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The Implementation of the Biophilic Architecture in the Design of the Office and Automotive Centers in Surabaya

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ABSTRACT

Urban buildings often prioritize economic value over green spaces, leading to a disconnection from nature that negatively affects occupants' mental well-being and productivity. To address this issue, this study explores how biophilic design can be integrated into office and automotive centers to promote environmental sustainability and enhance user well-being in Surabaya. This study uses a qualitative-descriptive method within a research-through-design framework, combining site observations, literature and precedent reviews, and digital modelling to develop a biophilic design based on the core principles of biophilic architecture: direct experience with nature, indirect experience with nature, and the experience of space and place. Among these, direct interaction with nature plays the most significant role, demonstrated through rooftop gardens, sensory therapeutic areas, urban farming zones, and vegetated breakout spaces. These features not only enhance aesthetic and recreational quality but also support passive environmental control strategies, such as natural lighting, ventilation, and thermal regulation. Indirect experiences are achieved through the building's organic form and facade elements such as tree-shaped columns and low-emissivity glass that allow daylight while reducing solar heat gain. The spatial configuration reflects the experience of place through transitional zones and stepped gardens that foster movement, interaction, and connection with the outdoor environment. While the building involves daylighting and natural ventilation, further performance evaluations are needed to ensure the design meets sustainability goals in terms of energy use, water efficiency, and material performance.

Keywords: automotive, biophilic, high-rise, nature, office

1. Introduction

Over the past decade, Surabaya has experienced rapid urbanization. Not only contributed to economic growth, improved human capital, and increased consumption, it also creates new social challenges, such as traffic jams, environmental issues, pollution, waste management problems and land degradation [1]. Several areas in Surabaya, including the Basuki Rahmat area, have developed numerous of high-rise buildings such as office spaces, hotels, shopping centers and industrial zones [2]. This trend reflects a significant change driven by urbanization and the growing scarcity of land. High-rise buildings have become symbols of the city's progress toward modernity, highlighting advancements in urban development [3].

Figure 1. The offices and automotive centres located on Basuki Rahmat Street.

Basuki Rahmat Street is a prime location in the center of Surabaya for the development of high-rise buildings serving various functions, mainly for trade and service purposes [3]. Based on the Detailed Spatial Planning and Zoning Regulations of Surabaya City for 2018–2038, the maximum allowed building height is around 100 meters [4]. However, some parts of Basuki Rahmat Street are still occupied by low-rise buildings, such as offices and automotive centers, that are less than four floors tall, leading to inefficient land use (Figure 1).

In addition to land use inefficiencies and environmental issues, , the modern office environment itself often contributes to worker stress and decreased well-being. Monotonous, the fast-paced and repetitive office environment, along with heavy workloads, affects employee productivity. This pressure can lead to stress, which negatively impacts performance. In response to these challenges, biophilic design is proposed as a key architectural strategy. Biophilic architecture focuses on strengthening the connection between people and nature by integrating natural elements into the built environment. This design approach leverages natural lighting, ventilation, greenery, and organic forms to create a positive relationship between humans and nature through building designs that act as a bridge [5]. Additionally, it can improve awareness of the importance of protecting the environment [6].

Studies indicate the postive impact of biophilic design benefits in high-rise buildings. Study at Pertubuhan Arkitek Malaysia (PAM) Centre at Bangsar, Kuala Lumpur indicated a 20-35% improvement in office workers' comfort, productivity, creativity, social well-being, as well as stress reduction [7]. Studies on high-rise residential buildings in Dubai showed strong support for various strategies: 76.4% favored balcony adjustments, 82.7% supported outdoor roof gardens, 78.9% indoor gardens, and 71.8% vertical farming [8]. Research at the Bloomberg Headquarters in London demonstrated a 25% decrease in energy expenses, along with a 20% increase in employee satisfaction, mood, productivity and performance [9].

This study explores the application of biophilic design in the context of high-rise developments, focusing specifically on mixed-use buildings Office and Automotive Centers on Basuki Rahmat Street. To address the dual challenges of urban development and occupant well-being in Surabaya's evolving cityscape, this study is guided by the following research question: How can biophilic design principles be incorporated into high-rise Office and Automotive Centers to improve sustainability and user well-being in Surabaya's urban environment? The objectives of this study are to identify the potential application of biophilic design principles in high-rise mixed-use buildings, particularly those serving as office and automotive centers; and to develop a design concept for a high-rise building that integrates biophilic strategies to create a healthier and more productive working environment

1.1. Biophilic design

Biophilic design refers to design strategies that reconnect people with nature by integrating natural elements into the built environment [10]. Biophilic design aims to fulfil human deep-rooted connection to nature within modern architectural spaces. Building on the concept of biophilia, it acknowledges that humans have spent over 99% of their evolutionary history adapting to natural environments rather than artificial, human-made settings [11], [12]. This leads humans to have developed an innate affinity for natural elements, which is believed to be essential factor for maintaining physical health, mental well-being, and overall resilience [13], [14].

Biophilic design offers numerous benefits to human well-being, environmental quality, and economic sustainability, especially in high-rise buildings where access to nature is limited. For human well-being, it enhances physical, mental, emotional, and social well-being by reducing stress and sick building syndrome, improving focus, boosting immunity, enhancing motivation, and strengthening the emotional connection to nature and living spaces. In high-rise buildings, where people are far from the ground and natural environments, biophilic elements such as indoor greenery, natural light, views of nature, sky gardens, and green balconies support this human-nature connection, improving quality of life. For environment, biophilic design improves indoor air quality, maintains temperature and humidity, reduces energy use, and supports urban biodiversity through green roofs, green walls and vertical gardens. Futhermore, it promotes climate resilience in dense urban areas. For socio economic, it incrases worker productivity, raises real estate value, reduces operational costs and contributes to carbon reduction through vegetation, leading to a smart, sustainable investment in the design of high-rise buildings [14], [15].

1.2. Biophilic design principles

Biophilic design was first introduced by Stephen Kellert with a detailed framework of two dimensions, six elements, and 72 attributes. This framework is simplified by Browning into three main categories: nature in the space, natural analogs, and nature of the space, with 14 design patterns focused on improving human well-being. Kellert later renewed his model to highlight the importance of human perception, emphasizing that biophilic spaces should be flexible and adapt to users' changing needs. This newer approach focuses on three design principles: direct experience with nature, indirect experience with nature, and the experience of space and place [11], [15], [16], [17].

The direct experience with nature principle emphasizes physical interaction with natural elements through sensory engagement, involving sight, hearing, touch, smell, taste, and movement [11]. To achieve this sensory engagement, the design incorporates elements such as natural light, natural ventilation-to improve air quality-, and water features like fountains or ponds that promote relaxation. Greenery, plants and landscapes, including gardens and green roofs, are proposed as they contribute to create natural atmosphere, air quality, and psychological restoration [17].

The indirect experience with nature involves connection with natural elements through visual or symbolic forms rather than direct contact [11]. This can be achieved by utilizing biomorphic forms, patterns and shapes that mimic living organisms into architectural elements such as building facades, structural components, and interior layouts [17]. Elements like natural colors, earthy tones, curves, arches, domes, and organic shapes help create nature-inspired atmosphere. The use of natural materials like wood, stone, or bamboo supports sensory engagement and meaningful connection to the natural world within built environments [6].

The experience of space and place in biophilic design elevates how people navigate and connect with their environment, especially in high-rise buildings. This can be achieved through incorporating transitional spaces like balconies, courtyards, and atria that blend indoor and outdoor areas, and intuitive wayfinding elements such as open corridors, stairs, and glass elevators. Landscape and natural design elements—such as savanna or forest like environments—also help strengthen the sense of place and connection to nature within vertical buildings [11], [14].

Research on biophilic design in early 21st-century high-rise and office buildings highlights two main common approaches in biophilic high-rise buildings: integrating natural elements into the facade and incorporating them within interior spaces. On the facade, this includes features like glazing barriers for light

and ventilation control, as well as balconies, loggias, and green buffer zones. Meanwhile, biophilic elements for interior areas are often applied into indoor green areas, such as indoor gardens. Those gardens are designed as multi-story green areas or recreational zones distributed throughout the building, to enhance comfort, well-being, and environmental quality [18].

2. Method

This study uses a qualitative-descriptive method within a research-through-design approach. The method combines observation, literature review, case studies, and digital modeling to design a high-rise Office and Automotive Centers that uses biophilic principles. It starts with collecting both primary and secondary data. Primary data were obtained through site observations on Basuki Rahmat Street, focusing on land use, existing building types, traffic conditions, climate factors (such as sunlight and wind direction), and the interaction between existing automotive activities and the surrounding urban environment. Secondary data were obtained through literature reviews of city planning documents, building design standards for office and automotive facilities, and key theories on biophilic architecture. The precedent studies of biophilic buildings also included as design references. These precedents were analyzed for their layout, use of natural elements, and how they connect people with nature.

The design process consists of two steps. First step was analyzing the site and creating early design ideas using sketches and diagrams. In this step, biophilic design principles were applied, focusing on three main categories: direct experience of nature, indirect experience of nature, and experience of space and place. These principles were supported by literature review from the precedent studies. The next step was developing the design into digital 3D models using Revit software. This software was used to build a detailed architectural layout and integrate the biophilic elements into the design.

3. Result and Discussion

3.1. The existing site analysis

The site of the project consisted of various existing buildings, where almost half of it functioned as motorcycle dealerships, which located in the southwest up to south sides of the site. The other buildings consisted of small rented commercial buildings next to one of the dealerships in the south side. Moreover, the west and northern side of the site contains a decent abandoned vacant land, which some of it contained the ruins of buildings that once stood there. This vacant land was used by small number of people for storage and car park, whilst others as a street food place. Regarding this existing condition, it can be concluded that almost half of the site was unused and bore a negative view from Basuki Rahmat Street as it was blocked by a temporary wall made of zinc wall that was also vandalized. It is also implied that the land use of the site had not been use properly, considering its strategic and prominent position in Basuki Rahmat Street as one of the primary roads in Surabaya, that should be used as a high end commercial or business buildings, but was instead a vacant land that was abandoned.

The site itself holds a significant role as it acts as a starting point or gateway to Embong Wungu Street from its northwest side, which is a one-way road. On the other hand, the southeast, south, and southwest side of the side acts as the end point for those that used Embong Sawo Street, which also a one-way street. On the west side of the site as stated above, it borders directly with Basuki Rahmat, one of the main streets in Surabaya that also a one-way street. The existing condition of all the streets above that surround the side are accessible to vehicle, with Basuki Rahmat Street has a well pedestrian sidewalks, one side of sidewalks on Embong Sawo Street, and there are no sidewalks on Embong Wungu Street. Another physical discrepancy is that Basuki Rahmat Street is the largest street amongst the three with six lanes and a width of about 15 metres, it is also accessible by various land transportation existed in Surabaya. While Embong Wungu has a two-lanes street with a width of about 7 metres, and Embong Sawo Street also with two lanes and a width of about 7 metres, that gives both Embong Sawo and Embong Wungu a similar physical characteristic.

Looking back at the location, the site has a physical shape of a compact trapezoid (Figure 2). This compact size provides a good and flexible building form and making it has a good visual connection from the site to the outside and vice versa, considering its prominent position facing many intersections. Remembering that

the site borders directly to Basuki Rahmat Street, it is imperative for the building to face this street, to create a more welcoming environment. The existing state of the site as stated above also gives a good value, as almost half of the site is a vacant unused land. While the other half consists of an existing automotive building that its function can be preserved as the identity of the location, that still holds a relevant context soon. This only concludes that the site has a balance value that holds an immense value if utilized properly.

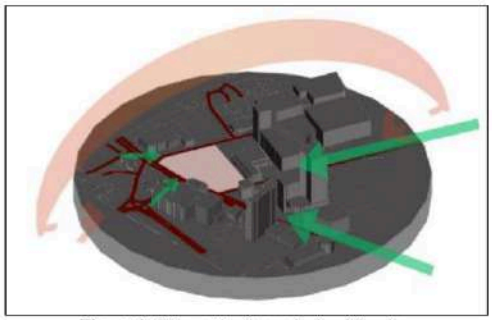

Figure 2. Schematic site analysis of the site.

3.2. Precedent study analysis

The precedent study analysis examines two office buildings that implement biophilic design: Mr. Green's Office, completed in 2021 in Vietnam, and NION, a proposed design in Frankfurt, Germany. Mr. Green's Office integrates extensive greenery, natural ventilation, and daylight optimization to create a healthy and energy-efficient workspace, enhancing occupants' well-being while reducing environmental impact. Meanwhile, NION envisions a high-rise structure with abundant vertical gardens, open terraces, and renewable energy integration, aiming to redefine urban sustainability by fostering a strong connection between occupants and nature. By analyzing these two projects, the study explores how biophilic principles can be effectively applied in modern office buildings to promote sustainability, productivity, and user well-being.

The concept design of Mr. Green's Office is to presents an "outdoor office" feeling indoor. This also supported by the clients interests in plants, flowers, comfort and lightness, which can be interpreted under one label, which is landscape. Creating a new environment of office that blends well with nature. Moreover, the background issue about this project is that the common phenomenon in urban area where the green spaces is lost, which also existed in Vietnam, the location of this project. The increasing growth of the economy demands more high-rise concrete blocks in urban areas, which then sacrifice the outdoor green spaces. Whilst the occupants of these buildings will spend the majority of their time in a day inside this building, limiting some aspects of their life, including the physical aspects [19].

As the occupants explores more of each section of the room, the occupants will totally lose the cramped, stuffy, and monotonous feeling of the city that is invaded by concrete blocks. The meeting area of the office is arranged to be surrounded by garden (Figure 3). This was done to create a buffer zone providing a sense of privacy, while also acts to regulating light, and reducing sun glare into the office. As the other part of the office, the meeting room also implements a light colours and materials in it to create the contrast with the plants. It is also noted that on the edge of the ceramic floor of the meeting room were a gravel floor made from small stones, implying the intentions to really brings the sense of outdoor inside and allowing the occupants to be able to interact sensory with the nature element, even in indoor.

Figure 3. Office interior environment [19].

The intention to bring nature inside is done in a way that the occupants can feel the sense of outdoor and not just a room filler. To achieve this the designs really put a significant amount of nature that surrounds the person inside or on the other word the proportion of nature is bigger (Figure 4). The presence of nature in the office also comes in a form of water in a pond located next to the meeting area and lounge. The placement of this pond is right next to the edge of the building with the pond meets the outer window of the building. This also means that if looked from the inside side of the pond, it will give the scenery of city view by the water of the pond, resembling the typical sight of riverside city view, thus another outdoor element presents inside [19].

Figure 4. Nature placement schematic (left) and pond with city view in the background (right) [19].

NION office building aims to be one of the most sustainable office buildings in Germany by prioritizing both environmental and social well-being. Some of the strategies are placing an extensive greenery, the building will also utilize a low-carbon structural system, also emphasizing a quicker and more sustain construction process with prefabricated elements and a modular framework. It also uses an adaptable floor plan for space efficiency and long-term usability. The building also able to dynamically adjust to weather conditions and real-time usage, reinforcing its sustainability goals. It also use a photovoltaic facade, a rainwater collection system, and a geothermal system that provides 30–40% of the cooling and 70% of the heating needs [20]. Advanced technologies such as intelligent air conditioning, LED lighting, energy-recovering elevators, and smart building management will enhance efficiency. Furthermore, e-charging stations with load management and open, green workspaces will promote an eco-conscious work environment. A semi-closed facade covering 50% of the exterior will also help mitigate solar heat absorption.

The building incorporates a sloped and stacked form in some of its corners, which the design intends to helps control the wind flow by directing it upwards (Figure 5). Therefore, ensuring that the upper level get a good wind flow. Where the existence of plants in some of its level helps to boost the coolness of the wind that go straight into it. Some of its part that receive the most amount of wind flows are then used as a communal space for the occupants to socialize, relaxing, or simply to take a break from work. Helping to reduce energy usage of the building in accommodating such public areas, while also encouraging the communal activity to

be nature-based that seeks to bring a new experience and allowing users to interact with nature directly or indirectly [20].

Figure 5. Sloped building form help directing the wind (left) and form context (right) [20]

Some of the building communal areas are designed with different styles of levelling such as split level and the use of stacked terraces (Figure 6). This resulting in the creation of a more playful communal area or plaza that is not monotone and straightforward but have some kind of exploration and emotion in it. This stacked plaza also implements nature in various points of level, boosting a more vibrant, calm, and cool atmosphere. While also helps to reduce the sun glare, and make the air cooler and clean by filtering it. The stacked design also helps to make the area clean by minimizing the use of excessive furniture, because it has already creates a place to sit, socialize, and relax in the stairs form the design. Moreover, the use of natural-based materials and colours helps to make all the elements in the area integrates well and able to produce a more cohesive atmosphere [20].

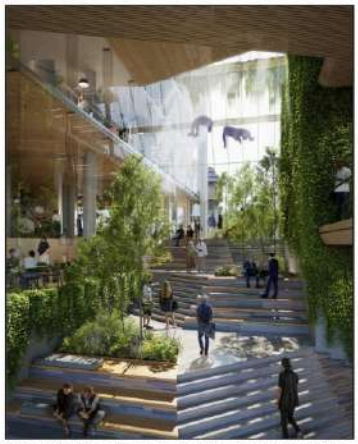

Figure 6. The stacked plaza inside the building.

3.3. Implementation of biophilic architecture

The site as stated previously, is in the city centre of Surabaya that is surrounded by various kinds of business-related buildings. Moreover, as explained in the site analysis the site has a physical condition of mostly half abandoned land and the other half being an automotive-related building. The unused land itself already had various trees that is also unmanageable and on the other hand, the surrounding area of the site, also had no real communal space. While the area around the site also can be considered to disconnect with nature, as the existing nature is just a tree that was placed in the pedestrian sidewalk, implying that its presence just as a room filler. This can also be interpreted that the people in the area often disconnect to nature as the built environment around them did not provide such relationships to occurs. This phenomenon can be answered with the biophilic approach. Which will then allow the building to act as a bridge that reconnects the people with nature, where the building will act as a platform that brings the nature back into the area (Figure 7). This then are transforms into concept, which is reconnect that will guide the designing process. The concept seeks to reconnect the community in the site are which is automotive community and the growing needs of the area to support the rapid growth of Surabaya's economy, like office building. Both of these aspects are commonly known to have no relation to nature. Meanwhile, the building tends to break away from this commonality and tries to combine the community aspect, needs aspect, with nature aspects, which will result in the creation of a more unique, attractive, interactive, and vibrant space.

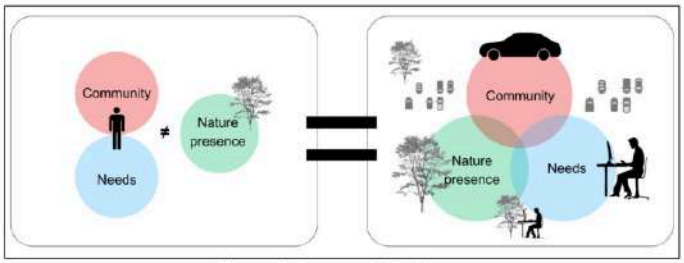

Figure 7. Concept design ideas.

The building design are done by considering a the physical state of the site and its relation with the surrounding area (Figure 8). Responding the shape of the site, the building uses a two masses tower creating a corridor in between. This corridor are meant to provide a continuous visual connection from Basuki Rahmat street in the northwest side down to southeast side and vice versa. This also allows wind and daylight to enter, helping to minimize the energy usage of the building. The corridor area are then subtracted in order to create a more playful and exploration by implementing various kinds of levelling. Moreover, both towers mass are then subtracted to create a more focused connection to the center corridor, and to enhance the effect of the wind flows as well as the daylight for both towers. While both towers are finished by adding an envelope facade, providing a more attractive looks, but also to help control the daylight and wind flow received.

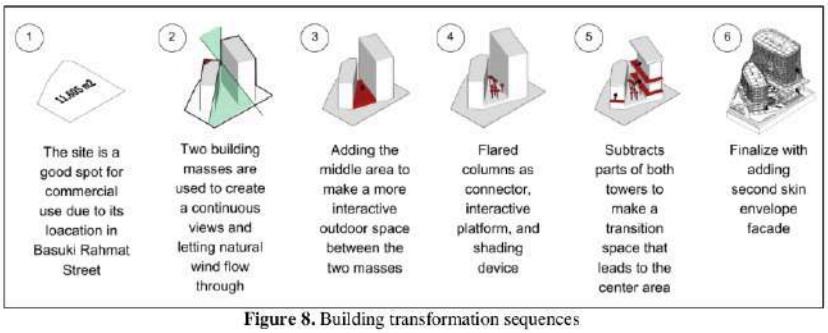

Figure 8. Building transformation sequences

The automotive community area is accommodated from the ground floor to the second floor, providing open spaces, connector areas, car modification workshops, car expos, car exhibitions, and showrooms. Additionally, the third to eighth floors accommodate commercial and shopping areas, while in the other tower, the fourth to fifteenth floors serve as office spaces (Figure 9). By incorporating multiple functions, this building operates as a mixed-use development primarily focused on commercial activities, aligning well with the urban development along Basuki Rahmat Street.

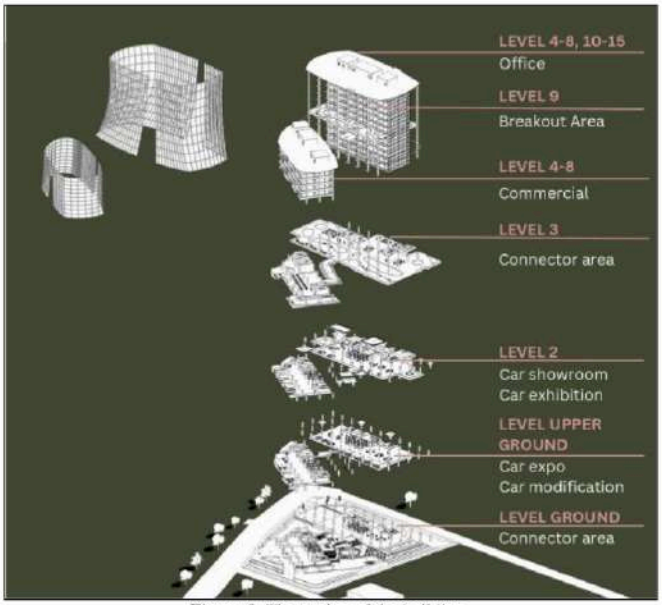

Figure 9. The zoning of the building.

The building features an envelope facade inspired by the dynamic forms of nature. This design choice not only enhances the building's aesthetic appeal but also serves a crucial functional purpose: reducing sun glare. This is achieved through the use of low-emissivity (low-E) glass embedded within a steel pipe frame.

Additionally, the dynamic slope of the facade is strategically designed to control wind direction, channeling airflow upward. This allows the upper levels of the building to receive better ventilation and an improved supply of fresh air. The envelope itself, particularly the steel pipe elements, is finished in a wooden color to create a more vibrant appearance that harmonizes with the various plants integrated into the building's design. In addition to its facade, which is inspired by the dynamic forms of nature, this building incorporates three key principles: direct experience with nature, indirect experience with nature, and the experience of space and place. Table 1 shows the implementation of the principles in architectural design.

Table 1 Implementation of biophilic design.

Principle	Design implementation
Direct experience with nature	• Rooftop garden and sensory-based therapeutic garden • Designated urban farming area • Utilization of daylight and natural ventilation in perimeter zones, breakout spaces, and garden areas • Reflecting water feature within the breakout area
Indirect experience with nature	• Architectural massing with an organic and biomorphic form • Facade system incorporating low-emissivity (low-e) glazing and steel pipe framework finished in wood-tone coatings • Tree-shaped bridge structure in transitional zones
Experience of space and place	• Green-integrated transitional zones with embedded garden elements • Transitional areas functioning as natural corridors and ecological gateways

The direct experience with nature is realized through designated sensory areas within the building. These areas primarily take the form of gardens, providing occupants with spaces where they can freely interact with nature. The goal is to foster a reconnection with the natural environment, offering a means to relieve stress and enhance well-being. The sensory-based therapeutic garden is not just an ordinary garden—it is designed to engage all five human senses, allowing users to have an immersive interaction with nature. The sensory experiences include visual engagement, where occupants can observe a variety of plants and greenery; auditory experience, with natural sounds such as the rustling of plants in the wind, the presence of small animals, and the distinct sounds of different flooring materials like wooden planks and gravel; tactile interaction, encouraging users to touch various plants and even pick flowers from designated areas; olfactory stimulation, provided by a diverse selection of fragrant flowers that create a pleasant aroma throughout the space; and taste, which is particularly relevant in the urban farm section, where users can harvest and consume fresh fruits grown within the building. Some of these sensory areas also serve functional purposes, such as urban farms that produce various fruits and vegetables (Figure 10). This multifunctional approach not only strengthens the direct connection to nature but also contributes to sustainability by generating fresh produce for occupants. Every corner of the building is designed to serve a purpose, ensuring efficient use of space.

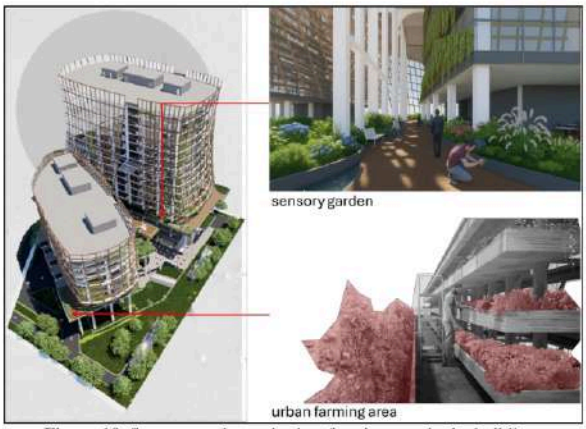

Figure 10. Sensory garden and urban farming area in the building.

Certain floors in the building are designed to include two full levels dedicated entirely to garden spaces with seating areas and a semi-outdoor atmosphere. Known as breakout areas, these spaces serve multiple functions for office occupants, offering a flexible environment for taking breaks, dining, holding informal meetings, relaxing, or even enjoying short walks. Daylight, sunlight, fresh air, and the presence of water are key natural elements incorporated into garden spaces and breakout areas within office buildings, providing places where workers can relax and connect with nature (Figure 11). These spaces are intentionally designed using passive design strategies that harness natural environmental features to create a comfortable atmosphere while minimizing reliance on artificial lighting, mechanical ventilation, and air conditioning. By integrating greenery, water features and open-air elements, these areas enhance the overall workplace experience, promoting both physical and mental well-being while fostering a more dynamic and engaging office environment.

Figure 11. Breakout areas with nature experience in the building.

An indirect experience with nature is created through biophilic design, which uses shapes and building elements inspired by nature. In the northern tower's facade, the curved shape helps guide the wind into the building. The design includes low-emissivity (low-e) glass inside a steel pipe frame to reduce glare from the sun while keeping the building energy efficient. To strengthen the connection with nature, the steel pipes are given a wooden color, making them blend well with the greenery and plants around the building (Figure 12). This design not only benefits the people inside but also helps the building function better and reduces its impact on the environment. It also ensures that nature is present throughout the building, even in spaces where direct contact with nature is difficult or impossible.

Another indirect experience with nature can be found in the upper transitional area, where a bridge is inspired by tree shapes (Figure 12 and 13). The columns start narrow at the bottom and gradually become wider at the top, like tree trunks. This allows for a larger platform that can be used for different activities while still being structurally strong. The building's exterior is mostly in shades of brown, reflecting the colors of tree bark. Another way this nature-inspired design is applied is using materials that look natural. Instead of using real natural materials, the building uses synthetic materials designed to look like wood or stone but last longer and require less maintenance. This reduces the need for frequent replacements, making the building more sustainable.

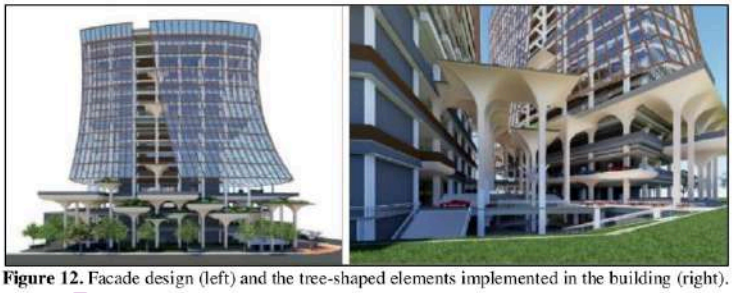

Figure 12. Facade design (left) and the tree-shaped elements implemented in the building (right).

The concept of experience of space and place refers to a space-oriented strategy that enhances the experience of occupants through spatial design (Figure 13). In this project, the concept is applied by organizing the building into two main transitional spaces. The first transitional space connects Basuki Rahmat Street on the northwest side to the southeastern part of the site. This spatial linkage is supported by the massing strategy: the two towers are arranged to form a central void reminiscent of a natural valley. This central space acts as a bridge between different parts of the building and serves as the main entrance area that links the site to the city beyond. Located at the ground level, this central transition zone becomes the main pedestrian pathway into the building. Its central position helps guide visitors intuitively through the site and improves circulation. (Figure 12 right).

The second transitional space is placed between the two towers, which are used for different purposes. This helps to keep each function separate and avoids potential conflicts in use. The open space between the towers also acts as a natural corridor, allowing air and sunlight to pass through. This improves indoor comfort by supporting natural ventilation and lighting, which in turn helps reduce energy use. Apart of being functional, this open area also works as a shared green space, offering a pleasant and relaxing environment where people can gather or take a break. The design uses split levels to create multiple layers of green spaces, forming a stepped garden that adds visual interest and brings nature closer to the users. By including natural elements in the design, the space feels more welcoming and alive. This design approach also breaks away from the usual layout of typical urban office buildings, offering a more engaging and nature-connected experience for those who use the building (Figure 13 and Figure 14).

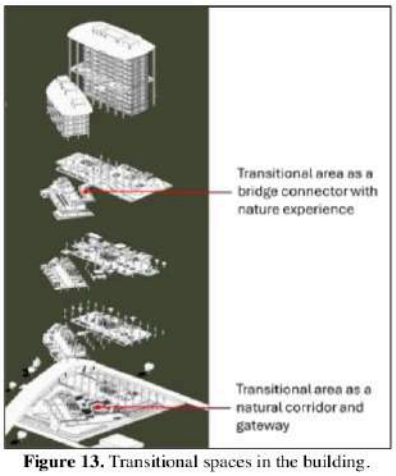

Figure 13. Transitional spaces in the building.

Similar transitional spaces can be found on the upper levels of the building, such as office balconies and breakout areas in the office sections. The balconies are adorned with hanging trees, forming a vertical garden that provides fresh air and reduces sun glare (Figure 14). These spaces help break the monotony of standard building layouts by introducing variety in the spatial experience. The presence of nature in these spaces further enhances the experience, providing users with direct interaction with greenery. The entire wayfinding and spatial arrangement of the building is designed to be simple and easy to navigate.

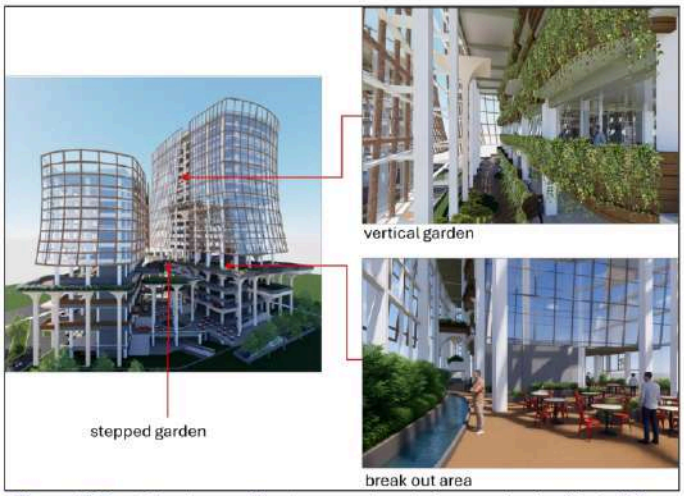

Figure 14. Transitional areas with nature experience in the upper levels of the building.

3.4. Discussion

The biophilic design of the Office and Automotive Centers in Basuki Rahmat incorporates three main strategies: direct experience with nature, indirect experience with nature, and the experience of space and place. Among these, direct experience with nature dominates, as shown in Table 1, due to its strong impact and fundamental role, while the other strategies are less influential and rely more on artificial elements [21]. Key design features include rooftop and sensory gardens, urban farming areas, and breakout spaces that act as three-dimensional green buffers. In a high-rise building, these features help regulate natural light, support natural ventilation, and improve thermal comfort. They also serve as shared recreational spaces for employees. A similar approach is seen in the SBF Office Building in Guangdong Sheng, China. The SBF building similarly employs rooftop greening, sky gardens, and vegetated terraces to deliver multifunctional ecological and recreational functions [18]. In both cases, the spatial arrangement is not merely decorative but embedded within the core architectural and environmental logic of the building. These precedents reinforce the growing trend of high-rise urban developments adopting nature-integrated solutions to respond to the dual challenges of urban density and occupant well-being.

The concept of indirect interaction with nature is expressed through the building's flowing, organic form and the tree-shaped bridge structures located in its transitional areas. These natural-inspired shapes foster a sense of harmony with the environment, subtly reminding users of nature's presence [22]. Furthermore, the curved shape of building mass helps guide the wind into the building and enables passive ventilation [20]. The low-e glass installed on building's facade maximizes daylighting and minimizes solar heat gain. In high-rise buildings, this facade sytem acts as a fixed protective barrier, improving climate control for interior areas. These strategies are implemented in The Shard by Renzo Piano and 30 St Mary Axe by Foster + Partners, where advanced glass systems are designed to mitigate wind impact and solar radiation, for reducing the overheating [18].

The design of the transitional areas in this building is based on the experience of space and place concept. The concept emphasizes the role of spatial design for enhancing users' physical and emotional experience [22]. In this Office and Automotive Centers building, transitional spaces are created to provide direct interaction with nature. The ground floor transition area, functioning as the main entrance, is shaped like a natural valley with tree-shaped columns and multiple layers of greenery. The other transitional area incorporates a natural corridor, a stepped garden bridge connecting the two towers, and balconies on the upper floors.

The design that divides a building into two separate towers with green spaces in between can also be seen in Green Spine in Melbourne and New Heart in Düsseldorf. Those buildings integrate balconies, loggias, and terraces at the area where the towers divide, creating spaces that connect the building to the natural surroundings. The use of balconies as green, intimate biophilic zones is a growing trend in high-rise architecture. This can be seen in One Central Park in Sydney by Ateliers Jean Nouvel and Tour Trinity in Paris designed by Jean-Luc Crochon and Cro & Co Architecture [18]. These examples reflect a significant concept in urban design aiming to merge vertical living with direct access to greenery and open-air environments.

Although the Office and Automotive Centers in Basuki Rahmat successfully applies biophilic design principles, several challenges remain. The main obstacles come from budget limitations and maintenance demands [23], which is not considered in the design phase. Furthermore, since direct interaction with nature—especially through vegetation—is a key focus, this creates additional issues related to the complexity of plant integration, lack of clear guidelines for vertical and three-dimensional greenery, and the need for collaboration between designers, builders, and maintenance teams [24]. Another concern is the overemphasis on greenery can lead to neglect of other important aspects, such as thermal comfort, daylight access, and natural ventilation [25]. In this building, the issue is addressed by utilizing daylighting and natural ventilation in perimeter and open space areas, although not throughout the entire building.

Related to sustainability issues, this building faces challenge in meeting green building standards. These include managing energy use, water efficiency, material choices, and waste reduction [26]. The Office and Automotive Centers in Basuki Rahmat incorporates daylighting, ventilation, and thermal comfort features, but its actual performance must still be assessed—particularly in terms of energy consumption, water

efficiency, and material sustainability—to ensure that the benefits of biophilic design are not merely conceptual, but measurable and truly support its role as a sustainable strategy for high-rise buildings.

4. Conclusion

The Office and Automotive Centers in Basuki Rahmat shows a strong application of biophilic design by combining three key strategies: direct experience with nature, indirect experience with nature, and the experience of space and place. Among these strategies, the direct experience with nature stands out as the most dominant and impactful. This is realized through rooftop gardens, urban farming areas, and three-dimensional green buffers that not only serve recreational purposes but also contribute to daylighting, natural ventilation, and thermal comfort. The building also uses organic shapes, tree-like structures, and low-emissivity glass, reflect the principle of indirect experience with nature, to connect users with nature and improve energy efficiency. Transitional spaces, like the central valley-shaped entrance and green corridors between towers, create both functional and emotional experience of space and place for users. These design ideas follow global examples of biophilic high-rise buildings, showing a growing trend of integrating greenery into vertical buildings.

This design approach is especially relevant within the urban context of Surabaya, a rapidly growing metropolitan area characterized by high population density and intense land use competition. In such settings, access to green open spaces is increasingly limited, and buildings are often developed vertically to meet the demands of urban expansion. The implementation of biophilic principles in high-rise architecture, as seen in this project, offers a sustainable response to these urban challenges.

However, while the building successfully demonstrates the potential of biophilic design, it faces significant implementation challenges. Key barriers include budget constraints, complex maintenance demands, and the technical difficulties of integrating vegetation into the built environment. Future studies should consider the strong focus on vegetation may risk overshadowing other essential biophilic aspects. To ensure the biophilic features are effective, the building's performance still needs to be measured, especially in energy use, water efficiency, and material sustainability. This will help confirm that the design is not only visually appealing but also supports long-term environmental goals.

5. Acknowledgements

The authors have no acknowledgments to declare.

6. Conflict of Interest

The authors certify that the manuscript does not have a conflict of interest.

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