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Research Article

Sick Building Syndrome (SBS): A Proactive Mitigation Strategy Focused on University Office Buildings in the United Kingdom

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Since most people spend more time at work in recent times, this has led to more workplace issues and health problems. The well-being of occupants and their overall health are strongly impacted by factors that determine the standard of indoor environments. These factors include the air quality, the level of thermal comfort, the inclusion of indoor plants, the admission of daylighting, and a variety of other factors. The absence of any of these may result in sick building syndrome (SBS). Therefore, well-planned indoor workspaces are vital for occupants' health and productivity at work. The aim of this article is to investigate proactive measures for mitigating SBS in office buildings located within universities in the United Kingdom. The study administered a questionnaire to gather perceptions of office occupants, followed by a comparative case study analysis of two office buildings at the University of Greenwich located on different campuses to highlight the correlation among the physical parameters of indoor office spaces and the occurrence of SBS. The results showed that a notable percentage of participants reported experiencing at least two symptoms of SBS. This study provided clear evidence that symptoms of SBS are primarily associated with the physical characteristics of the building, and these elements significantly influence the occupants' experiences. The mitigation of potential adverse effects on the well-being of inhabitants during the operating phase of a building resulting from physical variables can be achieved by the implementation of conscious design considerations during the initial planning stages of future buildings. One of the practical implications of this study is that it raises the urgency for built environment professionals to be fully aware of how their design decisions could either contribute to or prevent SBS symptoms.

1. Introduction

Sick building syndrome (SBS) is used to describe the adverse impacts on well-being that may be related to time spent in a building [1]. SBS can be characterised as a group of symptoms related to the indoor characteristics of certain facilities [2]. It is an increasing health concern for workers in modern office settings. However, SBS symptoms, in contrast to building-related illness (BRI) symptoms, typically improve shortly after vacating the building [3]. The World Health Organization (WHO) has been recognised as being the first to propose the concept of SBS in 1983 [4, 5]. However, the first reports of SBS date back to the 1960s [6]. It is characterised as a cluster of nonspecific symptoms such as eye, nose, and throat irritation; mental fatigue; headaches; nausea; dizziness; and skin irritations, which appear to be associated with the occupation of specific workplaces [4].

Additionally, according to Murphy [7], the term "SBS" was first introduced in a Swedish article in 1984 and later included in medical literature. Besides that, Jennings [8] noted that the initial instance of SBS was documented in 1863 among office workers in Columbus. The symptoms reported in that case were nonspecific and resembled the ones currently associated with SBS. Furthermore, it was later classified as a collection of unspecific signs brought on by exposure to potentially dangerous substances and prolonged usage of certain workplaces [4, 5]. SBS has several points of connection to other subjects and is mostly discussed in areas relating to medicine, the environment, engineering, and construction [9]. Although SBS was first viewed as associated with health [10], it has since gained increasing acceptance in the building and construction industries. Therefore, it is determined that the primary cause of SBS originates from buildings.

The decrease in air movement inside a building is one factor that leads to SBS [11]. The health and comfort of building occupants may be negatively impacted by poor indoor air quality (IAQ), as suggested by Cheek et al. [12]. The recent COVID-19 pandemic has revealed this relationship. Preventing SBS is especially important now because of changes to air quality in buildings brought on by the post-COVID-19 era measures along with the adoption of environmentally friendly and energy-effective building practices. In addition to being energy-efficient, sustainable buildings that manage occupant satisfaction and IAQ are required to prevent SBS.

As a result, Gao et al. [13] recommended that proactive measures be implemented from the early stages of building construction rather than relying solely on reactive measures to mitigate the occurrence of SBS. Buildings and their architectural characteristics have been found to influence the physical well-being of individuals [14]. Similarly, the work efficiency of workers is impacted by the design parameters, which in turn affects their well-being and satisfaction [15]. In fact, SBS associated with the indoor setting has been highlighted as a serious risk to employment [16]. According to Gao et al. [13], it constitutes one of the most widespread health-related concerns, with prevalence rates of 57% in workplaces, 31% in university labs, and 23%–41% in administrative structures. A survey conducted in the United Kingdom found that 80% of office employees find it difficult to pay attention because of excessive interior temperatures, 78% of office staff are not able to be innovative at work, and 60% of office individuals believe that it takes them 25% longer to finish their responsibilities because of this [17].

Accordingly, the comfort and efficiency of the building's occupants depend critically on the indoor environment's temperature. In addition, issues with IAQ, ventilation, and thermal comfort that contribute to SBS can have a negative effect on user satisfaction, efficiency, and other areas of concern. Consequently, SBS has been the subject of attention in recent years [3, 18–21]. However, in these studies, there appears to be no focus on how design features or spatial organization can affect the prevalence of SBS. According to Gao et al. [13], current literature about preventing SBS is presented in the form of reactive and preventive actions instead of proactive ones involving either the renovation or replacement of already-existing structures [22, 23]. This suggests the need to explore ways in which proactive strategies can be incorporated into the planning and design of buildings from the inception to deliver healthy buildings. This is the gap in research that this article seeks to address.

To this end, the aim of this paper is to explore the proactive mitigation strategies for SBS in university office buildings in the United Kingdom. The foundations of productivity are the occupant's satisfaction and good health, which is why it plays such an integral role in human-centred design [24]. This study would be useful in ensuring that inhabitants of future buildings will have a healthy environment to live in by proactively implementing measures from the very early phases of building design. The remainder of this paper is structured in this manner: Section 2 delivers the literature review with a focus on the concept of SBS, starting with a historical overview before exploring aspects relating to SBS contributors in relation to user experience and design elements that influence SBS. Section 3 presents the methodology, while the results and findings, discussion, and conclusion and recommendations are covered in Sections 4, 5, and 6, respectively.

2. Literature Review

2.1. Concept of SBS: Definition and Historical Overview. SBS was first formulated by the WHO in 1983 [4, 5], and it has been defined as a collection of nonspecific symptoms including eye, nose, and throat irritation; mental fatigue; headaches; nausea; dizziness; and skin irritations, which seem to be linked with occupancy of certain workplaces [10, 25]. Although it has been studied since the 19070s [26], Murphy [7] noted that the term SBS was initially introduced in a Swedish publication in 1984 and subsequently incorporated into the medical literature. It is interconnected among different disciplines such as medicine, environmental science, engineering, and construction [9]. Since it was first identified as being associated with health in 1990, SBS has gradually acquired acceptance in the design and construction industries [10]. Arguably, there is a consensus that the fundamental cause of SBS is attributed to buildings.

According to Greer [27], SBS refers to a collection of unknown symptoms that have been linked to time spent in a certain building but have no cause. Similarly, SBS is a set of indoor health issues produced by a physical environment or space [28–30]. In addition, Murphy [7] argues that for SBS, the symptoms, when present, are often mild and might change with each session of exposure, but there is no objective evidence. SBS is a condition where individuals exhibit a variety of symptoms that appear not to be evident immediately after exiting the building [31–35]. In another view, WHO [4] and Jansz [36] defined SBS from the perspective of the proportion of employees' complaints, which is 20% of a building's inhabitants experiencing SBS symptoms over a minimum of 2 weeks. Consequently, it has been established that the symptoms of SBS are indeterminate or *nonspecific*, and the impact is linked to a multitude of factors rather than a single factor.

SBS has been widely reported as a health problem in buildings, particularly workplaces [37–41] and educational institutions [29, 42, 43]. Since the early 1980s, health concerns related to IAQ have drawn more attention [44, 45]. This suggests that studying the quality of indoor air becomes increasingly crucial in the present and post-COVID-19 settings [30, 46–53]. Besides that, the incidence of SBS was found to be much greater in the older structures as compared to the newer buildings [54]. However, according to the WHO report documented in Boubekri [55] and Wong et al. [56], up to 30% of newly constructed and renovated buildings may result in SBS. Therefore, it is important to compare the prevalence of SBS in preexisting buildings with that of recently built ones.

2.2. SBS Within Office Buildings. SBS can be identified in diverse building typologies, including office buildings [5, 38, 57], dwellings [58, 59], schools [29, 43, 60, 61], universities [62], and hospitals [63–65]. SBS and IAQ have been the subject of numerous research in the workplace since the closing decades of the 20th century [66–68]. Similarly, in recent years, various research in Europe and North America indicate that office employees frequently experience unspecific symptoms, known as SBS, connected to workplace occupancy [25, 69].

Additionally, due to the multifaceted nature of SBS and the difficulty in isolating its origin, multidisciplinary research has investigated its occurrence in office structures, linking it to distinct indoor environmental factors [18, 21, 70–77]. However, since a large percentage of people in the United States spend at least 40 h a week in their office indoors [78], scholars have also paid considerable attention to the productivity of office building inhabitants [79, 80]. To this end, SBS in office space refers to typical symptoms that are linked to primarily airtight office structures [24, 81, 82].

Likewise, it has been proven that such symptoms are more prevalent in some structures, such as big and sealed structures having numerous employees in open-plan sections [6, 24, 83]. This design has been shown as the most prevalent form of business in real estate in recent years [67, 84]. This further justifies that there is a significant need for the study of occupants' comfort and productivity in office buildings in relation to IAQ. Marmot et al. [85] stated that 33% of 4052 employees working in 44 UK buildings had five or more SBS symptoms. Another study reported that over 80% of office workers submitted that working in a warm indoor environment makes it hard to remain focused, while 60% think they require 25% additional time to finish their work, and 78% believe their work setting partly destroys their innovation [17]. There are some studies related to educational office spaces in relation to the physical office setting, occupant productivity, and SBS conducted across the world, but very few in the context of the United Kingdom [3, 18–21]. As a result, enhancing occupants' satisfaction and performance in the workplace holds great significance within the UK's context. Hence, the main emphasis of this paper is on office spaces within educational buildings in the United Kingdom.

2.3. SBS Contributors in Relation to User Experience. The physical characteristics of a building are linked to SBS symptoms, which can have serious health consequences for those exposed to them [24, 26]. In addition, most of these adverse consequences are intertwined, meaning that the presence of one symptom may lead to the emergence of another [86, 87]. As a result, providing a physically comfortable setting is critical to improving the efficiency of its inhabitants and overall user experience by fostering a more productive and healthy work environment [86, 88–91].

The following factors can have major impacts on comfort, satisfaction, and health.

2.3.1. Ventilation. According to Bako-Biro et al. [92]; Amin, Akasah, and Razzaly [93]; and Pawar et al. [94], the symptoms of SBS and other health problems may be attributed to poor ventilation systems. Reduced productivity, user comfort, and other SBS symptoms may result from a lack of adequate ventilation [92, 95–99]. Besides that, symptom prevalence is typically greater in offices that use air conditioning than in those that rely on natural ventilation [78, 100–102]. Alternatively, ASHRAE has changed ventilation requirements to a baseline outside airflow rate of 15 cfm/person to prevent issues connected to insufficient ventilation, and maintaining 20 cfm/person is the norm for office spaces [33, 103]. Hence, indoor air comfort and productivity both improve with increasing ventilation rates, thereby reducing SBS [104–109].

2.3.2. Temperature and Humidity. Variation from the ideal temperature limit for the interior setting of a building may result in SBS [110, 111]. Seppanen, Fisk, and Lei [112] and Porras-Salazar et al. [113] established a relationship between indoor air comfort, employee productivity, and temperatures. Likewise, Wargorcki et al. [114] indicated a 10% decrease in productivity was seen at both 30°C and 15°C, as against functioning in a temperature range of 21°C–23°C. In addition, it is generally accepted that temperatures in the range of 21°C–23°C in the winter and 22°C–27°C in the summer are appropriate for work environments [115]. As a result, Vimalanathan and Babu [116] submitted that keeping the office at a comfortable 21°C had positive effects on workers' health, efficiency, and output. Heat impacts an individual's function through the interplay of several factors, including wind, radiation, temperature, and humidity, while it is generally viewed as a simple result of temperature [117]. According to ASHRAE [115], the optimum range for relative humidity (RH) in an indoor office space is between 30% and 60%. On the other hand, the direct impact of humidity on well-being made it stand out among these elements, as established by Liu et al. [118] in a study to explore the influence of indoor air temperature and RH on the learning performance of undergraduates. Additionally, temperatures exceeding 32°C and RH above 60% are considered an allowable range [119–123]. Besides that, the health and productivity of the occupiers of a building can be adversely affected by its IAQ [124–130]. Thus, indoor air comfort is a vital component in interior environmental factors and strongly impacts user satisfaction, well-being, and performance.

2.3.3. Lighting. The inhabitants' visual comforts are immediately affected by low-quality lighting, which might have a negative impact on their health [131, 132]. Equally, inadequate illumination can also have an adverse effect on people's eyesight, decrease productivity, and increase the likelihood of dangerous incidents happening [133]. As per ASHRAE [115], the maximum lighting power density (LPD) for office buildings is 0.64 W/sq.ft. Also, the recommended illumination level for office settings, according to Rea [134], is an optimal range of 300–500 lux. It might be argued that offices with a lighting intensity of 1000 lux are shown to have a positive effect on worker productivity, efficiency, and well-being [116]. Even though employees in offices with adequate number of windows facing the outside for better illumination demonstrated 15% more creativity and 6% improved performance [123, 134]. Therefore, workplaces with more daylight and greater illumination have been linked to lower absenteeism and enhanced productivity.

The above suggests that physical features may play a greater role in causing SBS symptoms, highlighting the importance of focusing on these features to enhance the inhabitant's satisfaction, health, and well-being to achieve the benefits of healthy design.

2.4. Design Elements Contributing to the Factors Causing SBS

2.4.1. Office Layout. A workplace layout that encourages productive communication and reduces undesirable interruptions may mitigate the negative impacts of open-plan workplaces on employee well-being and work efficiency [80, 136]. Besides that, Shaw [137] and Fadilah and Juliana [138] noted that the primary factors contributing to undesirable IAQ are associated with the layout and functioning of the structure, the existence of air pollutants, and insufficient airflow. Additionally, factors such as building block orientation [139, 140], workspace dimensions and furniture layout [78], and window positioning and area [141] can all contribute to a reduction in SBS. Several solutions to the problems associated with SBS include the installation of effective airflow systems and the deliberate planning of rooms, especially the positioning of seats [29], the setup of sunshades, the construction of environmentally friendly structures, and improved accessibility towards nature [24].

As illustrated in Figures 1 and 2, an office layout mainly consists of the following design elements: building orientation; floor area and proximity between spaces, dimensions, and shape of the spaces; position and size of the windows; and furniture layout.

The integration of these various elements culminates in a workspace arrangement that considers the requirements, satisfaction, and welfare of the occupants. Function and form must work together harmoniously [87]. In a scenario where the dimensions, configuration, or placement of the structure are unsuitable for the users, it can be believed that the design fails to adequately address the specific requirements, consequently resulting in SBS.

2.4.2. Building Materials, Colour, and Passive Design Techniques. As illustrated in Figure 3, there are several early planning and design strategies that can be taken to prevent physical discomfort that leads to SBS, including selecting building materials that are suitable for climatic conditions [142, 143] and applying passive methods [144–148]. The prevalence of SBS is directly correlated with tangible factors, such as the colour of the interior walls and the materials used, which can influence the comfort, satisfaction, and performance of individuals. Additionally, the optimal levels of indoor noise and the reduction in SBS are guaranteed by the careful selection of materials and the appropriate allocation of space.

2.4.3. Biophilic Design and Indoor Planning. There is a growing consensus that structures and living environments designed with biophilic principles could enhance people's connection with the natural world, providing a multitude of health benefits [149–151]. Natural ventilation, natural lighting, organic shapes (which occur naturally), and natural settings are the foundational components of biophilic design, as presented in Figure 4. In addition, these characteristics enhance the connection between individuals and their immediate surroundings [152]. Furthermore, Cramer and Browning [153] and Ryan et al. [154] submitted that a biophilic open workplace layout has been shown to reduce the negative impact of SBS on workers while also boosting motivation, efficiency, and productivity.

Besides, the natural environment has a healing effect [155, 156], and the proximity of users to windows has the potential to decrease SBS problems [101]. Therefore, direct exposure to the natural environment could be enhanced by the implementation of design elements such as atriums, courtyards, and collaborative rooftop gardens that incorporate vegetation that is capable of absorbing air pollutants from the atmosphere, thereby alleviating symptoms of SBS.

2.4.4. Visual Connection to Outdoor Nature. Outdoor views, particularly in open-concept workplaces that have low walls and indoor vegetation, enhanced user productivity and comfort [14, 157]. Likewise, as illustrated in Figure 5, an opening that looks out onto a beautiful natural view along with well-planned interiors could improve employee wellness, reduce stress, and boost productivity [158–162]. Furthermore, Alalouch, Aspinall, and Smith [163] conducted an evaluation of UK-based architects on hospital room design criteria and discovered that achieving a visual connection to the outdoors is a priority. Hence, it is crucial to maintain the visual link with nature through the incorporation of window openings or indoor green spaces, since this aids in mitigating the occurrence of SBS.

2.4.5. Design Elements for Daylighting. The strategic placement of windows, atriums, skylights, and other openings will enable the passage of daylight into different areas, thereby promoting an energy-efficient design by ensuring sufficient sunlight reaches each space [78, 164]. In addition, a workstation near a window increases the perception of efficiency along with satisfaction with illumination [165]. As a result, it is imperative to incorporate architectural components that improve occupant satisfaction, productivity, and comfort to ensure the optimum level of illumination in the indoor environment, thereby alleviating SBS symptoms.

In summary, these physical aspects must be considered throughout the planning and construction phases of buildings [166–168]. Indeed, occupant requirements, convenience, and satisfaction need to be fundamental design criteria today [169, 170]. Consequently, a notable requirement exists for the establishment of design standards that account for the health and satisfaction of building occupants. However, by taking these measures from the early design stages, a comfortable and productive work environment for occupants can be delivered [123]. Therefore, the potential adverse effects of

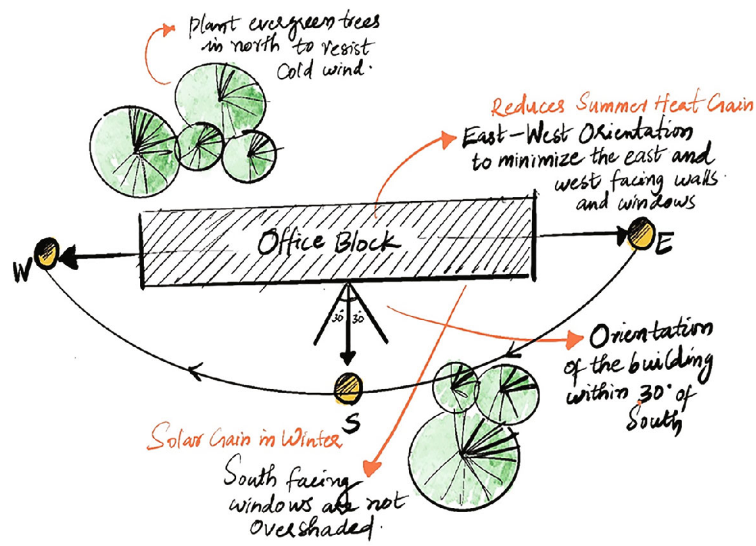

Figure 1: Schematic diagram of building orientation (*Source:*Authors, 2024).

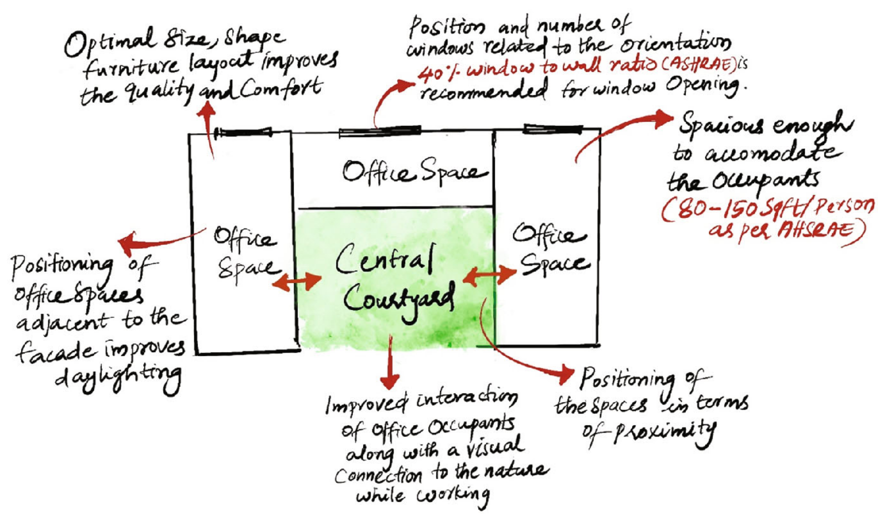

Figure 2: Major components of an office layout (*Source:*Authors, 2024).

physical factors on the health of users throughout the structure's functional stage could be mitigated by prioritizing health-related design elements during the preliminary planning phases of a building.

3. Methodology

This paper adopts a research philosophy rooted in pragmatism, which encompasses both positivism and interpretivism. This choice is made due to the adoption of multiple research approaches and methods. This study utilised a mixed methods approach, incorporating both qualitative (comparative case study) and quantitative (online survey) methodologies, to improve the reliability of the research findings within the framework of pragmatic philosophy. The mixed method techniques provide several benefits by utilising the respective strengths of qualitative and quantitative analysis [171–176]. In terms of research approach, this study employs both the inductive (theory building) and deductive (theory testing) approaches to data collection and analysis.

A survey as a research strategy was conducted among office occupants of two university office buildings to examine the relationship between occupant perceptions of various physical characteristics of indoor office environments. This study adopted an online questionnaire with closed-ended questions based primarily on a Likert-scale rating system. According to Sekaran [177] and Hyman [178], using closed-ended questions makes things simpler for everyone involved. In this case, the respondents may quickly choose between the options provided, and the researcher can more simply examine the data. Additionally, there were some open-ended questions intended to obtain the respondents' thoughts on perhaps areas not covered with the close-ended questions.

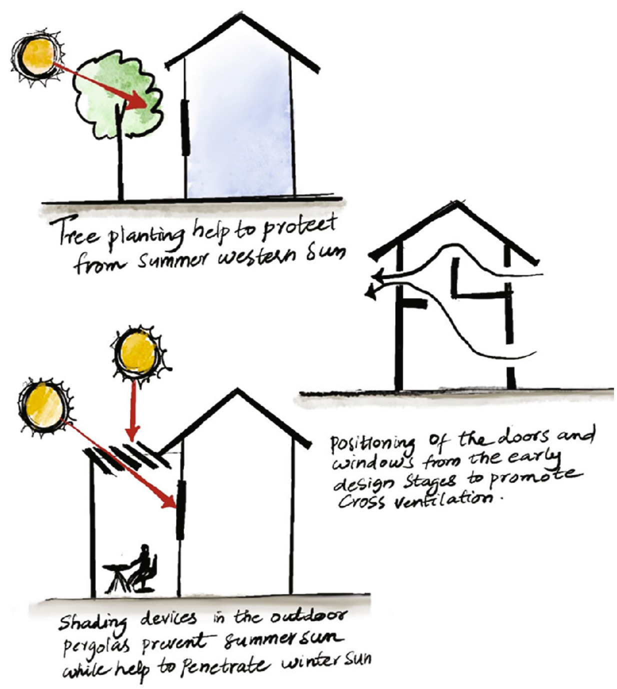

Figure 3: Application of passive methods (*Source:*Authors, 2024).

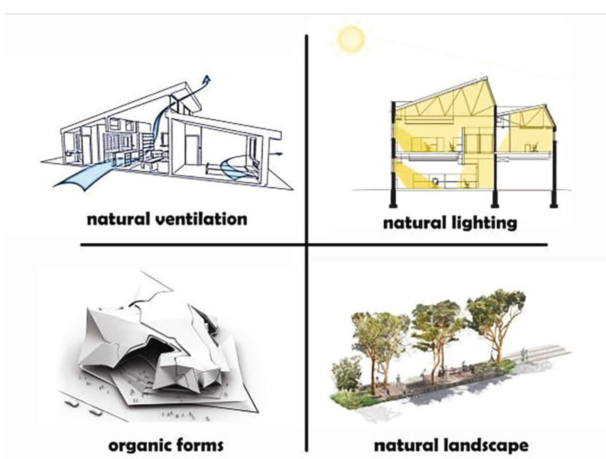

Figure 4: Biophilic design elements [152].

Using random sampling, the participants were selected from two office buildings located on the campuses of the University of Greenwich in the United Kingdom. These buildings are the "Pembroke building" and the "Queen Mary Court" which are on two different university sites. The former is at the Medway campus in Kent, and the latter is at the Greenwich Maritime campus in London. Besides the distinct site location as a criterion, the study also attempted to explore whether the age of a building influences the experience of SBS symptoms. While the Queen Mary Court was built in the closing decades of the 18th century, the Pembroke building was completed in the opening decade of the 20th century. Three other criteria for selecting these buildings are architectural elements, adaptive reuse, and similarity in office functions.

The questionnaire was structured into two sections. The first section (A) focused on gathering background information on participants. The second section (B) was aimed at collecting data on the occupants' perceptions of the physical factors of the building, as well as any symptoms related to SBS. The survey primarily focused on respondents' perceptions of their own comfort and satisfaction at work. The qualitative data, which is based on the experiences of individuals, was gathered and examined to gain a better understanding of the factors that contribute to the cause of the poor IAQ, thermal comfort, and well-being that ultimately results in SBS.

The questionnaire link, which also comprises the participant information sheet and the consent form, was sent to a total of 173 office occupants in the Queen Mary Court and 160 in the Pembroke building. Out of the total population, 55 individuals completed the questionnaire, with 22 and 33 office occupants from Queen Mary Court and Pembroke buildings, respectively. Therefore, the Pembroke and Queen Mary Courts' response rates are roughly 20.6% and 13.7%, correspondingly. Out of the 33 respondents in the Pembroke building, 29 and 27 respondents completed Sections A and B of the questionnaire, respectively. However, all respondents in Queen Mary Court completed both sections. What perhaps may be responsible for the response rate is the hybrid mode of working which has been adopted by most office users following the COVID-19 pandemic. To address this, a comparative case study analysis [179, 180] was further conducted among the two chosen university office buildings. This comparative case study analysis focused on specific design elements of both buildings that were directly linked to SBS and its effects on IAQ. Hence, the study integrated quantitative analysis, which focuses on occupant experiences, with qualitative analysis, which involves the design and physical aspects of office spaces that enhance IAQ.

A flowchart illustrating the methodological steps is presented in Figure 6.

Before collecting field data, the study was approved by the University of Greenwich Faculty of Engineering and Science Research Ethics Committee with a reference number of FES-FREC-22-06.04.88.

4. Results and Findings

This section presents the results and findings from the questionnaires and the comparative case study analysis.

4.1. Occupant's Background Information. The study on the background data on occupation of the 29 office occupants in the Pembroke and 22 Queen Mary buildings included information on the types of offices, years of employment, number of workdays per week, average daily hours worked, and so on, as presented in Table 1. About 21% of Pembroke office users and only 5% of Queen Mary occupants use the single-user office type (one individual in an office). However, the shared office space for two to five employees is most of the workspaces in each of these buildings, which is around 69% of the Pembroke and 68% of the Queen Mary. In addition, around 10% of the occupants in the Pembroke building

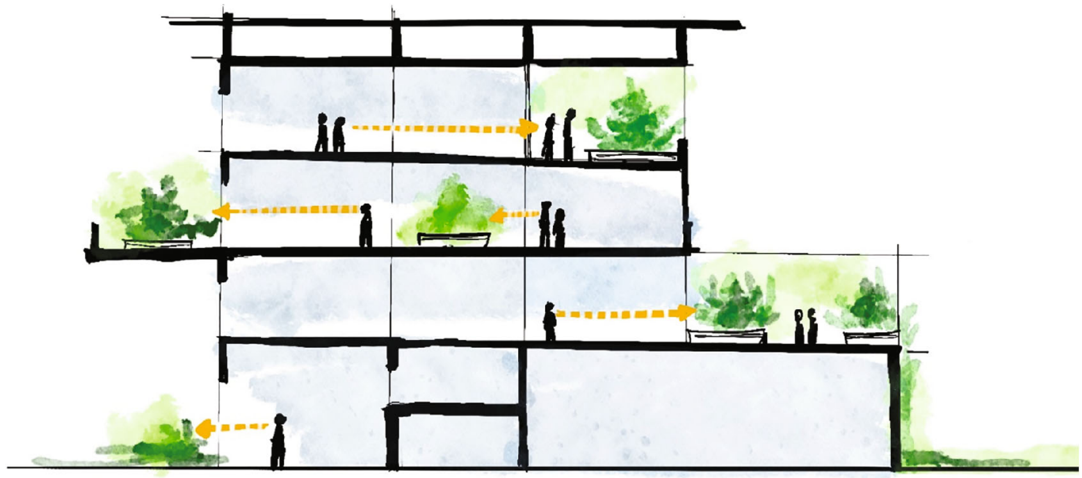

Figure 5: Visual connection to natural setting (*Source:*Authors, 2024).

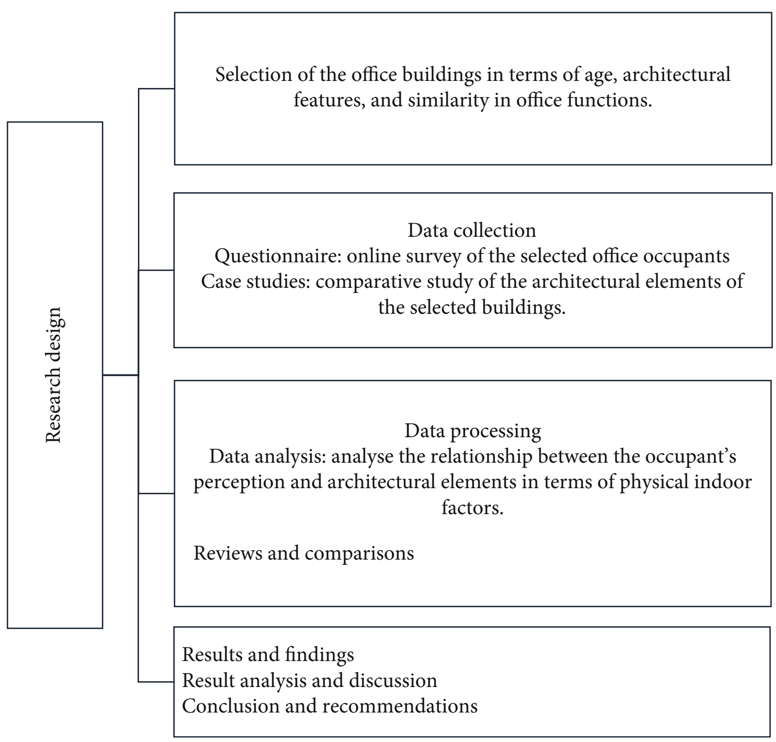

Figure 6: Methodological step adopted for study.

and 27% of the occupants in the Queen Mary building used shared office space for more than five employees.

Approximately 6% of respondents have been using the office for 6–10 years and about 8%, along with 2% of users, for 11–15 years and 16 years or above, respectively. The majority (84%) of respondents in both buildings have been there for 0–5 years. Also, about 53% of users in each building work 2–3 days per week, compared to 37% and 10% of inhabitants who work more than 3 days per week and only 1 day, respectively. In addition, most (61%) office users in the chosen buildings spent 7–10 h each day inside the offices, representing the normal working day hours, whereas 29% and 8% spent just 4–6 and 0–3 h, respectively, as shown in Table 1.

4.2. Experience of SBS Symptoms. The number of people from these two buildings suffering from SBS was classified according to having at least two of the SBS symptoms. The symptoms disappeared quickly after exiting the building and had nothing to do with any prior medical conditions. In the Pembroke building, where the incidence of SBS symptoms among employees was estimated, 13 out of 27

Table 1: Percentage distribution of background information of office occupants in both buildings.

Background information of office occupants	Pembroke building Total no. of participants = 29	Queen Mary Court Total no. of participants = 22
Office type		
Single-user office type (one individual in an office)	(6/29) 21%	(1/22) 5%
Shared office space for two to five staff	(20/29) 69%	(15/22) 68%
Shared office space for more than five staff	(3/29) 10%	(6/22) 27%
Year of experience in the office		
0–5 years	(25/29) 86%	(18/22) 81%
6–10 years	(2/29) 7%	(1/22) 5%
11–15 years	(2/29) 7%	(2/22) 9%
16 years and above		(1/22) 5%
Number of working days per week		
1 day	(2/29) 7%	(3/22) 14%
2–3 days	(13/29) 45%	(14/22) 64%
More than 3 days	(14/29) 48%	(5/22) 22%
Average hours spent in a day in the office		
0–3 h	(3/29) 10%	(1/22) 5%
4–6 h	(4/29) 14%	(11/22) 50%
7–10 h	(21/29) 72%	(10/22) 45%
More than 10 h	(1/29) 4%	

respondents (48.14%) reported relief from symptoms after vacating the facility, whereas 12 out of 22 respondents (54.54%) reported doing so in Queen Mary Court.

According to the findings from both buildings, single-user office-type occupants (one person per office) have more SBS symptoms (57%) than shared office users with two to five staff or more (45%) or more than five staff (44%). This perhaps is a result of the fact that 75% of single-user offices' occupants dislike the colour scheme, level of comfort, and overall office layout in addition to the furniture arrangement. Furthermore, around 50% of respondents expressed dissatisfaction with daylighting in terms of visual comfort, and 25% noted that the workplace spaces were too small. Therefore, the main design factors influencing the prevalence of SBS in single-user office types as compared to others are the interior colour scheme, overall office design or furniture layout, daylighting, and the size of the room.

The most common symptom was fatigue experienced by 48.15%, followed by redness or eye irritation and joint pain (44.44%), and headache experienced by 40.74% in the Pembroke building. While in Queen Mary Court, fatigue and headache were the most common (50% each), followed by redness or eye irritation and joint pain (45.45% each), as shown in Figure 7. Results also showed that symptoms were completely relieved after leaving the workplace in 40% of cases. In the rest of the cases (i.e., 60%), symptoms were only partially relieved after leaving the workplace.

The frequency of SBS symptoms was measured on a 0–4 scale (0 = *never*, 1 = *rarely*, 2 = *sometimes*, 3 = *very often*, and 4 = *always*). As shown in Figure 8, fatigue has the highest value (1.6), followed by joint pain and eye redness or irritation (both 1.4). In addition, headache and throat sourness have respective values of 1.30 and 0.80. Therefore, the occurrence rate of symptoms related to SBS in both buildings falls within the range of 1–2 (i.e., rarely to sometimes). This indicates that the frequency of symptoms is relatively low in both buildings, which may be attributed to the positive effect of the current design parameters in the office interiors.

4.3. Occupants' Perceptions of Physical Characteristics of Building Causing SBS. A total of 27 participants occupying offices in the Pembroke building and 22 participants in Queen Mary Court completed this section of the questionnaire. The result is presented in Table 2 and further explained.

- Office wall colour

Regarding the description of the workplace as reported, the number of satisfied employees with the office wall colour was greater in the Pembroke building (70%) than in the Queen Mary Court (68%). The percentage of dissatisfied employees was nearly identical in both buildings: 30% in the Pembroke building and 32% in the Queen Mary Court.

- Office design and furniture

Queen Mary Court was viewed as having a more acceptable office design and furniture arrangement than the Pembroke building, as reported by 91% and 67% of the respondents, respectively. About 9% and 33% of Pembroke and Queen Mary residents were dissatisfied, respectively.

- Noise level

About 30% and 18% of occupants in Pembroke and Queen Mary Court, respectively, were unaffected by the noise level, while 59% and 64% of occupants in both

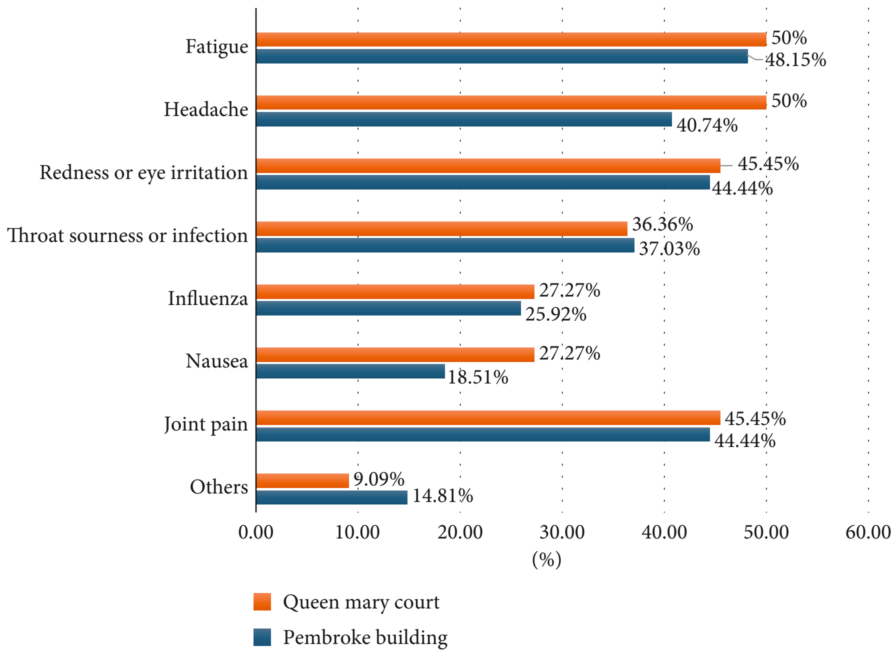

FIGURE 7: Percentage distribution of each symptom suffered by occupants in both buildings (*Source:*Authors, 2024).

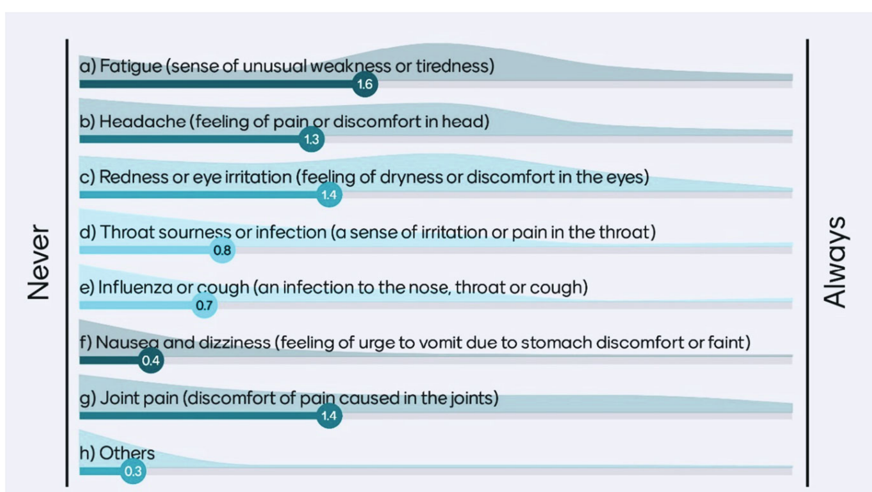

FIGURE 8: Graph showing the frequency of SBS symptoms (*Source:*Authors, 2024).

buildings were affected moderately or mildly, followed by 11% and 18% of occupants who were severely affected. Therefore, the noise level had less impact on the occupants of the Pembroke building compared to the Queen Mary Court.

- Indoor plants and green outdoor views

Almost 40% of respondents in both buildings did not have any indoor plants in their workplace (16% in Pembroke and 24% in Queen Mary, respectively). About 39% of occupants in both buildings believe that indoor plants positively influence their health and productivity, while only 20% of occupants believe that indoor plants have no effect. In both buildings, 36% and 7% of offices could not have a view of an outdoor garden, with Queen Mary Court having a higher percentage. Most respondents from the Pembroke building believe that green outdoor views improve user performance as compared to the Queen Mary Court (74% and 50%, respectively). Whereas only a small percentage of users from both buildings believe that green outdoor views have no effect at all (19% and 14%, respectively). Consequently, the presence of indoor plants and green outdoor views in office interiors has a positive effect on occupants, and the higher proportion of Queen Mary Court respondents without indoor plants and green outdoor views compared to Pembroke building occupants may increase the prevalence of SBS symptoms.

- Office spaciousness

Table 2: Percentage distribution of occupant perception on the physical factors in both buildings.

Physical factors	Pembroke building Total no. of participants = 27	Queen Mary Court Total no. of participants = 22
Colour scheme		
Acceptable	(19/27) 70%	(15/22) 68%
Poor	(8/27) 30%	(7/22) 32%
Office layout		
Acceptable	(18/27) 67%	(20/22) 91%
Poor	(9/27) 33%	(2/22) 9%
Noise level		
Not at all	(8/27) 30%	(4/22) 18%
Moderately	(7/27) 26%	(5/22) 23%
Slightly	(9/27) 33%	(9/22) 41%
Very	(1/27) 4%	(4/22) 18%
Extremely	(2/27) 7%	
Indoor plant setting		
Not applicable	(9/27) 33%	(11/22) 50%
Not at all	(4/27) 15%	(6/22) 27%
Positively effected	(14/27) 52%	(5/22) 23%
Spaciousness		
Agree	(24/27) 89%	(16/22) 73%
Undecided	(2/27) 7%	(2/22) 9%
Disagree	(1/27) 4%	(4/22) 18%
Green outdoor views		
Not applicable	(2/27) 7%	(8/22) 36%
Not at all	(5/27) 19%	(3/22) 14%
Slightly	(4/27) 15%	(3/22) 14%
Moderately	(4/27) 15%	(3/22) 14%
Very	(10/27) 37%	(4/22) 18%
Extremely	(2/27) 7%	(1/22) 4%
Indoor temperature		
Very dissatisfied	(1/27) 4%	(2/22) 9%
Dissatisfied	(8/27) 30%	(10/22) 45%
Neither	(8/27) 30%	(3/22) 14%
Satisfied	(9/27) 32%	(6/22) 27%
Very satisfied	(1/27) 4%	(1/22) 5%
Daylighting		
Very dissatisfied	(1/27) 4%	(1/22) 5%
Dissatisfied	(4/27) 15%	(4/22) 18%
Neither	(2/27) 7%	(2/22) 9%
Satisfied	(18/27) 67%	(12/22) 55%
Very satisfied	(2/27) 7%	(3/22) 13%

Table 2: Continued.

Physical factors	Pembroke building Total no. of participants = 27	Queen Mary Court Total no. of participants = 22
Indoor air quality		
Very dissatisfied	(1/27) 4%	
Dissatisfied	(2/27) 7%	(4/22) 18%
Neither	(9/27) 33%	(6/22) 27%
Satisfied	(13/27) 49%	(11/22) 50%
Very satisfied	(2/27) 7%	(1/22) 5%
Overall comfort		
Very dissatisfied	(1/27) 4%	
Dissatisfied	(1/27) 4%	(3/22) 14%
Neither	(4/27) 15%	(6/22) 27%
Satisfied	(20/27) 73%	(12/22) 54%
Very satisfied	(1/27) 4%	(1/22) 5%

A higher proportion (89%) of Pembroke building users expressed satisfaction with the spaciousness of their office space and 73% in the Queen Mary Court. Conversely, very few of the occupants in both buildings expressed dissatisfaction (4% and 18%, respectively).

- Indoor temperature:

Fifty-four percent of respondents in Queen Mary Court and 34% in the Pembroke building expressed dissatisfaction with the indoor temperature. Additionally, it is worth noting that the indoor temperature was deemed to be comfortable in both buildings, with nearly the same distribution of 32% in Queen Mary Court and 36% in the Pembroke building.

- Daylighting in terms of visual quality

Twenty-three percent of Queen Mary Court respondents and 19% of Pembroke building were unsatisfied with the daylighting in terms of visual quality. However, 68% and 74% of Queen Mary Court occupants were satisfied with the daylighting.

- IAQ

IAQ was likewise regarded as undesirable in Queen Mary Court than in the Pembroke building (18% and 11%, respectively), despite the fact that the same number of respondents in both buildings were satisfied with the IAQ (55% and 56%, respectively).

- Overall office comfort

In summary, more respondents from Queen Mary Court compared to Pembroke building were unsatisfied with physical characteristics such as room size, interior temperature, daylighting, and IAQ, which leads to more SBS symptoms (as presented in Figures 9 and 10). Furthermore, 77% of respondents in the Pembroke building found their office to be an overall comfortable space, compared to 59% in the Queen Mary Court. Eight percent in the Pembroke building and 14% in the Queen Mary Court were unsatisfied with the overall comfort of their office.

The study found a substantial correlation between the occurrence of SBS symptoms in Queen Mary Court and the effect of colour of the walls, the level of noise, the presence of indoor plants, the indoor temperature, and the office's view of outside greenery. This is because residents of Queen Mary Court are less satisfied with their indoor physical parameters than those of the Pembroke building, where more respondents reported being satisfied with their indoor plant environment and not having SBS. In addition, more employees reported that their office was sufficiently spacious and had a better indoor temperature. The same is true for overall office comfort. In the Pembroke building, most respondents exhibit SBS work in offices that do not have garden views.

4.4. Responses From Open-Ended Questions. Numerous respondents expressed a need for ways to enhance both productivity and wellness within the working environment. The comments have brought attention to significant issues present in both facilities.

- Pembroke building

Respondents from the Pembroke building expressed dissatisfaction with some physical characteristics such as indoor temperature, window type, and wall colour. They have provided suggestions for enhancing the quality of their workplace interiors by altering these factors.

One of the respondents noted that:

"Change colour scheme to produce a more homely feeling rather than a very sterile one."

Many of the other opinions primarily focused on the indoor temperature and should be taken into account to mitigate the onset of symptoms related to SBS in the building.

A few of the suggestions are captioned hereafter:

"Working toilets, hot and cold running water, filtered drinking water, staff lounge/relaxation area, pleasant ambient temperature, ergonomic furniture, deep cleaning & redecorating, plants."

"Room Temperature need to be monitored, especially during the winter and summer."

"Repair broken window, optional heating when central heating is switched off."

"Better temperature control e.g. heating and air conditioning when appropriate."

- Queen Mary Court

Most of the responses at Queen Mary Court emphasised the need for more indoor plants and green outdoor views. Here are some comments:

"I would like more plants, it gets quite cold in the office for me personally, I can see a window, but it would be nice if I was closer to one, I know it is a grade listed 1 building but having some deck."

"More regular cleaning, and better windows, fresh paint, plants."

"Natural light and green space, new furniture etc."

Respondents also reported numerous complaints regarding the windows, poor IAQ, indoor temperature, and uncomfortable office design or furniture layout, as captioned below:

"The office is often freezing cold or too hot, there needs to be a better way to regulate the temperature to a comfortable level."

"More ways to move at work, e.g., sit/stand option desk. Make central heating work correctly and able to turn fully off in hot weather. Fix sash windows so they open properly. Sort out air con."

Furthermore, there were comments about the aspects like wall colours, and some of them expressed dissatisfaction with the office's size.

"Better decorated offices and use space in a better way with more colour."

"The office is shared by some 8 staff and has never been decorated. I think if the office was painted would be an improvement."

"Some colour on walls, maybe some plants."

"Maybe a bigger office. It is supposed to have six people in and can get very stuffy."

"Making it little more spacious. Having separate meeting rooms to avoid inconvenient loud noise and a dedicated space to interact with students."

To enhance the quality of the space and consequently lessen the likelihood of SBS symptoms, comments have been made on several physical components of both buildings. According to the findings, Queen Mary Court, where 55% of respondents expressed significantly higher SBS symptoms than the Pembroke building (48%), may perhaps be linked to more suggestions for improvement than those in the Pembroke building. Therefore, properly designed architectural elements such as wall colour, indoor planting, green outdoor views, daylighting, IAQ, indoor temperature, size of the office, and also overall office design result in a reduction of SBS symptoms inside the office, thereby increasing occupants' health and productivity.

4.5. Comparative Case Study Analysis. By examining the design aspects of both the Pembroke building and Queen Mary Court, it is possible to assess the survey results based on the occupant's perception of various physical factors within their indoor workspace. Consequently, a comparative case study was undertaken to examine the architectural design components present in both buildings and their potential impact on occupants' productivity and health, specifically in relation to the occurrence of symptoms associated with SBS.

4.5.1. Pembroke Building—Case Study A. The Pembroke building, which dates to 1902 and was originally constructed as a royal naval base structure, is presently used as a part of the University of Greenwich's Medway campus. There are three distinct blocks to the building: the north and south

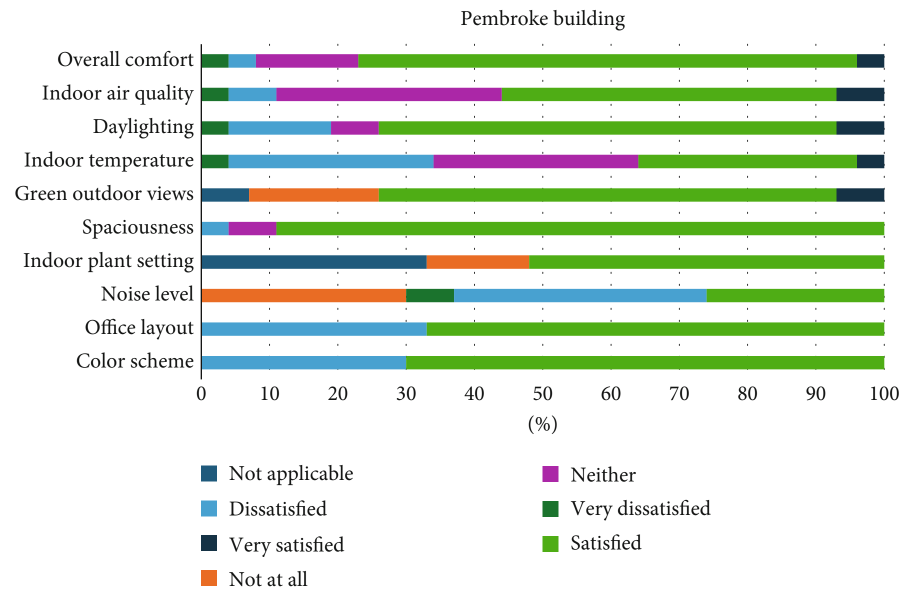

Figure 9: Comparison of the percentage of occupant's perception to the physical factors in Pembroke building.

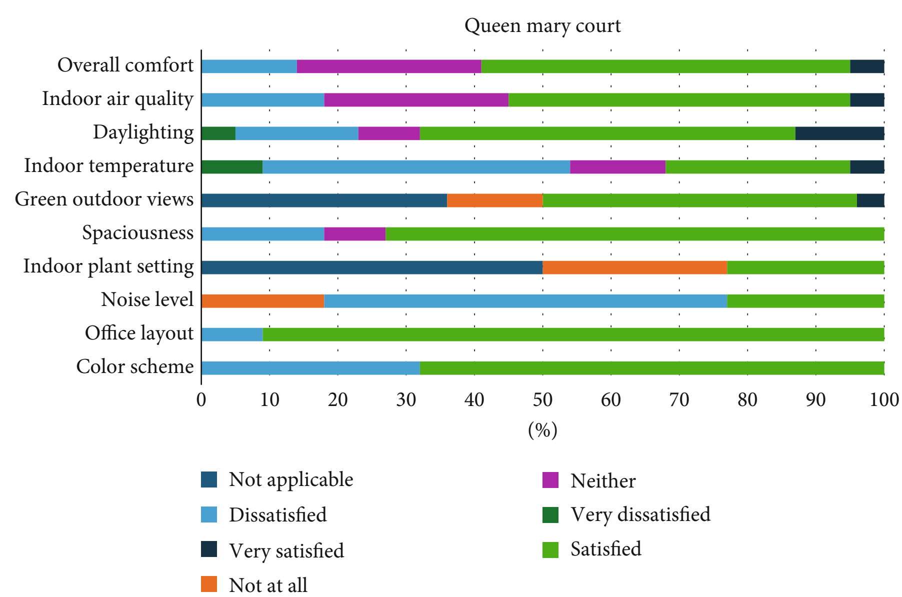

Figure 10: Comparison of the percentage of occupant's perception to the physical factors in Queen Mary Court.

blocks, each of which has four floors, and the central block, which has three. The northern and southern blocks are where most of the office spaces are located, and they are linked to the central block. The fact that the interior of this building was initially intended for naval use and was later converted into a university office function may influence the comfort, efficiency, and well-being of the building's occupants. Physical parameters such as building block shape, office type according to the number of users, room size, position and number of windows, daylighting, window proximity, indoor planting, and green outdoor views from windows were used to analyse the Pembroke building's floor plans, as shown in Figure 11. The correlation between the occurrence of SBS symptoms (48% as per survey results) and the influence of these factors on the occupant's perception inside the indoor environment was also examined.

Most offices located in the north and south blocks exhibit one or two green outside views, as depicted in the floor plan, which improve the user's comfort and productivity. Moreover, the presence of more than two or three individuals in an office setting exhibits differences in their productivity and comfort levels, particularly in relation to the availability of daylight and a strong visual connection with the external environment. The proximity to windows is an important aspect of visual comfort for occupants. Individuals positioned closer to windows tend to exhibit higher

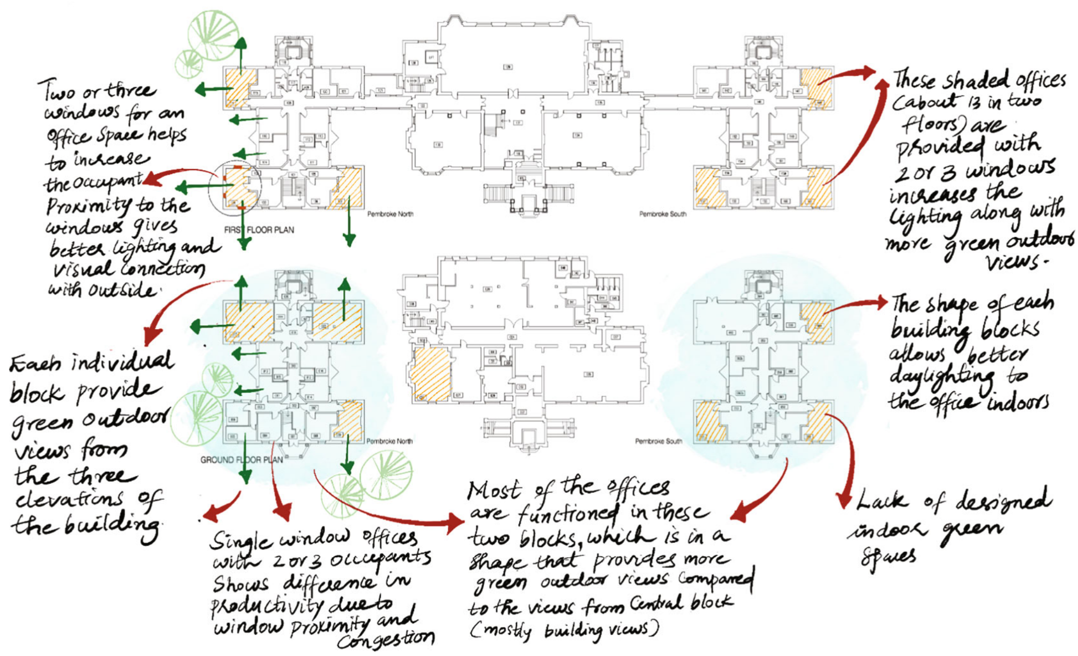

Figure 11: Pembroke building floor plan analysis (*Source:*Authors, 2024).

production levels compared to those situated further away, as illustrated in Figure 12.

Based on the analysis presented in Figure 13, some offices possess outdoor views of neighbouring buildings, an aspect that was found to decrease the productivity levels of inhabitants as compared to those individuals who have the advantage of green outdoor views. The shape and size of windows have an impact on how much light enters the room as well as how many people can use the space next to the windows.

The number of offices that have views of neighbouring buildings is lower in comparison to the offices that have green outside views in the Pembroke building. This is due to the design of the Pembroke building block, which, in comparison to the Queen Mary Court, minimises the proportion of inhabitants experiencing at least two symptoms of SBS. However, there are other physical factors present in the interiors of Pembroke that have an impact on the occupants' perception, resulting in a 48% occurrence of individuals experiencing symptoms of SBS.

4.5.2. Queen Mary Court—Case Study B. The Queen Mary Court, built in 1751 as a naval hospital and refurbished in 2000, currently serves as an integral component of the University of Greenwich's campus. The structure is a five-story building designed with a central courtyard layout, primarily serving as a facility for offices and classrooms. Most of the offices were situated along the periphery of the building, with an intermediate veranda serving as a circulation area. The original purpose of the building's interior as a naval hospital, followed by its subsequent conversion into a university office space, could potentially impact the comfort, efficiency, and well-being of the individuals occupying the structure.

The analysis of the ground floor plan of Queen Mary Court, as depicted in Figure 14, involved the study of various physical parameters which include the shape of the building blocks, the type of office based on the number of users, the size of the rooms, the position and number of windows, the availability of daylighting, the closeness of windows, the availability of indoor planting, and the presence of green outdoor views from the openings. The study also examined the association between the prevalence of symptoms associated with SBS, as reported by 55% of survey respondents, and the impact of these characteristics on occupants' perception of the indoor environment.

The offices situated on the southern and eastern sides of the Queen Mary Court have pleasant green outdoor views, which contribute to enhancing the comfort and productivity of the occupants. Approximately 50% of the offices located in the Queen Mary building lack access to green outdoor views due to architectural planning, which is notably lower in comparison to the Pembroke building. Furthermore, the productivity and comfort levels of persons in an office setting are impacted by the presence of more than two or three people, specifically in terms of access to natural light and a strong visual link with the green outdoor environment. The proximity to windows is a crucial factor in ensuring visual comfort for individuals occupying a space. There is a positive correlation between proximity to windows and productivity levels, as depicted in Figure 15.

Based on the analysis depicted in Figure 16, it is evident that certain offices have views of nearby buildings, which has been observed to have a negative impact on the productivity of occupants when compared to persons who have access to green outdoor views. The amount of light that enters the room and the number of persons who can use the area next to the windows are both greatly affected by the size and shape of the window.

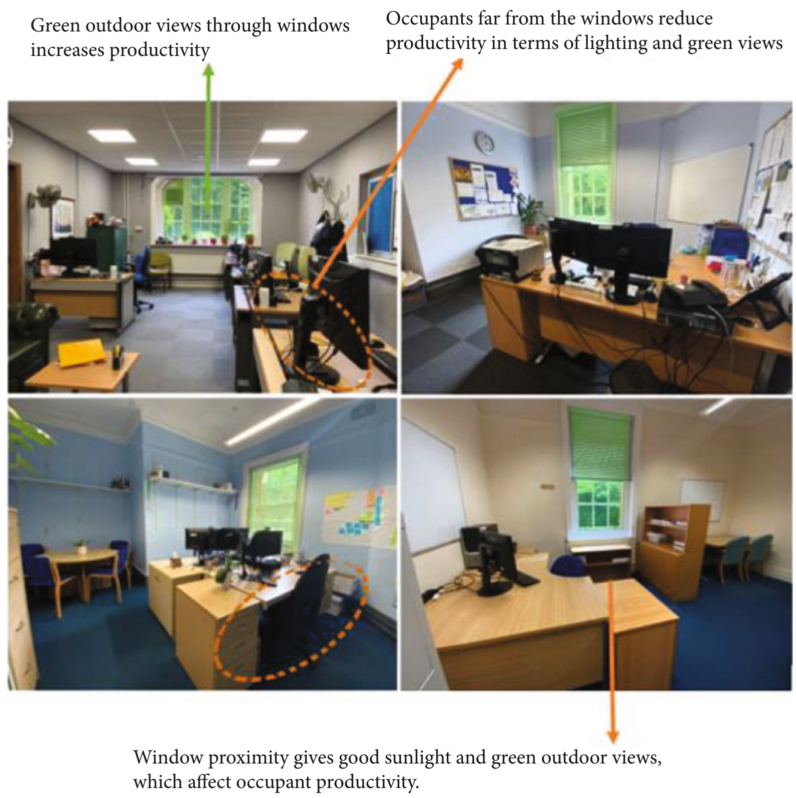

FIGURE 12: Office interior images from Pembroke building with green outdoor views (*Source:*Authors, 2024).

FIGURE 13: Office interior images from Pembroke building with adjacent building views (*Source:*Authors, 2024).

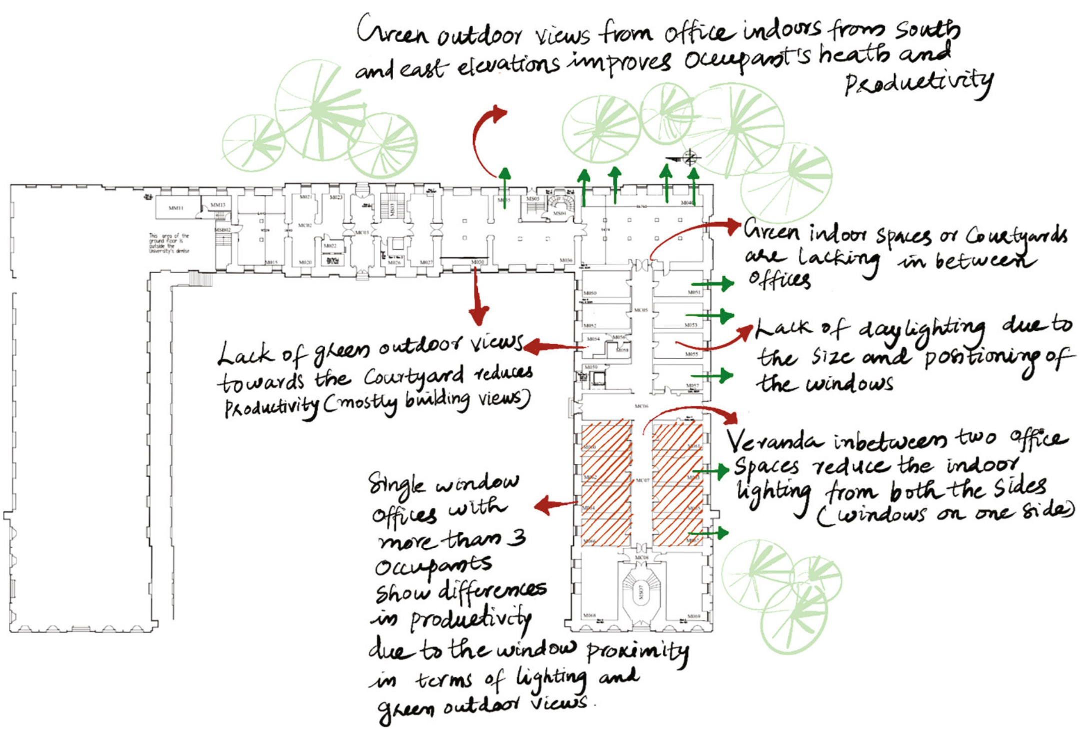

Figure 14: Queen Mary Court floor plan analysis (*Source:*Authors, 2024).

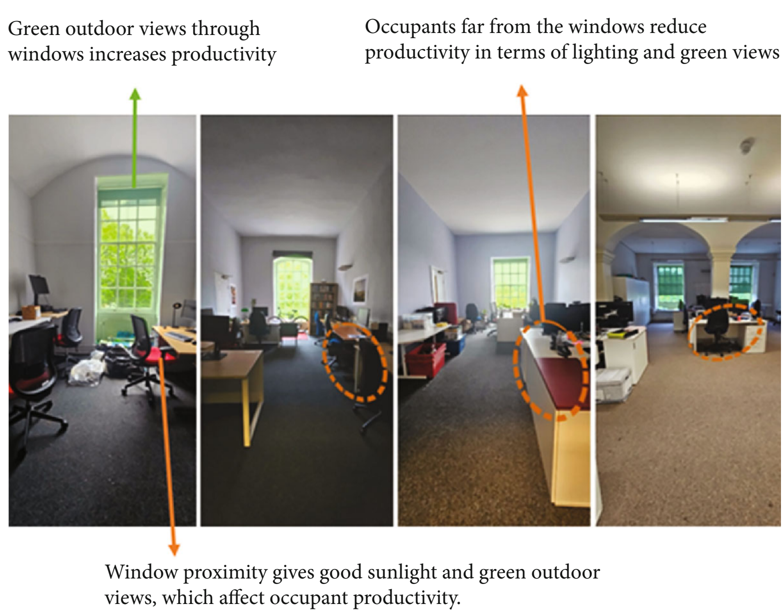

Figure 15: Office interior images from Queen Mary Court with green outdoor views (*Source:*Authors, 2024).

In Queen Mary Court, the number of workplaces with views of nearby buildings is greater than the number of offices with views of green outside areas. This is because more people in the Queen Mary Court than in the Pembroke building had at least two SBS symptoms, due to the layout of the Queen Mary Court. However, other physical parameters present in the interiors of Queen Mary Court influence the perception of the inhabitants, leading to a higher prevalence of individuals reporting symptoms of SBS at 55% in Queen Mary Court than at 48% in the Pembroke building.

5. Discussion

This section presents some of the issues that emerged from the results and findings as discussed.

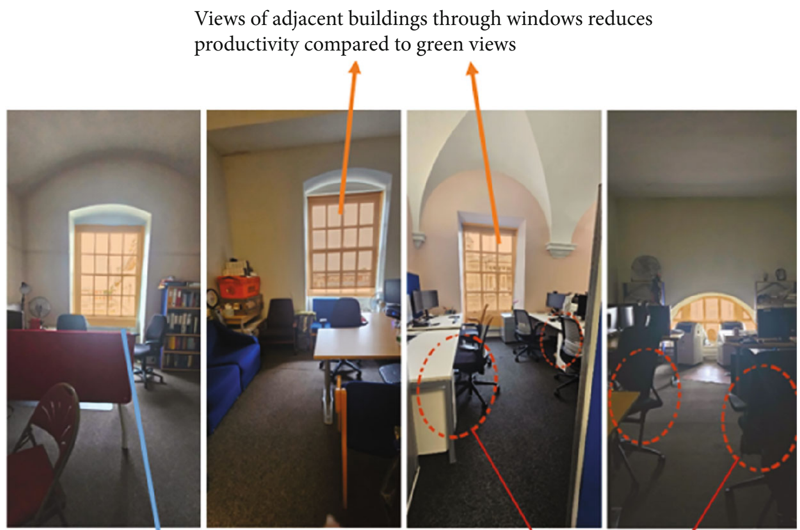

Figure 16: Office interior images from Queen Mary Court with adjacent building views (*Source:*Authors, 2024).

5.1. Dominant SBS Symptoms. The occurrence of SBS symptoms in both Pembroke and Queen Mary Court buildings revealed that fatigue was the most common symptom in both buildings, followed by redness or eye irritation, joint pain, and headache in both. Influenza and nausea symptoms were least frequently reported in both the Pembroke building and Queen Mary Court. These findings correspond with a study at Ain Shams University in Cairo, which revealed that fatigue and headache were the most reported symptoms, with prevalence rates of 76.9% and 74.7%, respectively. Joint pain was also a prevalent symptom, reported by 65.8% of participants [3]. Similarly, according to Gomzi et al. [37], a study that investigated the impact of SBS on productivity in the workplace found that a large percentage of participants had fatigue (60.2%) and headaches (44.4%). Furthermore, several additional studies have revealed similar findings, wherein prevalent complaints include fatigue, headaches, and eye symptoms, among others [181, 182].

The findings of this study also revealed that symptoms were totally cured after leaving the workplace in 40% of cases, whereas symptoms were only somewhat reduced in the remaining cases (60%). Similar results were seen in another study, where 55% of individuals said their symptoms completely disappeared after leaving the office indoors, while the other 45% felt partially better [3]. This further corroborates the fact that the symptoms associated with SBS tend to disappear shortly after the inhabitants left the space or building [5, 38].

5.2. Relationship Between SBS Symptoms and Overall Occupant Comfort. In both buildings, a statistically significant relationship was identified among the overall comfort of the workplace and the presence of SBS symptoms, as regards the physical characteristics of the working environment. According to the analysis and responses of the occupants from this study, office spaces were uncomfortable for the users, mainly because of an inadequate amount of daylighting, limited window proximity along with the green external views, a lack of indoor planting, an unfavourable indoor temperature, and noise levels. As per the results, a significant percentage of participants in both buildings expressed discomfort with the indoor temperature and noise levels inside the office environment. Furthermore, a certain proportion of the individuals working in both buildings expressed dissatisfaction regarding enough daylighting in relation to visual comfort. Therefore, the findings of this study demonstrate that the implementation of optimal indoor temperatures, noise levels, and adequate lighting in office environments, through effective utilisation of design features, can effectively decrease the occurrence of symptoms associated with SBS and promote improved employee well-being.

This agrees with current literature that potential risk variables for SBS might involve high temperatures [110, 114], high levels of noise [183, 184], and inadequate lighting [131, 133]. Also, these various physical factors impacted the occupant's comfort and productivity in relation to the occurrence of SBS symptoms. This strengthens the findings of studies that were presented previously, which showed that the level of comfort present in an office environment has a significant impact on the health of the workers.

5.3. Role of Indoor Plants and Green Outdoor Views in Addressing SBS Symptoms. As previously discussed, the presence of plants is an essential component in elevating the overall quality of office settings [80, 185]. In addition, according to Cramer and Browning [153] and Ryan et al. [154], it was observed that the implementation of a biophilic flexible workplace design might mitigate the adverse effects of SBS on employees while simultaneously enhancing their enthusiasm, performance, and efficiency. Furthermore, it has been suggested that the natural environment possesses curative benefits [155], and individuals who have proximity to windows report a reduction in symptoms associated with SBS [101].

Moreover, according to research conducted in China, a physical view of plants can make people feel better [186]. This uplifted state of mind has a favourable impact on workers' well-being and performance. Consequently, the establishment of a visual link between the built environment and the surrounding natural landscape can be achieved by incorporating windows and interior green courtyards. This is supported by the findings of this study, where a significant proportion of participants in both Pembroke and Queen Mary Court buildings reported a lack of indoor office plants. Approximately 39% of the individuals working in both buildings have an opinion that the presence of indoor plants has a beneficial impact on their overall well-being and effectiveness in doing tasks.

On the other hand, in both buildings, a higher number of office spaces in Queen Mary Court did not have a view of an outside garden. Based on the findings of the survey, a significant proportion of respondents expressed their opinion that having green outside views had a positive impact on user performance. In comparison, half percentage of respondents from the Queen Mary Court also shared this viewpoint. Hence, the inclusion of indoor plants and the provision of green outdoor views from office interiors have been found to have a beneficial impact on individuals occupying these spaces. Moreover, the greater number of respondents in Queen Mary Court who lack indoor plants and green outdoor views, in comparison to occupants of the Pembroke building, may contribute to a higher occurrence of symptoms associated with SBS.

5.4. Innovative Design Strategies for Office Spaces. According to Dave [187], design strategies play a crucial part in attaining user satisfaction. An architectural design including centrally located courtyards surrounded by office buildings or green spaces in between enhances internal illumination, provides direct access to views, and allows for direct exposure to natural surroundings, hence increasing the occupant's comfort. Courtyards serve as effective microclimatic regulators and improve the comfort of the occupants [188]. Therefore, the inclusion of courtyards between office areas facilitates social interaction among coworkers during leisure time.

The direction of the courtyards and their length-to-width ratio must be carefully considered, considering the building's orientation in relation to the climate. Additionally, the geometry of the rooms should be designed accordingly [189]. In the summer, south-facing rooms should be deep to prevent overheating; nevertheless, having skylights or double-height rooms allows for additional windows, which improves the inhabitants' thermal and visual comfort. Additionally, it is necessary to make the north side rooms shallower during winter to enhance heat absorption and maintain optimal illumination.

Open offices have higher levels of engagement than closed office spaces, but they also have higher noise levels and distractions, which can lower productivity [190]. Adding natural settings or central atrium areas between them helps to break up the open layout and maintain a degree of privacy among occupants. In addition, it preserves the visual link to the green areas and enhances user satisfaction and productivity by allowing them to spend time there with their coworkers, thus reducing SBS.

5.5. Limitations of Study. While the two buildings investigated in this study were built in the 18th and 20th centuries, it would be worthwhile for future research to capture the perceptions of users in a 21st-century building. It would be interesting to know if the most and the least dominant SBS would be the same which may be helpful to perhaps conclude that the age of a building does not influence the SBS symptoms experienced in the building. Additionally, it may be worthwhile to conduct a similar study on a building that has been known to deliver optimal indoor temperatures, reduced noise levels, and adequate lighting to identify the associated SBS symptoms and overall comfort of users. Although there has been research that established the relationship between indoor plants and green outdoor views in addressing SBS symptoms outside the United Kingdom, a key area for future research would be to examine how the availability of these in a university office building in the United Kingdom can help reduce SBS symptoms. Furthermore, because this study was conducted during the summer (July 2023), it would be interesting for a future study to be conducted in the winter months to establish a correlation between climatic seasons and SBS symptoms.

6. Conclusions and Recommendations

This study focused on understanding the causes of SBS in terms of various physical factors in university office buildings from the experience of users. This is with the aim of identifying proactive strategies for mitigating SBS by strategically integrating architectural design aspects that influence occupants' experiences within indoor office environments. The findings indicated a higher prevalence of symptoms related to SBS in Queen Mary Court as compared to the Pembroke building. However, the frequency of SBS symptoms in both buildings ranged from rarely to sometimes, indicating a relatively low to medium incidence rate of SBS. Furthermore, the prevailing symptoms reported by individuals were fatigue, eye redness, or irritation, which was followed by headache and joint pain. In most cases, symptoms improved upon leaving the working environment.

The study revealed a few important aspects that influenced the productivity and health of office occupants, hence contributing to the occurrence of SBS. These factors included indoor temperature, noise levels, daylighting, indoor plants, and the presence of green outdoor views from within the office space. Furthermore, it could be suggested that a worker who experiences satisfaction inside a well-designed office environment, characterised by elements such as a connection to nature, an optimised office layout, and aesthetically pleasing wall colours, is more likely to exhibit higher levels of productivity. This can be attributed to the presence of a healthy indoor environment devoid of SBS symptoms. Thus, the design elements present in both buildings, such as building orientation, the shape of the building blocks, type and number of windows, number of occupants relative to room size, and proximity of windows to occupants in terms of daylighting and outdoor views, had an influence on occupant comfort and satisfaction with regard to the physical parameters.

The practical implications of this study are as follows: One is that it emphasises how crucial and important it is to consider the effect of SBS on employees when planning a building in its early phases. Two is that it raises the urgency for built environment professionals to be fully aware of how their design decisions could either contribute to or prevent SBS symptoms. This is because the potential negative impacts of physical factors on the well-being of occupants in the operational stage of a building can be mitigated through the implementation of effective architectural considerations during the design process. Three, through the output of this study, policymakers concerned with delivering healthy buildings can further justify their action plans, especially as it relates to university office buildings.

In conclusion, it is advisable to undertake various future recommendations to strengthen the capabilities of healthy buildings and make significant contributions to the general well-being and productivity of occupants.

- Incorporate appropriately designed components that correlate with the building's physical characteristics throughout the planning and design stages of the project.
- Incorporate a substantial amount of interior green spaces or a biophilic workplace layout, as well as an optimal number of windows and their proximity to the users to maximise daylighting along with a strong visual connection with nature.
- Raise general awareness among the public regarding the effects of buildings on the well-being and productivity of their inhabitants.

Data Availability Statement

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

Conflicts of Interest

The authors declare no conflicts of interest.

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