.2. Layout

These findings align with the existing literature on workspace satisfaction and occupant perceptions. Studies have highlighted the trade-offs between privacy and communication in open-plan office layouts, emphasizing the impact of spatial configuration on occupants' satisfaction levels [48]. Additionally, research has underscored the importance of indoor environmental quality factors, such as layout, furnishings, thermal comfort, air quality, lighting, and acoustics, in influencing occupants' overall workspace satisfaction and performance [45]. Moreover, investigations into workspace designs have revealed that occupants in open-plan offices are more likely to experience thermal discomfort, poor air quality, and noise, leading to higher dissatisfaction levels than occupants in other office configurations [49]. The interplay between workspace location, indoor environmental quality, and employee satisfaction within office buildings has also been explored, emphasizing the significance of these factors in shaping occupants' perceptions of their work environment [50].

Furthermore, studies have probed into the influence of the workspace design on occupant satisfaction, highlighting the need for a balance between teamwork and confidentiality in academic workspaces to enhance occupants' overall satisfaction and well-being [51]. The correlation between physical workspace conditions, such as thermal, acoustic, and lighting conditions, and occupants' satisfaction has been a focal point in research to identify key factors contributing to workspace satisfaction [52]. In closing, the results presented in this section underscore the multifaceted nature of occupants' satisfaction with the workspace layout and interaction dynamics. Building professionals can better tailor workspace designs

to meet occupants' needs and enhance overall satisfaction by considering space allocation, ease of interaction, and environmental quality.

5.3. Visual Privacy

The survey emphasizes the importance of visual privacy as a distinct aspect of environmental quality within spaces, highlighting the need to evaluate it independently. Research has indicated that visual privacy significantly influences occupants' satisfaction and well-being in workspaces. Studies have shown that visual privacy and acoustic isolation, supported by physical settings, are associated with psychological privacy, emphasizing the significance of creating spaces that provide occupants with a sense of privacy and security [53]. Additionally, factors such as furniture adjustability, colors, textures, air temperature, noise levels, and workspace cleanliness have been identified as crucial elements contributing to employee satisfaction, including considerations for visual privacy [50]. Furthermore, extensive inquiry has been conducted on the influence of workspace design on occupants' experiences, particularly concerning privacy and interaction. Distractions and a lack of privacy have hurt self-reported productivity among knowledge workers, changing from single-cell offices to shared workspaces, underscoring the importance of addressing privacy concerns in workspace design [54].

Moreover, studies have explored the relationship between stress, workspace attachment, and user satisfaction, highlighting the role of visual privacy in supporting labor productivity and well-being in workspaces [55]. In remote work, there is a growing interest in identifying the experiences of remote workers and the potential for ambient workspaces at home. Research has proposed design concepts for ambient response and human–AI interactions in the built environment to enhance home workers' experiences. This indicates an increasing focus on creating conducive home workspaces that offer privacy and support well-being [56]. In conclusion, the research findings on visual privacy feature its importance as a critical component of occupants' satisfaction within workspaces. By addressing visual privacy concerns and creating environments that provide privacy and control, building professionals can enhance occupants' well-being, productivity, and overall satisfaction in various settings.

5.4. Furnishings

These findings support research emphasizing the importance of the physical environment in educational settings. Studies have shown that factors like comfort, adjustability, and the cleanliness of furnishings play a central role in occupants' satisfaction and well-being [57,58]. Additionally, the effect of the physical environment on learning outcomes and user experience has been widely recognized [59,60]. For instance, the space/furnishings subscale includes evaluations of the indoor space, furniture, and room layout, which create a conducive learning environment [58]. Furthermore, the results underscore the significance of considering occupants' needs and preferences when designing educational spaces. Adjustable and comfortable furnishings enhance satisfaction and contribute to overall well-being and productivity [61]. The ability to customize furniture to meet individual requirements is crucial for promoting a positive and conducive workspace [57]. In summary, the survey results highlight the importance of comfort and adjustability in furnishings within educational environments. By prioritizing these aspects, institutions can create spaces that promote satisfaction, well-being, and productivity among occupants.

5.5. Thermal Comfort

Thermal comfort is critical to indoor environments, significantly impacting occupants' satisfaction and well-being. This finding aligns with studies indicating that thermal comfort is a fundamental requirement for occupants, contributing considerably to dissatisfaction when not met [62]. Moreover, thermal comfort satisfaction has been closely linked to overall satisfaction with the work environment [63]. Various factors influence thermal comfort, including building layout and design. Studies have indicated that an office's layout

significantly affects overall comfort [19]. Additionally, the building shape, orientation, and window-to-wall ratios can impact energy efficacy and thermal comfort, with specific designs offering higher comfort levels [64].

Furthermore, the orientation and form of buildings and adaptive house design are crucial in achieving better indoor thermal comfort [65]. Their behavior and lifestyle changes also influence occupants' thermal experiences. Research emphasizes the importance of considering changes in occupant behavior, lifestyle, and income when studying thermal comfort, as these factors can lead to rebound or pre-bound effects [66].

Additionally, developing models that evaluate multiple parameters, such as indoor air temperature, mean radiant temperature, relative humidity, air velocity, clothing, and metabolic rate, can provide a comprehensive understanding of thermal comfort [67]. To wrap up, ensuring optimal thermal comfort in indoor spaces is crucial for occupant satisfaction and well-being. The building design, occupant behavior, and environmental conditions significantly determine occupants' thermal experiences. By considering these factors and implementing strategies to enhance thermal comfort, building occupants can experience improved satisfaction and productivity.

5.6. Indoor Air Quality

The indoor air quality significantly influences occupants' perceptions of their environment. Studies have shown that the perceived air quality, sick building syndrome symptoms, and productivity are closely linked to indoor air conditions [68–70]. Improving the indoor air quality by reducing pollution loads has been associated with enhanced perceived air quality and reduced sick building syndrome symptoms [68]. Additionally, the impact of indoor air temperature and humidity on perceived air quality and symptoms has been highlighted, emphasizing the importance of these factors in maintaining a healthy indoor environment [70]. The significance of indoor air quality has gained global attention, with efforts to enhance building occupants' comfort, health, and well-being [71]. Research has indicated that addressing the indoor air quality is crucial for promoting the health and well-being of occupants, especially in densely populated areas like office spaces [72]. Occupants' satisfaction with the indoor environmental quality is a critical aspect that reflects how they perceive their surroundings [73]. Studies have shown that occupants' perceptions of the indoor air quality is influenced by various factors such as the temperature, air movements, and pollutant concentrations [74–76]. Furthermore, the quality of the indoor environment, encompassing thermal, lighting, air, and acoustic qualities, plays a vital role in occupants' well-being and satisfaction [77]. The association between indoor humidity and occupants' perceptions of indoor air quality has been highlighted, emphasizing the need to manage indoor humidity levels effectively [78].

Additionally, a building's multifaceted environmental performance, including indoor air quality, impacts the occupants' health and satisfaction with living or working spaces [79]. In summary, high indoor air quality is crucial to occupants' well-being and comfort. Addressing pollution loads, the temperature, humidity, and pollutant concentrations is essential in creating a healthy indoor environment that promotes occupants' health and productivity.

5.7. Lighting and Views

When asked by occupants whether they were satisfied with the window view from their space, no participants indicated that they experienced some level of dissatisfaction with their window views. Interestingly, all participants indicated satisfaction with the window views from their space, with no one reporting any level of dissatisfaction, as also confirmed in [80]. Research focusing on the benefits of nature in indoor spaces, including natural views from windows, has highlighted the positive impact of biophilic interventions such as indoor plants and natural light on stress reduction and cognitive function [80]. Additionally, studies have shown that indoor plants can influence self-reported perceptions, emotions, cognition, health, and satisfaction, contributing to improved well-being and

productivity [81]. Field studies are suggested to explore how lighting can be optimized to enhance indoor environmental workplace satisfaction [82]. Furthermore, optimizing light source layouts and considering factors like illuminance and uniformity can significantly impact occupants' visual comfort and satisfaction with the lighting conditions [82,83]. Overall, the synthesis of these references stresses the importance of lighting and views in indoor spaces for occupant satisfaction and well-being. Incorporating biophilic elements like natural views and indoor plants, along with optimizing lighting design, can create a more comfortable and visually appealing environment for occupants, ultimately enhancing their overall experience and productivity.

5.8. Acoustic Quality

Occupants' satisfaction with acoustics in a space is a crucial aspect of their overall experience. The authors of [84] found that occupants in open-plan offices may experience adverse reactions due to overstimulation caused by excessive social contact and interruptions, impacting their satisfaction with the office environment. This result aligns with the findings of [85], who highlighted the potential negative impact of noise on occupant psychological well-being and health in open-plan offices. In the context of indoor environmental quality (IEQ), Frontczak et al. [42] examined the factors affecting occupants' satisfaction in office buildings. They found that specific indoor environmental parameters significantly influence occupants' satisfaction levels. Cheung et al. [43] also emphasized the importance of merging various IEQ variables, including sound privacy, into more prominent environmental factors to understand their substantial impact on workspace satisfaction. Zalejska [86] focused on the relationship between occupants' satisfaction and indoor environment quality, particularly addressing the impact of noise levels on general satisfaction and the perceived acoustic quality. This is in line with another study [87], which calculated acoustical satisfaction based on noise levels and sound privacy, indicating the importance of these factors in determining occupants' perceptions of acoustics. Overall, the synthesis of these references underscores the significance of acoustics in influencing occupants' satisfaction with their workspace. The level of noise and sound privacy plays a crucial role in determining occupants' overall experience, with excessive noise levels and lack of privacy potentially leading to adverse reactions and impacting their well-being and satisfaction.

5.9. Cleanliness and Maintenance

Maintaining cleanliness and addressing maintenance issues are essential aspects of indoor environmental quality that significantly impact occupants' satisfaction [43]. The study emphasizes the importance of cleanliness as one of the factors influencing occupants' satisfaction with the space [88]. Additionally, the study highlights the significance of occupants' satisfaction in the maintenance planning process, indicating that meeting users' satisfaction contributes to optimizing building costs and enhancing the overall user experience [89,90]. Furthermore, the research suggests that satisfaction with the amount of space is a critical factor influencing occupants' overall satisfaction, regardless of other demographic variables [42]. This implies that alongside cleanliness and maintenance, the perceived adequacy of space plays a vital role in occupants' contentment with their environment. In conclusion, the findings underscore the importance of cleanliness and maintenance in shaping occupants' satisfaction with a building. Addressing these aspects effectively can lead to higher overall satisfaction levels among occupants, contributing to a more positive indoor environment.

6. Conclusions

This study evaluated occupants' satisfaction concerning the indoor environmental quality of a higher education building in Saudi Arabia through a survey assessing their feelings about control over several environmental parameters. These parameters included layout, temperature, air quality, lighting, views, acoustics, cleanliness, maintenance, and

aesthetics. The study employed the Center for the Built Environment (CBE) web-based survey tool to assess occupant satisfaction with the indoor environmental quality (IEQ) within a green university. This tool evaluates various aspects of IEQ, such as thermal comfort, air quality, lighting, acoustic quality, and overall satisfaction. A cross-sectional survey was performed. The CBE Occupant Survey was originally created in 2000 as a research instrument at the Center for the Built Environment at the University of California, Berkeley, CA, USA. It is extensively employed for gathering input from occupants. This online application anonymously assesses indoor environmental quality based on people's perspectives using the space in question. This tool consisted of a set of organized questions that were evaluated using a Likert scale and spaces, allowing participants to provide open-ended responses. Participants were recruited from a target population (total of 376) of staff that used the building regularly, including students (323), faculty (42), and staff (11). Recruitment methods involved email invitations and website announcements. The number of respondents was 195 (52%), and 63 completed the questionnaire (32%), which comprises 17% of the population. The participants received an email with a link to the survey, instructions, and information about the study's purpose and confidentiality rights. The survey period was three months to ensure the number of participants was sufficient.

It was found that the satisfaction levels differed across various parameters. The respondents were asked about their feelings towards their ability to control multiple environmental parameters. The distribution of responses across the categories of "very dissatisfied", "dissatisfied", "neither satisfied nor dissatisfied", "satisfied", "somewhat satisfied", and "very satisfied". We have identified those with higher and lower satisfaction levels by analyzing the frequencies and percentages of satisfaction across various environmental parameters. For instance, the parameter "cleanliness" had the highest proportion of "very satisfied" responses, suggesting it is an area of high satisfaction. Conversely, the "views" parameter had higher proportions of "dissatisfied" and "very dissatisfied" responses, indicating it as an area of lower satisfaction. This analysis allows for a better understanding of the specific areas of the indoor environment that contribute to occupant satisfaction. The findings show the areas of least satisfaction, such as "thermal comfort" and "acoustics", which have a higher proportion of dissatisfied and very dissatisfied responses. With these identified, appropriate measures for improvement can be taken. For example, the management could review their policies and take corrective actions such as adjusting window views or reducing noise pollution. Although the effectiveness of workplace indoor environmental parameters and their impact on occupants' performance was not directly assessed in these statistics, one can infer that areas where higher satisfaction levels are observed might contribute positively to occupant performance. In summary, the results suggest that respondents significantly emphasize technology and the ability to control their workspace environment. The aesthetic appeal also holds considerable importance, while personalization and privacy show a range of opinions. Telecommunication technology is perceived as very important, reflecting the growing need for effective remote communication in today's workspace environment. These insights could be valuable in guiding office design and workspace policy decisions.

Similar to other survey-based research, this study faced potential limitations such as biases in self-reported data and the risk of non-response bias. Effective participant engagement strategies were employed to address these issues, and a thorough analysis was conducted. On the other hand, the results of this study were based on the survey distributed to the building staff in a private university in Saudi Arabia, including female faculty, staff, and students. The number of occupants who completed the survey is 32% of respondents, which comprises 17% of the total population. It needs to be more significant to generalize the survey results to all the educational buildings on the university campus. The study will be extended to include evaluations of more university buildings occupied by male and female staff participants to investigate the IEQ and general occupant satisfaction levels. It would have been interesting to analyze the study results based on the students' seniority in the university and examine how the time spent on campus affects their experiences. The

same approach can be applied to the staff as well. This can be witnessed as one of the development requirements for future inquiries.

Future research should collect more direct measures of occupant performance and correlate these with satisfaction measures to better understand the impact of indoor environmental parameters on performance. While these statistics provide valuable insights into occupants' satisfaction with indoor environmental quality, benchmarking against national and international LEED-rated buildings requires comparative data. This objective could be achieved if such data are made available through the shared platform of the Centre of Built Environment (University of Berkley, Berkley, CA, USA). Nevertheless, the current results establish a solid foundation for the comparison and will aid in identifying gaps and areas of improvement for the higher education building in Saudi Arabia. The study's methodology ensured a systematic and ethical approach to gathering and analyzing data on IEQ satisfaction, leveraging the strength and efficiency of the web-based CBE survey tool.

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