

2024

## Unleashing the Potential: The Impact of Biophilic Office Design on Enhancing Employee Productivity

Asmaa Elantary

*Architecture and Planning Department, Jubail Industrial College, Royal Commission of Jubail, Saudi Arabia.*, [asmaa.elantary@outlook.com](mailto:asmaa.elantary@outlook.com)

Follow this and additional works at: <https://mej.researchcommons.org/home>



Part of the [Architecture Commons](#), [Engineering Commons](#), and the [Life Sciences Commons](#)

---

### Recommended Citation

Elantary, Asmaa (2024) "Unleashing the Potential: The Impact of Biophilic Office Design on Enhancing Employee Productivity," *Mansoura Engineering Journal*: Vol. 49 : Iss. 4 , Article 7.

Available at: <https://doi.org/10.58491/2735-4202.3208>

This Original Study is brought to you for free and open access by Mansoura Engineering Journal. It has been accepted for inclusion in Mansoura Engineering Journal by an authorized editor of Mansoura Engineering Journal. For more information, please contact [mej@mans.edu.eg](mailto:mej@mans.edu.eg).

## ORIGINAL STUDY

# Unleashing the Potential: The Impact of Biophilic Office Design on Enhancing Employee Productivity

Asmaa Elantary\*

Department of Architecture and Planning, Jubail Industrial College, Royal Commission of Jubail, Saudi Arabia

### Abstract

The observed landscape influences people in numerous ways, including aesthetic appreciation, health, and well-being. The evidence of health benefits associated with viewing those landscapes has proven exceptional value. A comprehensive review of papers on landscapes and sound effects on health was conducted. According to a growing body of evidence, exposure to visible landscapes positively affects one's health and fitness. The most pressing social and economic challenge now is increasing worker productivity, attracting, and retaining exceptionally talented employees, and improving overall employee performance. This will not happen unless companies provide a safe, comfortable, and stimulating work environment; this will not happen.

The paper investigated employees' perceptions of workspace features and the effect of biophilic design concepts on staff productivity. The respondents from different cities in the Kingdom of Saudi Arabia showed high productivity and satisfaction rates where biophilic design concepts were used. The Pearson correlation test detected a strong relationship between the interior space's perceived quality through biophilic design elements and employees' productivity in offices and working spaces, where the *P* value is less than 0.05. Activating biophilic design concepts within workspaces is as crucial as having the space itself.

**Keywords:** Biophilic design, Sustainable architecture, Office buildings, Saudi Arabia

## 1. Introduction

### 1.1. Background

Edward O. Wilson promoted the idea of Biophilia in 1984, which is a concept used in building design to boost occupants' connectivity to the natural surroundings via the usage of direct nature, oblique nature, as well as area and location conditions (Wijesooriya et al., 2021; Tedjari et al., 2024). It is believed that this idea has health, environmental, and economic benefits for building occupants and users of urban surroundings at both the building and city levels, with few downsides. For example, in a 2004 study, when users were requested to explain their perfect city, more regularly they selected non-urban characteristics, greenery in

particular (Henson et al., 2020; Wijesooriya et al., 2021).

Other studies have shown that a pleasant and natural view can significantly increase the value of a home. Despite the fact that its name was just coined recently, signs of the biophilic layout have been visible in architecture from ways returning to the Hanging Gardens of Babylon.

A growing studies base has recognized the superb blessings of biophilic layout in assisting more than one organizational outcome (Yildirim et al., 2024), which includes well-being, productivity, and creativity. Office workers spend a lot of time inside buildings, where their physical surroundings have an impact on their well-being and, as a result, on their total work performance and productivity (Aqeel Salah AAER, 2010; Bilgic & Ebbini, 2023).

---

Received 25 December 2023; revised 28 February 2024; accepted 31 March 2024.  
Available online 10 May 2024

\* Department of Architecture and Planning, Jubail Industrial College, Royal Commission of Jubail, P.O.Box. 10099, Jubail Industrial City, 31961, Saudi Arabia.  
E-mail addresses: [asmaa.elantary@outlook.com](mailto:asmaa.elantary@outlook.com), [antaria@rcjy.edu.sa](mailto:antaria@rcjy.edu.sa).

<https://doi.org/10.58491/2735-4202.3208>

2735-4202/© 2024 Faculty of Engineering, Mansoura University. This is an open access article under the CC BY 4.0 license (<https://creativecommons.org/licenses/by/4.0/>).

It is commonly considered in the workplace that individuals who are happier with their physical surroundings are more able to develop better work results (Altomonte et al., 2020; Wu et al. (2020)). The study offers employees an understandable summary of the linkages between health and landscapes, revealing gaps in the knowledge body that require additional investigation. The identification of quantifiable landscape features that influence human health is viewed as a critical step toward future landscape design that is beneficial to human health (Wu et al., 2020). Additionally, the literature review done by Colenberg *et al.* shows that a new upcoming research field is the correlation between interior office space and employee wellness (Colenberg et al., 2020; Gao et al., 2023).

### 1.2. Topic's importance

There are two reasons why biophilic design is important. Natural subjects are often used as eco-false advertising or misleading strategies in design. Therefore, more research is necessary to determine their impacts and effects on sustainable architecture. Moreover, in the contemporary built environment, there is a well-known craving for nature, so it is crucial that it be made accessible within frameworks (Zhong et al., 2022).

The growing urbanization of the modern world has resulted in places that are characterized by the use of a predominance of manmade structures, which has sparked a surge in interest in biophilia during the last decade. The benefits of providing this connection to nature go far beyond simple employee happiness (Palazzo, 2001; Altomonte et al., 2020). Other research provides evidence of a successful methodology for integrating viable bacteria into ceramic and concrete materials for the users' benefit (Beckett, 2021). The role of the garden as a relief, as well as an emotionally intense enclosure that affects the senses, is explored also in different articles (Taylor, 2015; Colenberg et al., 2020).

### 1.3. Study questions

The following questions are addressed:

Main question:

In what ways can biophilic design contribute to the goals of sustainable architecture?

Sub questions:

- (a) How has the concept of biophilic design emerged, and how can it be defined?
- (b) What are the key design strategies in biophilic design?

### 1.4. Study aim

The aim of the research is to investigate and understand the relationship between biophilic office design elements and employee productivity. Specifically, the research aims to explore how the perceived quality of interior spaces, achieved through the incorporation of biophilic design elements, can enhance employee productivity in offices and working spaces. By conducting a thorough analysis and examination, the study seeks to provide insights into the potential benefits of biophilic design interventions on employee performance, well-being, and overall productivity.

### 1.5. Study hypotheses

The research hypothesis is that there is a strong relationship between the interior space perceived quality through using biophilic design elements and the employee's productivity in offices and working spaces.

### 1.6. Study problem

Many buildings in the kingdom of Saudi Arabia are seeking certification in the green buildings field. This will not happen without elevating the quality of the existing building performance through the evaluation of the current functions and the user's perception of the spaces they work and use on daily basis. The focus of this article is on the potential benefits of meeting people's biophilic requirements in the workplace, as well as the issues that come with working in environments that lack a connection to nature.

### 1.7. Literature review

#### 1.7.1. Topic trends

When the office is in the heart of the city and the employees can't see anything but identical buildings from their windows, it is time to invest in plants (Chang & Chien, 2017). Plants will allow for the creation of more natural surroundings and the addition of a relaxing atmosphere to the space. They can also be utilized for decoration, making your area feel even more friendly. People who work in green offices as shown in Fig. 1, which are literally surrounded by plants, are happier than those who work in lean offices, according to Reuters Health.

In studies, UK researchers discovered that adding potted plants to a bare office might boost productivity by 15%. It was also proven that a biophilic



Fig. 1. Plants placed at desk help to increase concentration level and reduce stress. <https://www.mashrita.com/best-10-office-plants-increase-productivity/>.

environment improves short-term memory by 14% (Yin et al., 2018; Hähn et al., 2020).

Participants in the green office reported higher workplace happiness, improved concentration, and perceived air quality when compared with workers in the lean space. Plants may increase productivity by being aesthetically pleasing and supporting in the improvement of air quality in the workplace (Haynes, 2008; Guastello, 2013).

### 1.8. The gap in current literature

While numerous studies highlight the benefits of biophilic design, there is a lack of comparative studies that directly compare the productivity outcomes of biophilic design with traditional office designs or other alternative design approaches. A comparative analysis would help to establish the specific advantages of biophilic design in relation to productivity.

In addition, there have been studies that specifically focused on the impact of geographic location on the mental health benefits of biophilic design. One such study is 'Exploring Biophilic Design and Its Implications for Mental Health (Jha and Behera, 2022)'. This study compared the mental health outcomes of individuals exposed to biophilic design in urban and rural environments. The researchers found that individuals in urban areas experienced greater mental health benefits from biophilic design interventions compared with those in rural areas. The urban participants reported reduced stress levels, improved mood, and increased feelings of well-being when exposed to biophilic elements in their built environment.

The study hypothesized that the differential impact of biophilic design on mental health outcomes could be attributed to the contrasting environmental contexts. Urban environments often lack natural elements and green spaces, making the integration of biophilic design more significant and impactful for residents. In contrast, rural areas typically have more access to natural landscapes and greenery, potentially diminishing the additional

mental health benefits derived from biophilic design interventions.

While this study provides insights into the influence of geographic location on the mental health benefits of biophilic design, it is important to note that further research is needed to confirm and expand upon these findings. Future studies could explore a wider range of geographic locations, considering variations in climate, demographic factors, and cultural differences to gain a more comprehensive understanding of how geographic location influences the mental health benefits of biophilic design.

## 2. Methodology

The methodology employed in this study involved the use of a self-administered questionnaire instrument to collect data from participants. The questionnaire was designed to assess employees' perceptions of different working spaces. The survey questions were distributed electronically, allowing for efficient data collection.

The questionnaire began by collecting general information about the respondents, including their age and the number of hours they spent in the working spaces. This demographic information provided context for the subsequent analysis of employee perceptions.

The main focus of the questionnaire was to evaluate factors related to the quality of interior spaces, particularly those incorporating natural materials and landscapes. Participants were asked to rate their perceptions on a five-point Likert scale, with Table 1 illustrating the scale used. The Likert scale allowed respondents to indicate the strength of their agreement or disagreement with statements or questions positively or negatively. By utilizing this methodology, the study aimed to capture employees' subjective perceptions of working spaces, providing valuable insights into the impact of biophilic design elements on their overall experience and productivity.

This detailed methodology aimed to ensure accurate data collection and analysis, enabling the study to explore the relationship between biophilic design elements and employee perceptions of interior spaces effectively.

Table 1. Five-point likert scale.

Likert-type scale	
1	Totally Disagree
2	Disagree
3	Neutral
4	Agree
5	Totally Agree

At the end of the questionnaire, an open-ended question was added asking respondents about the most important factors that should be present to improve the quality of working spaces and employee productivity.

Regarding the sample selection, participants for this study were selected using a convenience sampling method. The survey was distributed electronically to employees within the organization, and those who voluntarily chose to participate were included in the sample. While convenience sampling allows for easy access to participants, the study aimed to investigate the impact of biophilic design concepts on individuals in the workplace. The sample consisted of 71 respondents from different offices located in the eastern province of Saudi Arabia.

In terms of statistical analysis, descriptive statistics are employed to summarize and present the data collected from the questionnaire. This included measures such as means, standard deviations, and frequency distributions. The analysis took place using the statistical program SPSS to find out the most dominant reasons behind employees' satisfaction and the importance of applying the biophilic design principles. Figure 2 below represent the studied elements.

### 3. Results

#### 3.1. The principles of biophilic design

While there are many principles of biophilic design and all the principles are important, here are three key principles:

**Incorporate Nature:** this principle emphasizes the integration of natural elements into the built environment. It involves incorporating plants, natural

materials, and water features, as well as maximizing access to natural light and views. Bringing nature indoors or creating spaces that connect with the outdoor environment helps create a sense of well-being and connection to the natural world (Brown-ing & Ryan, 2020; Al-Dmour, 2023).

**Use Natural Materials:** The use of natural materials, such as wood, stone, and natural fibres, is a crucial principle in biophilic design. These materials create a tactile and visually appealing environment that reflects the textures and patterns found in nature. They can evoke a sense of warmth, authenticity, and biophilic connection.

**Provide natural light and views:** maximizing access to natural light and views of nature is another fundamental principle. Natural light has numerous benefits for both physical and mental well-being, and views of nature can have a calming and restorative effect. Designing spaces to optimize natural light and incorporate views of greenery or natural landscapes helps create a sense of connection with the outdoors.

These three principles lay the foundation for incorporating biophilic design elements and can significantly enhance the quality of the built environment, fostering a sense of well-being and connection with nature. However, it's important to note that all principles work together holistically to create a truly biophilic design solution. These principles have been considered in formulating the survey questions.

#### 3.2. The expected benefits of biophilic design

There is a growing body of research that supports the benefits of biophilic design. Some studies and

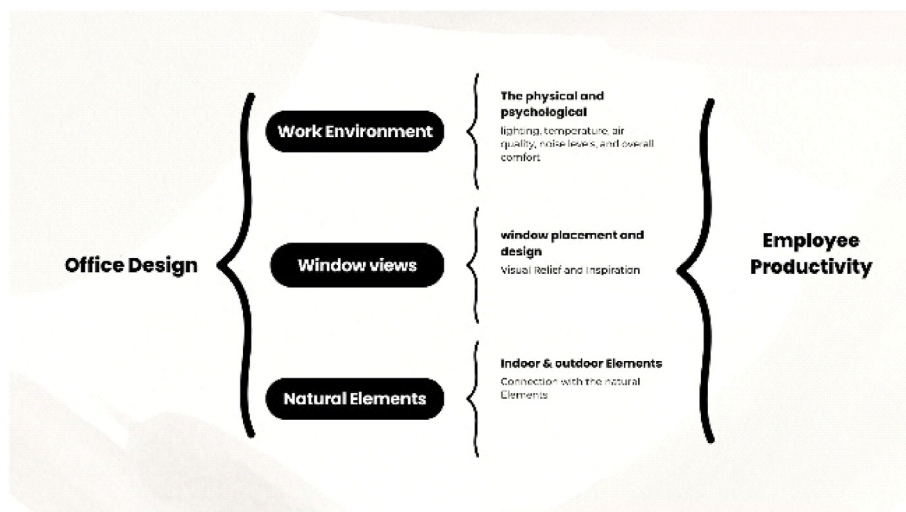


Fig. 2. Study design and elements investigated.

research findings highlighted the positive impacts of biophilic design as below:

### 3.2.1. Stress reduction and well-being

Numerous studies have shown that exposure to elements of nature in the built environment, such as natural light, greenery, and views of nature, can reduce stress levels, improve mood, and enhance overall well-being. For example, a study by Ulrich (2006) demonstrated that hospital patients with views of nature experienced faster recovery rates and required less pain medication compared with patients with views of a brick wall ('How does nature impact our wellbeing? | Taking charge of your health and wellbeing'; Ulrich, 1981; Ulrich et al., 2006; Louise, 2023).

### 3.2.2. Cognitive performance and productivity

Biophilic design has been found to positively impact cognitive performance and productivity. A study by Tennessen and Cimprich (Tennessen & Cimprich, 1995) showed that exposure to natural environments improved attention and performance on cognitive tasks. Similarly, research by Browning and Ryan and Bill (Bill, 2015) found that workplaces with biophilic elements, such as natural light and greenery, resulted in higher levels of productivity and satisfaction among employees (Browning & Ryan, 2020).

### 3.2.3. Health and healing

Biophilic design has been linked to improved health outcomes in various settings. Studies have shown that access to nature or nature-inspired environments can lower blood pressure, reduce symptoms of anxiety and depression, and enhance the healing process. For example, research by Altarawneh *et al.* Altarawneh, Al-Ajeely, and Khasawneh (Altarawneh et al., 2023), found that children with attention deficit hyperactivity disorder (ADHD) experienced improved symptoms when exposed to natural settings.

### 3.2.4. Enhanced learning and academic performance

Biophilic design elements in educational environments have been found to positively impact learning outcomes and academic performance. Studies have demonstrated that classrooms with natural light, views of nature, and greenery resulted in improved concentration, increased test scores, and enhanced student engagement (Pdxscholar & Winking, 2023).

These are a few examples of the extensive research that supports the benefits of biophilic design. The studies highlight the positive effects on

various aspects of human well-being, including stress reduction, cognitive performance, health, healing, and learning. It is important to consider these findings when designing spaces to promote a harmonious relationship between humans and the natural environment (Mahrous et al., 2024).

## 4. Discussion

This study was carried out to investigate the impact of biophilic design concepts on humans in the working place. Seventy-one respondents from different offices in the eastern province of Saudi Arabia answered the questionnaire. The targeted groups were people in specific age groups that correspond to the work needs, most responders' ages were between 20 and 29 years, representing 76.1% of the responders, and 21.1% were between 30 and 39 years old. Concerning the number of working hours, 36.6% of them spend 19 h or less per week, which represents part-time jobs, and another 36.6% spend 40 h as full-time equivalent as defined by [30] where it is apparent that people spend more than 50% of the day at work.

The Cronbach alpha reliability factor for all Likert scale questions was 0.706, where the questions are reliable, acceptable, and connected. When people were asked about their preferences to work indoors or outdoors, most preferred indoors, representing 80.3% of all surveyed respondents. This indicates that adding and activating the biophilic design concepts in the workplace is as important as providing the workspace itself.

Since the surroundings can influence the individual in both advantageous and poor ways (Haynes, 2008; Hähn et al., 2020; Wijesooriya & Brambilla, 2021), people strongly agreed, with an average of 4.46 out of five, that the interior design of a company affects their decision to work in that place. Besides, when they were asked if they believed that texture and materials such as wood, grains, stones, and natural colours have calming and positive effects, the majority, with 4.44, strongly agreed on these aspects.

The consequential questions investigated the employee's perception of the biophilic concepts, where the connection with nature is the main concern. This should occur through elements like windows, natural landscapes, organic or artificial plants' existence, and natural lighting. When people were asked how it is effective when have an open window at a working time to aid in their performance, 4.28 out of five strongly agreed that it is extremely effective. Besides, they strongly agreed with 4.64 out of five that viewing nature while working reduces stress levels.



Fig. 3. An example of an office Image Source: Magpie Creative Co) (Rose, 2023).

On the other hand, only 18.3% strongly agreed on having a moderate number of live plants in their working space, while 25.4% do not have any plants in their working areas. When it comes to the natural lighting amount, only 35.2% of them answered that they have, while the rest of surveyed employees either have not enough or no natural lighting exists at all.

When people were asked if they would describe their workplace as an effective place for high and good performance, the mean of their answers was 3.59 out of five, which indicates they do agree with the place's effectiveness, but there is room for improving and elevating the spaces quality and nature connectivity.

The final section was a short open-ended question with space for respondents to write down their thoughts on what helps employees feel less stressed

while working; more than 50% of all mentioned items are related to nature and biophilic concepts.

To test the research hypothesis, a Pearson Correlation test was conducted for the two concerned variables, where the first one is that all respondents evaluated their spaces' effectiveness on a scale from 1 to 5 as shown in Fig. 3. The second variable was related to the respondents feeling about their productivity over the past three months. The P-value, which equals 0.031, revealed a strong relationship between the two factors. The higher the employees' satisfaction regarding their working environment design elements, the higher the productivity gained as shown in Fig. 4.

These results agree with Yin *et al.* They found that a biophilic environment decreases negative emotions and increases positive emotions, which will increase the employees' productivity (Yin *et al.*, 2018; Yin *et al.*, 2019). Feeling good regularly equates to being capable of doing more. A plethora of research backs up the clear proof that Biophilia is linked to a company's productivity. The examination of the data sample demonstrated that a worker's creativity and productivity could be greatly influenced by their surroundings, particularly the extent to which natural components are present. This is compatible with the results of Gillis and Zhang (Gillis & Gatersleben, 2015; Zhang *et al.*, 2016).

More specifically, the researcher discovered that people who worked in locations with natural features, such as daylighting and living plants, reported better productivity levels than those who worked in areas devoid of nature. There is a strong relationship using Pearson correlation with a

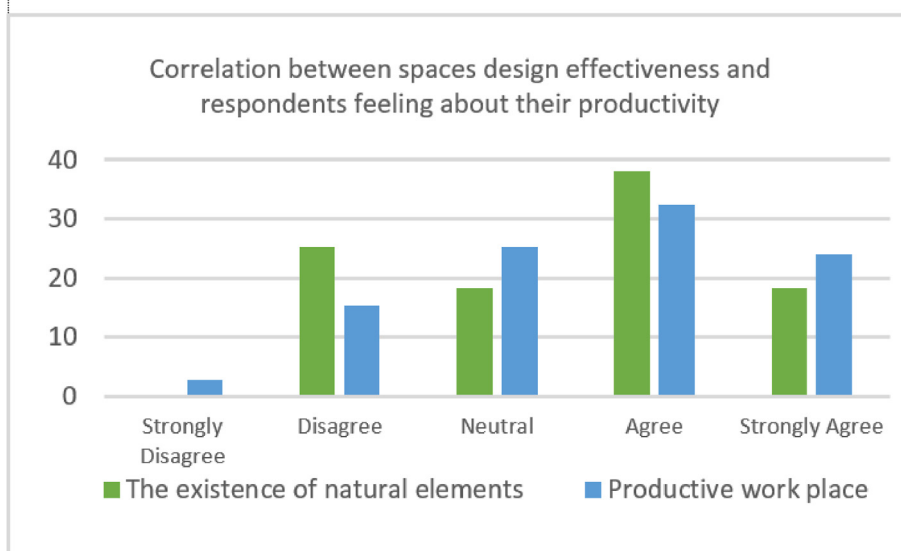


Fig. 4. Correlation chart between space design effectiveness and respondents feelings about their productivity.

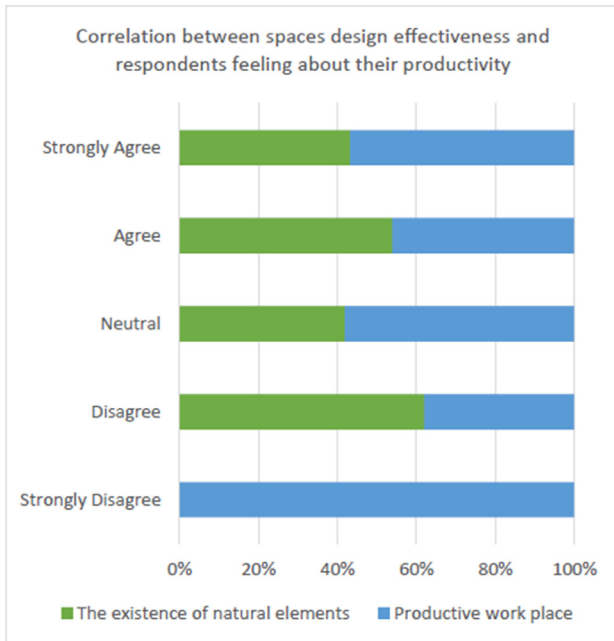


Fig. 5. Correlation between spaces design effectiveness and respondents feeling about their productivity.

$P$  value of 0.015 with work productivity and plants in the workforce.

Figure 5 represents the relation between design effectiveness and the users' reported productivity.

Natural light and views of the outdoor areas are most of the maximum relatively required elements for the work benefits, in line with a study performed through HR advisory firm Future Workplace. This same study also found that people sitting in the direction of windows are much more likely to show up for work and feature improved productivity during the day than those sitting below artificial light (Saraf et al., 2022). Many people agree that spending time in nature improves their concentration and broadens their imagination.

The incorporation of biophilic design concepts aligns with the principles of environmental psychology, which emphasize the importance of the physical environment in influencing human behavior, well-being, and productivity. This highlights how biophilic design elements can contribute to creating more supportive and engaging work environments.

#### 4.1. Conclusion and recommendation

This study investigates the various ways in which employees engage in pro-environmental behavior. Further, this seeks to understand the psychological outcomes of the employees' work behavior due to their attitude towards the environment so that this

could serve as a conceptual ground to conduct further quantitative research. This study demonstrates the link between well-being and workplace design. Regardless of the differences in work and workspaces between the cities that contributed to survey respondents, the following criteria were all related to productivity.

#### 4.2. The influence of window views

According to survey results, people who did not have a window view worked fewer hours/week. People who had windows with views of greenery, on the other hand, spent significantly more time in the workplace each week. Likewise, not having a window view was related to increased stress levels, whereas having views of trees and natural scenery outdoors was associated with lower levels of stress.

Employee productivity was significantly impacted by frequent exposure to the outdoors through a window within the workplace. Having no window view also harmed employee creativity. This is consistent with Gilli's findings, which indicated that in a well-designed office space, there is a considerable reduction in anger and stress (Elzeyadi, 2011; Gillis & Gatersleben, 2015).

#### 4.3. Impact of natural elements

People who worked in offices with natural light, live plants, and interior green space reported much higher productivity levels. Greenery in the workplace, such as plants, has been linked to higher levels of creativity. The absence of greenery in the workplace and the immediate outside environment has been linked to higher worker stress levels. Individuals working in offices with little natural light or vegetation report higher degrees of frustration and fewer working hours. Kim et al. examined this, proving that indoor plants can help with in-room assessment and response time reduction (Kim et al., 2018). Meanwhile, it contradicts Hahn et al., who found that planting had no significant effect on perceived health, tiredness, motivation, or well-being (Hamama et al., 2012; Gillis & Gatersleben, 2015).

#### 4.4. The effect of a spacious work environment in the office

Those who reported working in green spaces reported higher happiness, motivation, productivity, and creativity. Finally, studies in this area show that introducing natural factors into the workplace, whether natural or artificial, has a significant impact



on worker outcomes. As a result, while considering workplace layout and its effect on personnel, employers have to pay extreme attention to the quantity of nature touch supplied with inside the workspace to keep effective degrees of wellness amongst personnel and maintain overall worker performance at the most fulfilling stages.

The research has proven that diverse nature factors will have a high-quality effect on the individual work; the availability of natural light, a window, and greenery within the workplace space is the most important. According to the research study, there are numerous benefits to providing this nature of contact; however, failing to provide this connection may jeopardize the continuity of the working organizations. Many respondents, more than a half (59.2%) In fact, reported that workplace design would influence their decision to work for a specific company. This highlights how an individual's surroundings can directly influence how he feels about the organization, which will inevitably influence their feelings and behaviors in the workforce. As a result, providing employees with an environment in which they are comfortable and satisfied is likely to go a long way toward increasing well-being and productivity, contributing to worker retention, and lowering worker turnover.

After all, it is critical to consider the impact of lifestyle within the realm of workplace biophilic design. The nature of this study has allowed a diverse range of respondents from various offices to be investigated and analyzed in terms of worker possibilities for biophilic design and how factors of this design can also have varying influences on numerous worker outcomes. It has been demonstrated that cultural variations exist, implying that those possibilities can also be discovered on an organizational or personal level. Organizations have become more concerned about the impact of interior space quality on their business objectives (Grinde & Patil, 2009; Gillis & Gatersleben, 2015; Colenberg et al., 2020). Consequently, it is miles critical for companies and architects to cautiously keep in mind those variations so that everyone can make certain that the working environments are ideal for a high-performing, favorable, and healthy workforce.

#### 4.5. Research limitations

The limitations of this study may include the use of a specific sample from the eastern province of Saudi Arabia, which may limit the generalizability of the findings to other contexts. The need for future research to replicate and validate the findings in

diverse geographic locations, considering variations in culture, climate, and office environments.

Additionally, investigating the long-term effects of biophilic design on employee well-being and productivity, exploring the cost-effectiveness of implementing biophilic design elements in office settings, and evaluating the potential synergies between biophilic design and other workplace interventions.

#### Funding

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

#### Author contribution

The author confirms sole responsibility for the following: study conception and design, data collection, analysis and interpretation of results, and manuscript preparation.

#### Conflicts of interest

There are no conflicts of interest.

#### Acknowledgments

The author would like to thank all participants for their responses and companies' supervisors for their constructive feedback.

#### References

- Al-Dmour, Y., 2023. Flourishing the indoor environment quality of workplaces using the biophilic architectural design. Brunel University, London.
- Altarawneh, Z.S.A., Al-Ajeely, S.A., Khasawneh, M.A.S., 2023. The impact of ecotherapy on academic performance and adhd symptom severity in children. *Migrat. Lett.* 20, 1192–1204.
- Altomonte, S., Allen, J., Bluysen, P.M., Brager, G., Hescong, L., Loder, A., Wargocki, P., 2020. Ten questions concerning well-being in the built environment. *Build. Environ.* 180, 106949.
- Aqeel Salah AAER, 2010. The impact of workplace design on employees' performance.
- Beckett, R., 2021. Probiotic design. *J. Archit.* 26, 6–31. <https://doi.org/10.1080/13602365.2021.1880822>.
- Bilgic, N., Ebbini, G.W., 2023. Balancing complexity and restoration in virtual interior environments: user perceptions of organized complexity in biophilic design. *Archnet-IJAR: Int. J. Architect. Res.* <https://doi.org/10.1108/ARCH-07-2023-0173>. ISSN: 2631-6862.
- Bill, B., 2015. HUMAN SPACES: the global impact of biophilic design in the workplace. [https://greenplantsforgreenbuildings.org/wp-content/uploads/2015/08/Human-Spaces-Report-Biophilic-Global\\_Impact\\_Biophilic\\_Design.pdf](https://greenplantsforgreenbuildings.org/wp-content/uploads/2015/08/Human-Spaces-Report-Biophilic-Global_Impact_Biophilic_Design.pdf).
- Browning, W.D., Ryan, C.O., 2020. Nature inside: a biophilic design guide. Routledge, London. <https://www.taylorfrancis.com/books/mono/10.4324/9781003033011/nature-inside-william-browning-catherine-ryan>.

- Chang, K.G., Chien, H., 2017. The influences of landscape features on visitation of hospital green spaces—a choice experiment approach. *Int. J. Environ. Res. Public Health* 14, 724.
- Colenberg, S., Jylhä, T., Arkesteijn, M., 2020. The relationship between interior office space and employee health and well-being – a literature review. *Build. Res. Inf.* 49, 352–366.
- Elzeyadi, I., 2011. Daylighting-bias and biophilia: quantifying the impact of daylighting on occupants health. *School of Architecture & Allied Arts*, pp. 1–9.
- Gao, W., Jin, D., Wang, Q., Zhu, P., 2023. Integrating user-centered design and biophilic design to improve biophilia and intelligentization in office environments. *Buildings* 13, 1687.
- Gillis, K., Gatersleben, B., 2015. A review of psychological literature on the health and wellbeing benefits of biophilic design. *Buildings* 5, 948–963.
- Grinde, B., Patil, G.G., 2009. Biophilia: does visual contact with nature impact on health and well-being? *Int. J. Environ. Res. Public Health* 6, 2332–2343.
- Guastello, S.J., 2013. Human factors engineering and ergonomics: a systems approach. In: *Human Factors Engineering and Ergonomics: A Systems Approach*, second ed., pp. 1–458.
- Hähn, N., Essah, E., Blanusa, T., 2020. Biophilic design and office planting: a case study of effects on perceived health, well-being and performance metrics in the workplace. *Intell. Build. Int.* 13, 241–260.
- Hamama, L., Ronen, T., Shachar, K., Rosenbaum, M., 2012. Links between stress, positive and negative affect, and life satisfaction among teachers in special education schools. *J. Happiness Stud.* 14, 731–751.
- Haynes, B.P., 2008. An evaluation of the impact of the office environment on productivity. *Facilities* 26, 178–195.
- Henson, P., Pearson, J.F., Keshavan, M., Torous, J., 2020. Impact of dynamic greenspace exposure on symptomatology in individuals with schizophrenia. *PLoS One* 15, e0238498.
- Jha, H., Behera, S., 2022. Exploring biophilic design and its implications for mental health. In: *Understanding Psychology in the Context of Relationship, Community, Workplace and Culture*, pp. 297–314.
- Kim, J., Cha, S.H., Koo, C., Tang, S.-k., 2018. The effects of indoor plants and artificial windows in an underground environment. *Build. Environ.* 138, 53–62.
- Louise, D., 2023–. How does nature impact our wellbeing? Taking Charge of Your Health & Wellbeing. University of Minnesota Earl E. Bakken Center for Spirituality & Healing. <https://www.takingcharge.csh.umn.edu/how-does-nature-impact-our-wellbeing>.
- Mahrous, A., Dewidar, K., Refaat, M., Nessim, A., 2024. The impact of biophilic attributes on university students level of Satisfaction: Using virtual reality simulation. *Ain Shams Eng. J.* 15, 102304.
- Palazzo, D., 2001. *The Living Landscape. An ecological approach to landscape planning*, 2nd ed. by Frederick R. Steiner. New York: McGraw-Hill, Inc., 2000. 477 Pages, \$59.95 clothbound. ISBN 0-07-079398-0. *Landscape J.* 20, 190–191.
- Pdxscholar, P., Winking, A., 2023. The benefits of outdoor education for students with attention-deficit hyperactivity disorder. *University Honors Theses*.
- Rose, M., 2023. The benefits of biophilic design.
- Saraf, M.H.M., Ahmad, N.N., Tharim, A.H.A., Ahmad, A.C., Raffikhul, N.Q., 2022. The relationship between biophilic constructed design experience in home office setting towards perceived performances by academicians. *Malays. Constr. Res. J.* 16 (Special issue 2), 229–236. Retrieved from: <https://www.scopus.com/inward/record.uri?eid=2-s2.0-85129774924>.
- Taylor, M., 2015. Planting for pleasure: the eighteenth-century erotic garden. *Interiors* 2, 357–371.
- Tedjari, A.F., Rahmani-Kelkoul, L., Zerouati, W., 2024. Integrating biophilia in architectural design education: an examination of its impact on students' creativity. *Int. Online J. Edu. Teaching* 11, 1.
- Tennessen, C.M., Cimprich, B., 1995. Views to nature: effects on attention. *J. Environ. Psychol.* 15, 77–85.
- Ulrich, R.S., 1981. Natural versus urban scenes: some psychophysiological effects. *Environ. Behav.* 13, 523–556. <https://doi.org/10.1177/0013916581135001>.
- Ulrich, R.S., Quan, X., Joseph, A., 2006. The environment's impact on stress. Retrieved from. <https://www.researchgate.net/publication/291177936>.
- Wijesoorya, N., Brambilla, A., 2021. Bridging biophilic design and environmentally sustainable design: A critical review. *J. Clean Prod.* 283, 124591. <https://doi.org/https://doi.org/10.1016/j.jclepro.2020.124591>.
- Wijesoorya, N., Brambilla, A., Markauskaite, L., 2021. Biophilic Water Criteria: Exploring a Technique to Develop an Environmentally Sustainable Biophilic Design Framework. In: *Advances in Science, Technology and Innovation*. Springer Nature, pp. 437–447.
- Wu, Yegang, Swain, Robert E., Jiang, Nan, Qiao, Mengying, Wang, Haihua, Bai, Jialin, et al., 2020–. *Design with Nature and Eco-City Design*. *Ecosyst. Health Sustain.* 6. Taylor and Francis Ltd. <https://doi.org/10.1080/20964129.2020.1781549>.
- Yildirim, M., Gocer, O., Globa, A., Brambilla, A., 2024. Investigating restorative effects of biophilic design in workplaces: a systematic review. *Intelligent. Build Int.* 1–43.
- Yin, J., Zhu, S., MacNaughton, P., Allen, J.G., Spengler, J.D., 2018. Physiological and cognitive performance of exposure to biophilic indoor environment. *Build. Environ.* 132, 255–262.
- Yin, J., Arfaei, N., MacNaughton, P., Catalano, P.J., Allen, J.G., Spengler, J.D., 2019. Effects of biophilic interventions in office on stress reaction and cognitive function: A randomized crossover study in virtual reality. *Indoor Air* 29, 1028–1039.
- Zhang, X., Lian, Z., Ding, Q., 2016. Investigation variance in human psychological responses to wooden indoor environments. *Build. Environ.* 109, 58–67.
- Zhong, W., Schröder, T., Bekkering, J., 2022. Biophilic design in architecture and its contributions to health, well-being, and sustainability: a critical review. *Front. Archit. Res.* 11, 114–141.