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Neuroarchitecture and Cognitive Well-being in Communal Workspaces: A Comparative Review for Sustainable Design

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ABSTRACT

The high prevalence of mental health issues in urban work environments, particularly among productive-age populations in Indonesia, highlights the need for architectural approaches that prioritize well-being and sustainability. This study aims to provide an evidence-based understanding of neuroarchitecture principles and their application in communal workspaces as a strategy for achieving sustainable design and social sustainability. The research employs a Systematic Literature Review (SLR) of peer-reviewed journals published within the last five years, supported by a comparative analysis of four international case studies: Amazon Spheres, Google EMEA Engineering Hub, Second Home Hollywood, and Mr. Green's Office.The findings identify three key aspects that contribute to cognitive well-being. First, the integration of biophilic elements, such as vegetation, natural light, and water features, supports stress reduction and mental restoration in line with the Biophilia Hypothesis, Stress Reduction Theory, and Attention Restoration Theory (ART). Second, sensory stimulation through color, texture, and acoustics enhances physical, emotional, and intellectual well-being, supported by the principles of neuroarchitecture and Supportive Environment Theory (SET). Third, adaptive spatial layouts that emphasize flexibility, communal spaces, and spatial clarity encourage user control, social interaction, and social sustainability. Overall, the study shows that applying neuroarchitecture principles through biophilic design, sensory optimization, and adaptive spatial planning can create supportive communal workspaces and help address mental health challenges in both global and Indonesian contexts.

INTRODUCTION

A major challenge has emerged in relation to the working conditions of urban communities. According to Basrowi et al. (2024), work environments with a high risk of mental disorders are a serious problem in Indonesia. People of productive age have more serious mental health problems, with a significant increase, especially among the working population, with a consensus on the work environment of 49.3% (Basrowi et al., 2024). According to Elazab & Eltawil (2025), various recent studies even show a significant increase in cases of mental health disorders in urban areas, such as decreased cognitive function, stress, and anxiety, which have an impact on decreased productivity. In addition, the increasingly complex pressures of work are experienced by the younger generation, who are the dominant group in the future world of work (Ramadani & Sunarya, 2025).

In the context of architecture, this fact highlights the importance of workspace design that not only supports productivity but also focuses on reducing stress and improving worker well-being (Ramadani & Sunarya, 2025). The approach of neuroarchitecture as a field that integrates neuroscience and architecture is still relatively new in Indonesia, but it has begun to be researched and introduced (Satwiko et al., 2023). Neuroarchitecture studies and considers how design elements affect human psychological and neurological responses, such as stress reduction and improved cognitive function (Anna, 2025). Assem (2023) explains that the four main pillars of neuroarchitecture, namely neuroscience, architecture, physiology, and psychology (emotions and behavior), can fulfill the four pillars of human well-being (physical, emotional, intellectual, and social). Neuroarchitecture has been proven to have a positive impact on human well-being (Assem et al., 2023). Therefore, the neuroarchitecture approach can be applied in communal work environments to create spatial experiences that prioritize the well-being of their users.

Based on this urgency, this research was conducted through a comparative review of similar case studies. This study aims to provide an understanding of neuroarchitecture and examples of its application in the work environment that can contribute to sustainable design strategies in the field of architecture.

MATERIALS AND METHODS

This study uses a descriptive analytical qualitative approach with the main method being a systematic literature review (SLR). This method was chosen to synthesize and analyze information from published journals related to the application of neuroarchitecture, which was then followed by a comparative analysis (comparative study) of similar case studies.

The literature review in this study is classified into two types: a conceptual review discussing the neuroarchitecture approach, and an empirical review in the form of a case study of the application of neuroarchitecture in a communal work environment. The journals used as data sources are those published in the last 5 years from various scientific databases, but are reliable and have undergone a peer-review process, and are selected based on their relevance to neuroarchitecture, well-being, and communal workspaces or coworking spaces. Older studies are used if they are primary studies that are cited and reviewed comprehensively in review articles published in the last 5 years.

The analysis method used was comparative content analysis. Case study data obtained from other journal reviews were analyzed based on design element variables and the resulting impact. This analysis aimed to find similarities, differences, and patterns of effective neuroarchitecture design.

RESULTS AND DISCUSSIONS

Review of the Neuroarchitecture Approach

Definition and Development of Neuroarchitecture

Based on Anna's review (2025), rapid developments in psychology and neuroscience towards the end of the 20th century gave rise to a new awareness of the influence of the built environment on human behavior and well-being. A major breakthrough occurred through the success of functional magnetic resonance imaging (fMRI) experiments in the 1990s, which enabled researchers to study how architectural design affects brain activity. This marked the beginning of the field of neuroarchitecture, which aims to explore how specific design elements affect the human brain, emotions, behavior, and neurological processes such as stress reduction and cognitive function improvement (Anna, 2025).

(Ghamari et al., 2021) also explains that since the 1970s, environmental psychologists have studied the influence of architectural structures on human behavior and emotions through empirical studies. Research on the relationship between architecture and neuroscience has grown rapidly since the 1990s and continues to evolve. The intellectual basis of the field of neuroarchitecture has also begun to strengthen, especially since 2016 with the increase in research on the brain's response to architecture and urban design.

According to Assem et al. (2023), the concept of neuroarchitecture emerged through the integration of neuroscience and architecture to create built environments that support the four pillars of human well-being: physical (body), intellectual (brain), emotional (feelings), and social (behavior). Neuroarchitecture is defined as a multidisciplinary approach that combines the principles of neurology, architecture, physiology, and psychology to create spaces that can regulate human behavior, performance, and well-being.

Principles of Neuroarchitecture

Anna's review (2025) discusses theoretical frameworks such as the Biophilia Hypothesis, Prospect-Protection Theory, and Stress Reduction Theory ( ), which provide a scientific basis for understanding how spatial design elements such as natural light, the use of green plants, and spatial configuration affect neurological and psychological responses. Several theoretical models are also summarized by Elazab & Eltawil (2025), which provide a basis for how neuroarchitecture functions. For example, the Supportive Environment Theory (SET) proposed by Küller explains that environmental stimuli such as noise, excessive lighting, or visual disturbances can increase stress levels and mental fatigue, while well-designed spaces with good lighting, proportions, and spatial clarity can create a sense of comfort and support psychological recovery. Additionally, Attention Restoration Theory (ART) by Kaplan highlights that exposure to natural elements such as vegetation, water, and natural light can aid in attention restoration, reduce stress, and enhance mental clarity.

Elazab & Eltawil (2025) explain that neuroarchitecture strategies are increasingly being applied in environments that prioritize mental performance and emotional well-being, such as healthcare, education, and workplaces, where neurophysiological and biometric technologies such as electroencephalograms (EEG), functional magnetic resonance imaging (fMRI), eye tracking (ET), and functional near-infrared spectroscopy (fNIRS), researchers can objectively understand how design elements influence the cognitive and emotional states of space users. Advances in neuroimaging technologies such as MRI, fMRI, EEG, MEG, and PET have expanded our understanding of how the human brain responds to architectural design features and how initial experiences influence those responses (Ghamari et al., 2021). The review by Higuera-Trujillo et al (2021) also explains the use of neurophysiological and neuroimaging tools to measure the central nervous system ( ) with functional magnetic resonance imaging (fMRI), electroencephalography (EEG), and magnetoencephalography (MEG); the ANS (autonomic nervous system) with electrodermal activity (EDA, called Galvanic Skin Response, or GSR) monitoring tools, heart rate variability (HRV), and pupillometry; and the SNS (somatic nervous system) with eye tracking and electromyography (EMG) tools.

In addition, Assem et al. (2023) explain that the pillars of neuroscience, architecture, physiology, and psychology form the foundation for the application of neuroarchitecture. Each pillar contributes to the understanding of how space can affect human physiology, brain function, emotions, and behavior. This approach also includes an understanding of users' subjective emotions towards space, such as feelings of safety, comfort, boredom, or excitement, which are influenced by their perceptions of design elements.

Based on this understanding, it can be concluded that the principles of neuroarchitecture are formed from:

- Theoretical frameworks, such as the Biophilia Hypothesis, Prospect-Protection Theory, Stress Reduction Theory, Supportive Environment Theory (SET), and Attention Restoration Theory (ART) (as conceptual foundations explaining the impact of the built environment on the human brain and behavior).
- Advances in neurophysiological and neuroimaging technologies, such as MRI, fMRI, EEG, fNIRS, MEG, PET, EDA/GSR, HRV, pupillometry, ET, and MEG, which can measure and aid in understanding how the human brain responds to architectural design features or the environment, as well as the potential of architecture in shaping human experience (as objective validation of design effects).
- The four pillars of science, namely neuroscience, architecture, physiology, and psychology, form the foundation for the application of neuroarchitecture in fulfilling the four pillars of human well-being, namely physical, emotional, intellectual, and social (as a multidisciplinary framework for applying insights from theory and technology into design practice).

Impact, Benefits, and Relationship to Spatial Experience

Abbas et al. (2024) explore the complex relationship between the brain and the built environment by highlighting the role of the anterior cingulate cortex (ACC) and parahippocampal area (PPA) in processing and responding to architectural elements, as well as mirror neurons that elicit empathetic and emotional responses to spatial features. These interactions demonstrate that architecture has great potential in shaping human experience. It also identifies several important factors that need to be considered in designing spaces with a more empathetic and neuroscience-based approach, including the integration of natural elements, particularly sunlight and green open spaces, as well as the use of colors that can influence emotional and physiological responses. Architectural design has been proven to influence cognitive function and emotional experience through elements such as natural lighting, color schemes, and spatial layout. Thus, the combination of architectural design and neurological knowledge opens up opportunities for the creation of built environments that support human well-being (Abbas et al., 2024). This is supported by the opinion of Elazab & Eltawil (2025) that built environment design plays a major role in shaping experiences, well-being, and mental health in line with the increasing need for spaces that are not only environmentally friendly but also support psychological well-being amid rapid urbanization.

Neuroarchitecture plays an important role in creating workspaces that are responsive to the cognitive and emotional needs of users by increasing comfort, collaboration, and innovation, which in turn have an impact on performance and mental health (Ramadani & Sunarya, 2025). According to Assem et al. (2023), by combining physiological, psychological, cognitive, and behavioral aspects of architecture, neuroarchitecture-based design has been proven to help reduce stress, improve focus, and promote users' mental well-being. The emotional and affective responses arising from interactions with the environment show that architectural elements play a role in shaping human behavior and cognitive performance (Assem et al., 2023). In addition, Zamri & Ahmad (2025) explain that according to several studies, the application of biophilia in spaces can help reduce human mental disorders such as stress, depression, and anxiety. This aims to improve mental health, reduce stress, enhance emotions and feelings, improve mood and well-being, and motivate employees themselves, especially those working in urban areas with minimal natural elements (Zamri & Ahmad, 2025). This research reinforces the evidence that the application of neuroarchitecture and biophilic design not only impacts productivity but also the psychological balance of users.

Furthermore, Higuera-Trujillo et al. (2021) state that humans respond to the built environment not only functionally, but also cognitively and emotionally. According to them, advances in neuroscience and virtual reality technology allow researchers to record neural activity when individuals interact with spaces, providing a deeper understanding of the relationship between architecture and user experience. In addition, the evidence-based design (EBD) approach is relevant because design decisions are based on credible scientific research results.

Higuera-Trujillo et al. (2021) also summarized the architectural design variables studied in the application of neuroscience to architecture, which produced a neurophysiological foundation for the cognitive-emotional dimensions of architecture and neurobehavioral effects, including wayfinding, stress, illumination, color, contours and ornaments, windows, aesthetic assessment, and nature. This shows that the response or impact of architecture on users can be measured through neurophysiological and neuroimaging measurements, which will contribute to the development of actual architectural design tools. According to him, it is important to understand the fundamentals of the cognitive-emotional dimension of architecture because if the adaptation of this dimension is poor, the building may not collapse, but its users will.

Table 1. Elements of Neuroarchitecture Design and Their Impact on Human Well-being

Article Sources	**Neuro-architecture Elements**	**Effect of architecture elements on the 4 pillars of Human wellbeing**
[Shemesh et al. (2017); Gongora et al. (2019); Ergan et al. (2019); Choo et al. (2017)]	Form (3D) symmetrical	Emotional: arouses emotions, decreases satisfaction and excitement; Neuro-Cognitive: different architectural forms provide brain activity for different parts of the temporal cortex, symmetrical encouraged posterior part of the brain activity. Symmetrical forms are more preferred.
	Form (3D) asymmetrical	Neuro-Cognitive: provides higher cognition; Emotional: arouses emotions
[Llorens-Gámez et al. (2022); Shemesh et al. (2017); Elbaiuomy et al. (2018); Choo et al. (2017); Pati et al. (2016)]	Form (3D) curvilinear	Neuro-Cognitive: Improved memory in a square or cylinder area made of concrete, conical, glass spaces activate visual and spatial perception, Emotional: curved contours aroused higher fear response in contrast to sharp angled contours. More attractive & preferred by non-design expert subjects
	Form (3D) Sharp-angled	More attractive & preferred by expert subjects
Llorens-Gámez et al. (2022); Ergan et al. (2019); Qin et al. (2014); Barrett et al. (2017); Min & Lee (2020); Llinares et	Colour temperature (cool/warm): Warm are preferred by	Neuro-Cognitive: Prefrontal cortex activity is related to coloured objects, Difference between cold & neutral colour temperature regarding alertness, fatigue,

Article Sources	Neuro-architecture Elements	Effect of architecture elements on the 4 pillars of Human wellbeing
al. (2021)]	adults, & cool by children.	cognitive functioning; cold-hued colours (between yellowish green and Purple) improve attention and memory, cool temperatures cause less arousal than warm (regarding sleeping), but enhance attention more; warm temperatures enhance memory more; Physiological/Emotional: both temperatures caused heart rate variability HRV & electrodermal activity EDA.
	Contrast	Neuro-Cognitive: improved memory in spaces with high contrasting colours
	Bright Colours	Neuro-Cognitive: higher attention and problem solving with purple, followed by blue, green, yellow & red, moderately bright/bright colours improve perception; White colour with bright highlights encourages better performance in learning Emotional: bright colours cause positive emotions e.g., red, but not all colours were experimentally confirmed using digital devices; green causes satisfaction & comfort; colour of light has emotional effects; Behavioural: colour of sunlight has positive effects
[Zhang et.al (2017)]	Dark Colours of brown wood	Physiological: Least production of human perspiration in completely dark brown wooden rooms
[Bermudez et al. (2017); Ergan et al. (2019); Maghool et al. (2020); Barrett et al. (2017); Higuera-Trujillo et al. (2020)]	Furnished environments	Physiological: increased heart rate and larger brain theta power across frontal parts for high presence of furniture /Open office; Behavioural: more physical activity; Emotional: less stress, flexible furniture causes more stress reduction; Physiological: Less HRV (SDNN), Neuro-Cognitive: Flexible furniture design is correlated with better brain functional abilities for performance in maths
	Non– Furniture	Neuro-Cognitive: Less coherence than with furniture
[Shemesh et al. (2017); Cho & Kim (2017); Ergan et al. (2019); Barrett et al. (2017)]	Linear Shapes (2D geometry)	Emotional: Low arousal and pleasure; Neuro-Cognitive: decreased anterior cingulate cortex (ACC) activity in brain, sharp contours activated Amygdala in brain more than curved ones, simple linear shapes are better for students' performance while learning; Behavioural: did not affect exit decision from space (not avoided).

Article Sources	Neuro-architecture Elements	Effect of architecture elements on the 4 pillars of Human wellbeing
	Curved Shapes (2D geometry)	Neuro-Cognitive: Greater activation of anterior cingulate cortex, contours in hospital interiors & exteriors activated Amygdala greater than sharp, irregular windows activate attention; Behavioural: Anterior cingulate cortex with theta band are related to spatial characteristics, cause approach (rather than avoidance) behaviours; Physiological: decreased heart rate with irregular windows 3 authors agreed it is more preferred over sharp
[Bower et al. (2019); Llorens-Gámez et al. (2022); Vartanian et al. (2015); Ergan et al. (2019)]	Low Ceiling Height	Neuro-Cognitive: Low evaluation of beauty, stimulates item-specific processing; Emotional: calmness, causes negative emotions; Behavioural: causes exit decisions
	Higher ceilings	Neuro-Cognitive: arouse greater creativity, stimulates primarily rational processing, and areas involved in visual and spatial perception.; Emotional: freedom; Behavioural: positively affects wayfinding. Found more attractive.
[Vecchiato et al. (2015); Vecchiato et al. (2015); Barrett et al. (2017); Millán et al. (2021)]	Proportions: Wide	Not experimentally measured in many studies, Neuro-Cognitive: Wider classrooms are linked with poorer attention, memory, and performance; Physiological: lower arousal of emotions
	Narrow	Neuro-Cognitive: enhances attention and memory
[Qin et al. (2014)]	Smells	Not covered well in the studies. However, Emotional: spaces with slightly scented plants were the most preferred for human comfort
[Llorens-Gámez et al. (2022); Vartanian et al. (2015); Higuera-Trujillo et al. (2020)]	Sounds: quietness/ noise	Neuro-Cognitive: fairly quiet spaces improve attention and quiet ones improve perception; Emotional: Noise causes feelings of stress; Sounds of nature causes stress reduction; Physiological: music decreases diastolic blood pressure
[Nicolini (2022); Hu & Roberts (2020); Shemesh et al. (2022); Ergan et al. (2019); Qin et al. (2014); Higuera-Trujillo et al. (2020); Barrett et al. (2015); Pati et al. (2016)]	Lack of Vegetation	Emotional: generates feelings of stress, oppression, arousal; Physiological: more arousal measured by EDA; Behavioural: Negative effects on estimating distance
	Vegetation/ Natural Environment in pictures/ simulations or reality	Emotional: reduces stress and anxiety, pleasure increases based on tree density, and arousal with weed density, restorative; Neuro-Cognitive: ‘‘fascination,’’ ‘‘being away,’’ ‘‘coherence,’’

Article Sources	Neuro-architecture Elements	Effect of architecture elements on the 4 pillars of Human wellbeing
		and ‘‘compatibility”, emotional states affect the perception of brightness.Simulations activated spatial cognition and space expansion; Physiological: positive effects on views of nature; lower pain intensities & pain distress. Natural forms are always preferred.
[Elbaiuomy et al. (2018); Ergan et al. (2019); Qin et al. (2014); Jamshidi et al. (2020)]	Textures: Natural Materials (wood)	Physiological: decreased heart rate and sweat response without conscious perception of individuals, adjusted vision in the near-distance especially after working and improved performance for people with myopia eye condition; Neuro-Cognitive: coherence is greater, square wooden spaces are better for focusing and saving information; Emotional: more relaxed and comfortable; carpet material brings satisfaction in patient corridor
	Unnatural materials (metal)	Neuro-Cognitive: coherence is less than with natural materials, better attention in interiors made of steel, concrete, or glass.
[Cho & Kim (2017); Ergan et al. (2019); Barrett et al. (2017); Higuera-Trujillo et al. (2020); Jamshidi et al. (2020); Castilla et al. (2018); Castilla et al. (2018); Robinson & Green (2015)]	Natural Lighting	Physiological: decreases cortisol and stress levels, less patients stays in hospitals; Neuro-Cognitive: good natural lighting is correlated with better brain functional abilities needed for writing; Emotional: reduces stress
	Artificial lighting	Physiological: Light above 7500 K raises blood pressure; White light regulates sleep rhythms; Emotional: aroused differences in emotions at 5000 K& 3000 K, White regulates mood, blue light speeds up post-stress relaxation, indirect light lets participants feel cooler & more pleasant in comparison to direct light, LED lighting feels ‘‘attractive, comfortable, cutting-edge”; Artificial Ambient Light reduces feeling of pain; Neuro-Cognitive: ‘‘Clear-efficient, intense-brilliant & uniform lighting” improves vision and perceiving optical information, ‘‘Clear-efficient, Uniform and Surprising-amazing lighting” arouses attention, LED lighting is more stimulating than fluorescent. Behavioural:‘‘warm-cosy and non-intense brilliant lighting” facilitates reflection discussions.

Notes: Effect of architecture elements on the 4 pillars of Human wellbeing: physical, intellectual, emotional and social, through the 4 pillars of Neuroarchitecture: (physiological, cognitive, emotional and behavioural)

Comparative Analysis of Neuroarchitecture Design Patterns and Their Impact

Based on research by Ramadani & Sunarya (2025), a case study was conducted on three buildings that represent the application of neuroarchitecture principles. The three case studies were used as conceptual comparative studies to understand the application of neuroarchitecture principles in contemporary work environments. In addition, a case study by Anna (2025) also represents the application of neuroarchitecture. The following are details of the building case studies based on the analysis by Ramadani & Sunarya (2025), Anna (2025), and information about the buildings from ArchDaily, compiled in a comparison table:

Figure 1. Amazon Spheres, Seattle, AS (2018)
Sumber: Archdaily

Figure 2. Second Home Hollywood, Los Angeles, USA (2019)
Sumber: Archdaily

Figure 3. Mr. Green’s Office, Brasilisa, Brasil (2021)
Sumber: Archdaily

Figure 4. Google Emea Engineering Hub, Zurich, Switzerland (2007)
Sumber: Archdaily

Table 2. Neuroarchitecture Case Study Comparison Table

Neuroarchi-tecture Elements	Google EMEA Engineering Hub	Amazon Spheres (Ramadani & Sunarya, 2025)	Second Home Hollywood (Ramadani & Sunarya, 2025)	Mr. Green's Office (Ramadani & Sunarya, 2025)
Natural lighting	A lighting system that mimics natural light patterns Using a glass partition system, maintaining transparency and optimizing daylighting	Highly optimal – full glass walls, skylights	High – transparent panels and large openings	Sufficient – natural lighting regulated with metal shields
Vegetation/ Natural elements	Indoor and outdoor plants, green walls, and natural scenery Aquarium water lounge for relaxation	Very dominant – 40,000 tropical plants, micro-ecosystem system	Open garden with exotic plants throughout the pod	Large indoor trees, vegetation as thermal and visual elements
Flexible space	Open floor plan, transparent partitions, and minimal physical barriers Office layout designed for maximum adaptability so users can utilize any part of the space	Informal collaborative spaces, relaxation areas, and free circulation	Modular pods – users are free to choose their workspace	Open workspace, no rigid partitions, flexible according to weather and activities
Social & collaborativ e spaces	More communal areas, informal meeting areas, communal areas related to sports and recreation, flexible seating, and various collaborative zones	There is a lounge, a "bird's nest," and public seating areas	Open zones between pods, communal interaction spaces	Semi-enclosed outdoor lounge as a place for rest and informal discussions
Sensory stimulation	Each office floor is color-coded and themed for easy orientation View of plants and the presence of an aquarium lounge	Sound of water, tropical temperature, plant aromas	Bright colors, direct contact with nature, visual transparency	Leaf textures, natural airflow, soft lighting

Neuroarchitecture Elements	Google EMEA Engineering Hub	Amazon Spheres (Ramadani & Sunarya, 2025)	Second Home Hollywood (Ramadani & Sunarya, 2025)	Mr. Green's Office (Ramadani & Sunarya, 2025)
Personal control & comfort	Users can choose between several workspaces organized by topic, such as forests, the Arctic, cities, and others.	Users are free to move between spaces, without restrictions	Workspace selection based on mood or type of work	The open atmosphere, air circulation, and natural light adjust to the user's body
Impact on users	A more positive and interactive workplace culture, enhanced collaboration and communication; reduced stress, increased creativity, and improved well-being; better mood, alertness, and productivity; a sense of control and autonomy that positively affects motivation and job satisfaction.	Amazon Spheres are considered capable of improving psychological comfort and strengthening social relationships among employees. The presence of vegetation and natural lighting contributes to the creation of a healthier work environment, both mentally and emotionally.	The modular structure allows users to have freedom, control, and a greater sense of ownership over the space. In addition, the connection with nature and the ease of moving between work zones can increase comfort and job satisfaction, especially for young workers who need flexible and dynamic spaces.	Designs that blend in with nature allow for more freedom of movement, reduce stress caused by enclosed spaces, and strengthen emotional connections with the work environment. Open space models can also increase flexibility and comfort in activities.

*Table arrangement is adjusted to the Table Variables from (Ramadani & Sunarya, 2025)
Source: Different sources, arranged by Authors

Based on a review of neuroarchitecture and a comparative table of case studies, the following are the results of the analysis of their relationship:

- Integration of Biophilia and Healthy Buildings
  The application of biophilic elements in the fourth case study of buildings using vegetation, water elements, and natural lighting shows the integration between buildings/spaces and nature, both visually and in terms of views inside or outside the building, thereby contributing to healthy buildings and cognitive well-being that support sustainability in terms of both buildings and society. This is in line with the Biophilia Hypothesis, Stress Reduction Theory, and Attention Restoration Theory (ART), which state that exposure to and connection with natural elements can help restore attention, reduce stress, and improve mental clarity, thereby supporting cognitive well-being and productivity, which are part of social sustainability.
- Optimization of Sensory Stimulation
  The application of design elements through variations in color zones/themes, such as at Google EMEA Engineering Hub; the use of bright colors such as yellow at Second Home Hollywood; a room atmosphere that provides protection and comfort while maintaining visual transparency, such as Mr. Green's Office; and the presence of natural elements through visuals, touch, smell, and acoustics as seen in Amazon Spheres can trigger sensory stimuli that impact physical, emotional, intellectual, and

social well-being as pillars of Neuroarchitecture. This is also supported by Supportive Environment Theory (SET), which states that environmental stimuli can create a sense of comfort and support psychological recovery, as well as Prospect-Protection Theory, which contributes to a sense of security and well-being.

- Adaptive Spatial Planning and Social Sustainability
  The spatial arrangement with spatial openness, communal areas, flexibility, comfortable layout, and modular structure of the building case study provides freedom of control and ownership of space, and supports social sustainability through interaction and collaboration. This is supported by Stress Reduction Theory and Supportive Environment Theory (SET) related to spatial openness or clarity, which contribute to the stress levels and comfort of users.

Thus, it can be concluded that the application of neuroarchitecture through the integration of biophilia, design elements that trigger sensory stimulation, and adaptive spatial arrangements has a positive impact on user well-being. This shows that applying the principles of neuroarchitecture to building design can help address mental health issues in the workplace, both in Indonesia and globally.

CONCLUSION

Neuroarchitecture as an approach that can create well-being for its users can be proven theoretically, through measurement or experimentation using neurophysiological and neuroimaging technologies, and through the impact of its application on users. The use of biophilic elements, sensory stimuli, and adaptive spatial arrangements demonstrates the successful application of neuroarchitecture in creating spatial experiences that support cognitive well-being in a comparative study of four case studies. Thus, these findings prove that neuroarchitecture is an important strategy for achieving social sustainability or healthy buildings to support sustainable building design in communal workspaces that focus on user well-being. Future research is expected to provide broader and more in-depth contributions regarding how the application of neuroarchitecture can provide solutions based on issues/problems faced by society through design and experimentation to support/strengthen scientific evidence, thereby providing relevant evidence-based design solutions, especially to support sustainability in Indonesia.

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