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Biophilic and Healthy Aging Environments: A Sustainable Design Framework for Dementia Care Facilities in South Korea †

Karla Vitoria De Oliveira Mendes and Jihyun Park *

Department of Architecture, Ewha Womans University, 52 Ewhayeodae-gil, Seodaemun-gu, Seoul 03760, Republic of Korea; karlaoliveira@ewha.ac.kr

* Correspondence: jh.park@ewha.ac.kr

† This paper is an extended version of the paper published in the Architectural Institute of Korea 2025 Autumn Conference, Seoul, Republic of Korea, 30 October 2025; Volume 45, pp. 214–217.

Abstract

This research investigates the development of a biophilic conceptual design proposal tailored to dementia care environments in South Korea, responding to the country's rapidly aging population and the projected rise in dementia prevalence. The study integrates spatial and aesthetic strategies grounded in established biophilic design principles, including visual and non-visual connections with nature, thermal and airflow variability, dynamic and diffuse lighting, and the presence of water. Drawing on comparative case study analysis, the research emphasizes the therapeutic potential of nature-oriented environments in reducing stress, enhancing mood, improving physical health, and supporting cognitive function among residents with dementia. Emphasizing a human-centric perspective, the study also considers the experimental and behavioral needs of elderly users within the design process. In addition, it critically examines the challenges and limitations associated with implementing biophilic design strategies in architectural practice.

Keywords: biophilic design; dementia; dementia care environments; human-centric design; therapeutic-environments

1. Introduction

1.1. Research Background

Population aging is a main concern for all countries. Globally, the number of people aged 60 years and older is expected to increase from 1 billion in 2019 to 2.1 billion in 2050 [1]. Acknowledging the global challenges of population aging, the United Nations (UN) General Assembly declared 2021–2030 the UN Decade of Healthy Ageing with the WHO leading the implementation of a 10-year global action plan, which has the goal to reduce health inequities and improve the lives of older people, their families, and communities [2].

Longer lives reflect the advances in social and economic development, and the positive impact of aging gains can strengthen societies. Older, healthy, and active people can participate directly in the formal and informal workforce. However, the implications for older people and for society can be negative if the elderly experience poor health, social isolation, or dependency on care [1].

Population aging is a common phenomenon in advanced economies. Nevertheless, South Korea is one of the fastest-aging societies in the world, making it difficult to address the various social problems it faces. This phenomenon presents society with a complex policy challenge that accompanies economic, political, and socio-cultural changes and

Check for updates

Academic Editor: Xuan Ma

Received: 15 April 2026
Revised: 12 May 2026
Accepted: 26 May 2026
Published: 19 June 2026

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requires action across various areas [3]. The proportion of elderly citizens in South Korea is projected to rise from 17.5% in 2022 to exceed 46.4% in 2067 [4]. With the aging population and longer life expectancy, the risk of developing dementia is increasing significantly. In 2020, the estimated prevalence of dementia among the elderly over 65 years old in South Korea was 10.3% (approximately 840,000 people). For 2050, it is estimated to be 15.9% (3.2 million) of the elderly population. The economic costs of treating dementia and assisting dementia patients in national dementia management are projected to increase by approximately 100 trillion won [5]. With the increasing demand for elderly care, it is essential to secure sufficient facilities while simultaneously improving the quality of the care environment [6].

1.2. Research Objectives and Questions

The purpose of this study is to investigate architectural examples of elderly care facilities, focusing on dementia care models that incorporate biophilic design strategies. As a result, a conceptual design will be developed that highlights the therapeutic benefits of a nature-centered approach for people with dementia. The specific research objectives are as follows:

(1) How can biophilic 'Nature in Space' patterns be systematically integrated into dementia care architecture?
(2) What design principles can be extracted from existing dementia-care case studies?
(3) How can these principles be adapted to the Korean cultural and urban context?

2. Literature Review

2.1. Understanding Dementia and Types of Dementia Facilities

Dementia is defined as the loss of cognitive functions such as thinking, remembering, and reasoning. As the disease advances, it interferes with the person's daily life and activities. Depending on severity, dementia ranges from the mildest stage, where functioning is first affected, to the most severe stage, when a person needs assistance with basic daily activities. Dementia is more common as the person gets older; approximately one-third of all people age 85 or older may have some form of dementia. Types of dementia include Alzheimer's disease, frontotemporal dementia, Lewy body dementia, vascular dementia, and mixed dementia [7]. The most common dementia is Alzheimer's disease, which is a brain disorder that destroys memory and thinking skills and progressively affects the ability to complete simple tasks [8]. According to the severity of each patient's case, there are different types of dementia care facilities. First, residential care is designed for individuals who may have difficulties living independently at home but do not require regular medical supervision. It provides support with personal tasks such as washing, dressing, and personal hygiene, as well as assistance with meals and medication reminders. Second, nursing care provides the same support as residential care, with the added presence of qualified nursing staff on-site 24/7. This type of facility is suitable for individuals with more complex health needs requiring continuous monitoring and treatment [9]. Dementia villages focus on providing person-centered care in small-scale, homelike settings for people living with advanced dementia. These facilities address patients' social, psychological, and physical needs. It provides a secure environment that supports patients' participation in daily activities, enabling them to live as normally as possible [10]. The increase in new senior housing models may indicate that existing facilities are not meeting the needs of the current and future generations of older people. The new models have the potential to offer an age-friendly environment that supports independent living. Moreover, it can also offer social activities, mutual support, and help [11].

Following the explanation of the different types of dementia and the facilities, some decisions were made regarding the conceptual design. Because different types of facilities meet each patient's needs, the residential care model was chosen for this study for specific reasons. Nursing care facilities are much more complex, and since the result is a conceptual design, the residential care facility is sufficient to express biophilic design characteristics. The scale is smaller compared to the dimensions of the dementia village. Since the conceptual project is located in a park, patients with less severe dementia would have greater freedom to move around.

2.2. Dementia-Friendly Design

Several studies highlight the importance of dementia-friendly design in creating a more comfortable, safer environment for patients. Traditional models of care often fail to adequately meet the basic needs of their patients, which are usually characterized by efficiency-oriented institutional settings and inadequately address the necessities for those living with dementia [12].

The World Alzheimer Report 2020 [13] contains several recommendations when designing spaces for people with dementia. These principles can be summarized in the following points:

- Reduce risks. The internal and external environments should be safe and easy to circulate, and potential risks should be removed.
- Provide a human scale. The number of people a person with dementia encounters, the overall size of the building, and the size of the individual components influence a person living with dementia's behavior and feelings.
- Allow people to see and be seen. An easily understood environment can help to minimize confusion in a person with dementia. Good visual access provides an opportunity for engagement and confidence in exploring the environment.
- Reduce unhelpful stimulation. Exaggerated visual or auditory stimulation is stressful; large amounts of stimulation for a person living with dementia should be avoided.
- Optimize helpful stimulation. Providing cues in spaces can help to minimize confusion and uncertainty.
- Support movement and engagement. A well-defined pathway, free of obstacles and complex decision points, increases engagement in activities or social interaction.
- Create a familiar place. The individual spaces need to reflect residents' personal backgrounds, with familiar objects such as furniture and colors.
- Provide opportunities to be alone or with others. It is important for people living with dementia to be able to choose to be on their own or spend time in groups. The spaces in the dementia care environment should provide opportunities for time alone, quiet conversation, and larger groups.
- Link to the community. A person living with dementia loses their sense of identity; therefore, it should be encouraged through attractive and comfortable places, visits from friends and family, to help maintain their identity.
- Design in response to the vision for a way of life. The building design of a dementia facility should embody the philosophy of care it pursues, and that philosophy should be evident to residents and staff.

Other studies identify additional important characteristics for dementia-friendly environments. The author Quesada-García presents a framework for effective design for Alzheimer's inhabitants and highlights points, such as close and familiar location with large outdoor areas with vegetation, which creates an available area for gardens, terraces, and walkways; a mixed functional program that integrates both residential and care services; lighting, and climatic comfort, adequate lighting improves sleep cycles and reduces

agitation, in addition, climate control ensures comfortable temperature, reduce heat stress, and maintains good ventilation, among other principles [14].

Moreover, safety and accessibility features should include non-slip flooring, handrails, and accessible bathrooms. In addition, it should avoid monotonous corridors and introduce memorable spaces, with visual landmarks and structural variations along paths [15].

2.3. Principles of Biophilic Design

Wilson (1984) defines biophilia as an 'innate tendency to focus on life and lifelike process' or the 'innate emotional affiliation of human beings to other living organisms' [16]. Since human instinct evolved in the natural environment, biophilic design helps create spaces that reflect natural elements and align with human instinct [17]. In modern times, this existing human inclination to connect with nature continues to influence people's physical and mental health and well-being. Despite this, modern buildings and landscape design often treat nature as an obstacle to be overcome or as something to be neglected altogether. The challenge of biophilic design is to adopt practices that create meaningful and satisfying experiences of nature within the built environment [18].

In the evaluation system of several building standards and green building rating systems, biophilic design' is also added. The WELL Building Standard v2 (2025) identifies 'Nature and Place' and 'Enhanced Access to Nature' as important concepts in the 'Mind' (one of the features), with the approach to incorporate nature throughout the project in the interior design, exterior design, and access to nearby nature [19]. LEED v5 (2025) also includes 'Biodiverse Habitat' and 'Accessible Outdoor Space' as credits and encourages biophilic design through various strategies [20]. Beyond the therapeutic value, biophilic dementia-care environments can also foster sustainability. Research on urban building evaluation highlights the importance of understanding building performance within the broader urban context to support sustainable built environments and improved living standards [21].

Over the years, researchers have provided interpretations and frameworks for biophilic design studies [22–25]. In the report '14 patterns of biophilic design', Browning highlighted the importance of biophilic design in the built environment and categorized biophilic design into three principal groups: Nature in the Space Patterns, Natural Analogues Patterns, and Nature of the Space. For this paper, the focus will be on Nature in the Space Patterns and Nature of the Space, as Table 1 presents them, which encompasses specific biophilic design patterns that bring direct, physical, and ephemeral experiences of nature into the built environment and the spatial configurations in nature [26].

Table 1. Elements of biophilic design.

Biophilic Categories	Biophilic Design Patterns	Description
Nature in the Space	Visual Connection with Nature	A view of elements of nature, living systems, and natural processes
	Non-Visual Connection with Nature	Auditory, haptic, and olfactory stimuli that engender a deliberate and positive reference to nature
	Non-Rhythmic Sensory Stimuli	Stochastic and ephemeral connections with nature that may not be predicted precisely
	Thermal & Airflow Variability	Subtle changes in the air temperature, airflow across the skin, and surface temperatures that mimic natural environments
	Presence of Water	A condition that enhances the experience of a place through the seeing, hearing, or touching of water

Table 1. *Cont.*

Biophilic Categories	Biophilic Design Patterns	Description
Nature in the Space	Dynamic & Diffuse Light	Leveraging varying intensities of light and shadow that change over time to create conditions that occur in nature
	Connection with Natural Systems	Awareness of natural processes, especially seasonal and temporal changes, characteristic of a healthy ecosystem
Nature of the Space Patterns	Prospect	An unimpeded view over a distance, for surveillance and planning
	Refuge	A place for withdrawal from environmental conditions or the main flow of activity, in which the individual is protected from behind and overhead
	Mystery	The promise of more information, achieved through partially obscured views or other sensory devices that entice the individual to travel deeper into the environment
	Risk/Peril	An identifiable threat coupled with a reliable safeguard

2.4. Biophilic Design and Dementia

The environment has a huge impact on a person with dementia; agitation and other behavioral symptoms can be exacerbated if the environment does not accommodate the needs of patients with dementia. On the other hand, a well-planned space can be an important strategy for mitigating negative conduct [27].

Several studies have explored how contact with natural environments can contribute to patients with dementia. Murroni analyzed the benefits of visiting gardens and gardening therapy for people with dementia through a systematic review of 16 quantitative studies, which showed improvements in engagement, agitation, positive emotions, stress, and medication use [28]. Boffi also identified the effectiveness of shared community gardens in public senior houses, where they integrated psychology and landscape studies into the design process to create a sustainable, restorative, natural space that encourages social relations and interactions in natural, healthy contexts [29]. Another review by D'Andrea reported the benefits of olfactory stimulation interventions (e.g., lavender or orange) in dementia care. This showed improvements in responsive behaviors and cognitive function; moreover, exposure to scents can evoke positive emotions, such as memories of past personal experiences [30]. Humanizing health care environments and allowing patients to explore outdoor spaces empower them, reduce pain and stress, and enhance their mental health [31]. Moreover, a nature-friendly elderly care facility provides emotional stability, expansion of activities, and social connectivity for patients [32]. Biophilia improves patient outcomes, including faster recovery, reduced medication dependence, and enhanced emotional well-being. The benefits are also extended to employees. Biophilic design can lower stress, decrease absenteeism and turnover, and promote concentration and productivity [33].

Another way to help patients connect with nature is through gardening. Among non-pharmacological interventions for people with dementia, therapeutic horticulture is a promising approach. Therapeutic horticulture includes individual, community, and group programs and activities, such as watering, weeding, planting, propagating, cultivating, and sensory experiences. Studies show that therapeutic gardening for the elderly with dementia improves cognitive function, memory, physical function, social interaction, well-being, and quality of life [34].

Currently, individuals spend most of their time inside buildings. However, in the built environment, space is usually static and homogeneous, with no variations. The integration of nature into architecture creates multisensory, dynamic environments that

can maximize health and well-being outcomes [35]. Therefore, the design of a house has a significant impact on human health; one strategy to transform indoor spaces into therapeutic environments is biophilic design. Biophilic design can be applied to any residential indoor space, such as the living room, bedroom, kitchen, or dining room. This can be accomplished through sounds, smells, and textures associated with nature [36].

A study that developed a framework for biophilic residential design tailored to a diverse profile of seniors in South Korea, based on a nationwide survey, found the following results. To support physical comfort and sensory balance within the residential space, design options include varied daylight patterns, green walls and vertical gardens, ventilation systems, and natural materials. For cognitive stimulation, symbolic references help with orientation, memory, and spatial recognition. The recommended features are natural imagery, biomimetic structures, and nature-based wayfinding. Moreover, external and social connectivity foster interaction, openness, and a sense of community. Therefore, elements such as indoor gardens and plant arrangements, balconies, decks, curtain walls, and eco-friendly circulation paths are suggested [37].

In addition, a virtual biophilic residential environment can have beneficial effects on seniors, potentially healing and promoting recovery. A study on the application of virtual biophilic experience using 3D videos created with Enscape 3.1 in eight senior welfare centers in Daegu, South Korea, showed positive results. They were exposed to virtual natural elements, such as immersive media with water features, virtual 3D natural elements, and objects, while mapping the spatial characteristics of the physical environment (e.g., windows, walls, etc.), which revealed a great effect on reducing physiological stress. This can help enhance seniors' biophilic experience in high-density urban areas [38]. In this way, biophilic design and digital technology can enhance satisfaction with residential life [39]. These studies demonstrate that natural design features can be customized in senior residences to meet residents' specific requirements, not just in dementia care facilities.

2.5. South Korea Dementia Care Policy

Korea's healthcare system has expanded significantly over the past decades, alongside accelerated economic development. However, the structure of the healthcare system presents fundamental limitations in its operations. These problems are related to the decline in the productive population and the growth of the dependent population, driven by low birth rates and population aging. In this way, there is greater medical demand in a super-aging society, but a shortage of medical personnel [40].

In addition, surveys in South Korea demonstrated an increase in negative perceptions toward dementia, with percentage points increasing by 4.2 from 39.6% in 2014 to 43.8% in 2021. One of the reasons for these negative views was the fear of dementia (60.2%), which shows the importance of improving awareness and educational activities related to dementia. In addition, rapid aging, workforce decline, and economic conflicts between generations are leading to intergenerational issues [41]. Nevertheless, in 2017, Korea announced the 'National Responsibility for Dementia System', which has led to many achievements. It has established dementia care centers at 256 public health centers nationwide and provides services, including counseling, medical checkups, dementia prevention, therapeutic programs, and case management, to 2.62 million residents, dementia patients, and their family members. Currently, dedicated wards for dementia at 55 public long-term care hospitals are being installed to provide intensive care for patients with symptoms of severe hallucinations and violence [42]. Moreover, 'remote medical assessment' was launched in 2020, following the closure of the Dementia Care Center in Gangdong-gu, South Korea, due to the COVID-19 pandemic. The telemedicine service, combined with visiting nursing services, helped provide more equitable access to health care in the city [43].

In this context, South Korea has made significant advances in dementia care services. But there are areas that need more attention. In this way, a study introducing new methods and strategies for dementia care facilities can offer approaches applicable to South Korea's dementia care context.

3. Materials and Methods

This study adopts a qualitative research methodology that combines comparative case study analysis with design-based research to investigate how biophilic design principles can be integrated into dementia care architecture in the Korean context. The research is exploratory and interpretive, aiming to extract design knowledge from existing precedents and apply it to a conceptual architectural proposal.

The analytical framework for the case studies was developed from the biophilic design principles outlined in the study "14 Patterns of Biophilic Design". It is a well-known study that provides a framework for evaluating the benefits of contact with nature for humans in built environments. The author divided the patterns as follows: Nature in Space, Natural Analogues, and Nature of the Space. This paper focuses on design patterns of Nature in Space and the Nature of the Space. The biophilic design patterns selected for evaluation reflect the spatial, sensory, and cognitive needs relevant to dementia care environments. Moreover, each pattern was assessed using a standardized rating system to ensure consistency among the case studies. Each biophilic design pattern was evaluated on a scale from 0 to 4, as follows: 0 = absent; 1 = weak presence/limited therapeutic relevance; 2 = moderate integration; 3 = strong integration supporting dementia care; 4 = exemplary integration specifically adapted to dementia needs. Design-based research in this study enables the application of theoretical knowledge from literature to spatial strategies in the design process. The study consists of the following phases:

(1) Conducting a literature review on biophilic design and dementia care architecture;
(2) Developing an analytical framework based on selected biophilic design patterns relevant to dementia care environments;
(3) Extracting evidence-informed design principles from case studies;
(4) Applying the identified principles to the development of a conceptual design proposal for the Korean context.

Methodological Limitation

This study presents limitations. First, the design proposal is conceptual and has not been implemented or evaluated through post-occupancy studies. Second, the study relied on information available online, which may limit the investigation of user experiences or long-term performance. Finally, the study includes cultural background considerations about South Korea. However, the study lacks empirical research with users, caregivers, and healthcare professionals to strengthen validation. Despite these limitations, the methodology provides a structured approach for integrating biophilic design principles into dementia care architecture and offers a framework for future research.

4. Case Study Analysis

4.1. Selection of Case Studies

The selection aimed to introduce new methods that have not yet been applied in dementia care in South Korea. All projects studied integrate nature with the built environment. Moreover, it identifies characteristics of dementia care facilities relevant to conceptual design. International cases can broaden analytical design research by introducing new methods or design considerations relevant to future studies. In total, 4 case studies met these criteria. The selected projects represent different geographic, cultural, and opera-

tional contexts, which permit a comparative analysis of diverse design approaches. All the chosen examples presented documented material available on the internet and professional publications. Case studies were selected based on the following criteria:

(1) Dementia facilities with the incorporation of biophilic design principles;
(2) Relevance to dementia care or therapeutic environments for the elderly;
(3) Availability of architectural drawings, photographs, and published documentation;
(4) Geographic and cultural diversity are relevant to comparative analysis.

4.2. Case Study 1—De Hogeweyk

De Hogeweyk (Figure 1) is the world's first dementia village. It is designed specifically to provide care for patients with severe dementia. The village is structured as a typical residential neighborhood. Residents can walk freely through surrounding parks, small gardens, and tree-lined alleys. The pedestrian-oriented circulation lets residents move freely, engage with nature, and explore the space without feeling confined. This all happens while maintaining safety. At Hogeweyk, there are reports of significant improvements in patients' well-being living in the village format. Once Hogeweyk changed from a traditional long-term care model to the current village model, the proportion of residents on antipsychotic medication decreased from 50% in 1993 to less than 10% in 2022 [44]. The village also offers amenities such as a supermarket, a hair salon, a restaurant, and a cultural center. A study confirms that engaging in everyday activities, such as going to the cinema and shopping, is important for patients with dementia to maintain a normal life [45].



Figure 1. De Hogeweyk (Source: Be advice).

There are some limitations of this model, including financial challenges, cultural adaptation, regulatory and social resistance, and staffing and training. Building a dementia village requires a substantial investment in staff training and infrastructure. The characteristics of the village must be tailored to the local customs and expectations of each country. The model cannot simply be copied, as it needs to be aligned with the context. It must also comply with the zoning laws of each location. This may require slow progress toward a conclusion. Another important consideration is ensuring that care staff are adequately trained to create an environment that reflects a consistent person-centered philosophy [46]. Table 2 presents the application of biophilic design patterns in De Hogeweyk Dementia Village.

Table 2. De Hogeweyk Dementia Village. Rating (0 to 4) [0 = absent; 1 = weak presence/limited therapeutic relevance; 2 = moderate integration; 3 = strong integration supporting dementia care; 4 = exemplary integration specifically adapted to dementia needs].

De Hogeweyk Dementia Village (2009)		
Location: Weesp, Netherlands	Size: 4 acres (16.000 square meters)	Capacity: 188 residents
Nature in the Space Patterns	How the patterns were applied	Rating (0–4)
Visual Connection with Nature	Several Gardens are distributed throughout the village, featuring a variety of plants and flowers, allowing residents to be close to nature within the facility.	4
Non-Visual Connection with Nature	The effective layout of the building allows for direct, natural tactile and auditory experiences through the existing plants.	4
Non-rhythmic Sensory Stimuli	The diverse gardens within the building created ephemeral experiences, such as swaying grasses, insects, and animal movement, birds chirping, breezes, and other stimuli.	4
Thermal & Airflow Variability	The distributed gardens along the facility promote natural ventilation and airflow throughout.	4
Presence of Water	There is one reflecting pool in the facility; the water feature could be further developed, as the building's size allows for more natural elements.	2
Dynamic & Diffuse Light	The abundant natural light allows daylight to enter from multiple angles within the built environment and to create shades in the outdoor space.	4
Connection with Natural Systems	The visual connection to plants and natural light allows a sense of seasonal change and the flow of time.	4
Nature of the Space Patterns	How the patterns were applied	Rating (0–4)
Prospect	There are open visual connections between communal spaces and outdoor courtyards.	3
Refuge	Semi-enclosed resting areas and residential-scale spatial organization.	4
Mystery	The layout and partial garden views engage users, fostering curiosity and exploration without causing excessive disorientation.	2
Risk/Peril	The project incorporates limited forms of controlled sensory variation, such as subtle level transitions, changing pathways, and sensory variation.	2

4.3. Case Study 2—Alzheimer Residence for the "Foyer la Grange"

The Alzheimer Residence for the "Foyer la Grange" (Figure 2) has large windows that open to the green area with pine trees, and the terrace and some common areas face the town's skyline. The program is organized to allow circular wandering practiced by people with Alzheimer's disease [47].



Figure 2. Alzheimer Residence for the Foyer la Grange (Source: Archdaily).

To help people with dementia orient themselves, the room doors are painted in different colors. There are challenges in texture on vertical surfaces, and distinctions in color in walls and ceilings in hallways and common areas as well. There are no circulation obstacles, and handrails are provided in hallways and common areas [48]. Table 3 presents the application of biophilic design patterns in the Alzheimer Residence for the "Foyer la Grange".

Table 3. Alzheimer Residence for the "Foyer la Grange". Rating (0 to 4) [0 = absent; 1 = weak presence/limited therapeutic relevance; 2 = moderate integration; 3 = strong integration supporting dementia care; 4 = exemplary integration specifically adapted to dementia needs].

Alzheimer Residence for the "Foyer la Grange" (2014)		
Location: France	Size: 906 m^2	Capacity: -
Nature in the Space Patterns	How the patterns were applied	Rating (0–4)
Visual Connection with Nature	It is located in an urban setting, but the building is surrounded by trees, and there is a garden in the middle of the facility.	3
Non-Visual Connection with Nature	There are plants and trees in the outdoor area; however, it lacks diversity to provide natural sounds, aromas, or textures.	2
Non-rhythmic Sensory Stimuli	Since the plant types are not diverse and the green area is more limited, the ephemeral experiences are reduced.	2
Thermal & Airflow Variability	The rooms have individual windows, which allow control of airflow, but other information is unavailable.	2
Presence of Water	Absent	0
Dynamic & Diffuse Light	All patient rooms have windows that open directly to the outside, and the common rooms have large windows that allow natural light throughout the building.	4
Connection with Natural Systems	The existing trees and natural light evoke a sense of seasonal change and the flow of time, but the area is limited.	2
Nature of the Space Patterns	How the patterns were applied	Rating (0–4)
Prospect	The upper floors offer views of the town and nearby pines; the open visual organization facilitates spatial understanding.	4
Refuge	There are different common places within the facility that permit activities such as rest, reflection, and reading	2

Table 3. *Cont.*

Alzheimer Residence for the "Foyer la Grange" (2014)		
Mystery	Gentle spatial transitions create limited curiosity without disorientation.	2
Risk/Peril	Minimal environmental risk and strong safety prioritization.	0

4.4. Case Study 3—Alzheimer's Day Center

The outdoor spaces were designed to be part of healthcare therapies and treatments. The Alzheimer's Day Center (Figure 3)'s layout has simple circulation paths to ease the user's daily routines and features a central courtyard and other gardens, creating a wide, but calm space; the olive trees were used to convey a sense of sensitivity and tranquility. The wood was the primary material in the project, conveying a sense of spatial warmth and a friendly environment. The design, plant selection, and furniture were intended to connect users with nature and promote patients' well-being [49,50]. Table 4 presents the application of biophilic design patterns in the Alzheimer's Day Center.



Figure 3. Alzheimer's Day Care (Source: Archdaily).

Table 4. Alzheimer's Day Center. Rating (0 to 4) [0 = absent; 1 = weak presence/limited therapeutic relevance; 2 = moderate integration; 3 = strong integration supporting dementia care; 4 = exemplary integration specifically adapted to dementia needs].

Alzheimer's Day Center (2019)		
Location: Spain	Size: 1070 m^2	Capacity: -
Nature in the Space Patterns	How the patterns were applied	Rating (0–4)
Visual Connection with Nature	The facility has gardens around the built environment, featuring a diverse range of plants.	3
Non-Visual Connection with Nature	The plants are diverse and attract animals, creating experiences such as natural sounds, aromas, and textures. Materials such as stone and wood are widely utilized.	4

Table 4. *Cont.*

Alzheimer's Day Center (2019)		
Non-rhythmic Sensory Stimuli	The connection with nature through gardens offers ephemeral experiences, but the facility's size can limit them.	2
Thermal & Airflow Variability	Semi-open spaces and courtyards provide moderate environmental variation.	2
Presence of Water	Absent	0
Dynamic & Diffuse Light	The openings around the facility allow natural light and shade throughout the space.	4
Connection with Natural Systems	The extent of greenery and light allows a sense of seasonal change and flow of time.	3
Nature of the Space Patterns	How the patterns were applied	Rating (0–4)
Prospect	The presence of large windows permits visual continuity.	2
Refuge	There are spaces covered that permit rest, relaxation, and reading.	3
Mystery	The layout encourages users to walk around, fostering curiosity and exploration without causing excessive disorientation.	2
Risk/Peril	Minimal environmental risk and strong safety prioritization.	0

4.5. Case Study 4—The Village Langley—Alzheimer and Dementia Care

The Village Langley (Figure 4), instead of resembling a hospital setting, was designed to look and feel like a community, complete with a store, a hair salon, a local cafe, a woodworking shop, and a barn with animals. Therefore, it helps patients by providing regular social contact, physical activity, and time outdoors, which can help people with dementia feel connected to the space [51].



Figure 4. The Village Langley—Alzheimer and Dementia Care (Source: Architizer).

The residential buildings look like a cluster of cottages, set in a large park-like setting with a variety of gardens, paths, and outdoor spaces. The design permits a variety of activities, suitable for individuals or groups. Community building is open to the public to foster continuity in the surrounding area [52]. Table 5 presents the application of biophilic design patterns in The Village Langley.

Table 5. The Village Langley—Alzheimer and Dementia Care. Rating (0 to 4) [0 = absent; 1 = weak presence/limited therapeutic relevance; 2 = moderate integration; 3 = strong integration supporting dementia care; 4 = exemplary integration specifically adapted to dementia needs].

The Village Langley—Alzheimer and Dementia Care (2019)		
Location: Canada	Size: 5 acres	Capacity: 75 residents
Nature in the Space Patterns	How the patterns were applied	Rating
Visual Connection with Nature	The natural context, the farm's space, and the gardens within the village allow for strong integration with nature.	4
Non-Visual Connection with Nature	The effective layout of the building allows for direct, natural tactile and auditory experiences through the existing plants.	4
Non-rhythmic Sensory Stimuli	The outdoor environment provides non-rhythmic sensory stimuli through seasonal vegetation and dynamic natural conditions.	4
Thermal & Airflow Variability	The windows throughout the facility and its open spaces promote natural ventilation and airflow, but this is not extensively documented.	3
Presence of Water	Absent	0
Dynamic & Diffuse Light	All patient rooms have windows that open directly to the outside, and the common rooms have large windows that allow natural light throughout the building.	4
Connection with Natural Systems	The vast openings to nature, farming activities, and natural light allow a sense of seasonal change and the flow of time.	4
Nature of the Space Patterns	How the patterns were applied	Rating (0–4)
Prospect	The village layout offers open visual outdoor circulation and an easy environmental overview of the landscape.	4
Refuge	The project has residential-scale environments and semi-enclosed resting areas.	4
Mystery	Curved paths engage users, fostering curiosity and exploration without causing excessive disorientation.	2
Risk/Peril	The project intentionally minimizes perceived danger and environmental complexity.	1

The analysis of case studies on "Nature in the Space Pattern" indicates that nature in dementia care environments is primarily a therapeutic and behavioral support strategy rather than only an aesthetic intervention. Connecting to this biophilic pattern, it can be identified among the case studies that the following common points are:

- Natural Surroundings. Studies show that access to nature-based activities helps individuals with dementia engage meaningfully in outdoor spaces, promotes social interaction, and supports a sense of identity by enabling them to use skills they have developed throughout their lives and to maintain independence [53].
- Simple Circulation. Dementia is associated with impairments in spatial cognitive skills; it is important for seniors with dementia to have clear visual access to their destination to facilitate spatial navigation. In addition, it is important to limit the decision-making moments along the way to their destination [54].
- Courtyards/Gardens. Studies show that therapeutic gardens improve engagement and behavior and decrease the need for medication and agitation [28].
- Diversity of Plants. The color, smell, and texture of plants can enhance patients' experiences in nature. The smell, for example, can access memory areas of the brain, creating a stress-relieving therapeutic environment [55]
- Farming Activities. In the case of the Village Langley (Case Study 4), users have the opportunity to participate in farming activities, such as gardening, and to interact with animals, which can promote independence and support a sense of identity.
- Home-like atmosphere. Both examples of villages highlight the importance of de-institutionalized care and a more person-centered philosophy. In this context, it is important to highlight the role of healthy indoor acoustics in ensuring positive psychological and physiological effects [56,57]. Studies show the importance of the indoor acoustic environment with characteristics, such as attachment, privacy, autonomy, and controllability [58].
- Natural Materials. In the Alzheimer's Day Care (Case Study 3), the wood was used to convey a sense of spatial warmth and a friendly environment.
- Color differentiation. To improve navigational signage and help differentiate the building's functional areas, contrasting colors and textures are recommended.
- Exposure to Daylight. The presence of large windows in common places and individual windows in the room connects the facility with the natural surroundings. People with dementia often have sleep disorders, and exposure to natural light during the day may improve their sleep patterns. In addition, it affects the circadian rhythm, reduces agitation and anxiety, and improves safety, orientation, and cognitive stimulation [14]. On the other hand, the lack of daylight causes sleep disturbance, mood shifts, and depression [59]. However, to prevent glare, it is necessary to avoid excessive daylight or high-illuminance lighting [60].
- Natural Ventilation for Thermal Comfort. It can prevent falls, as falls are more common in Alzheimer's patients who are too cold or when condensation forms on surfaces due to poor ventilation. In addition, avoid hypothermia and hyperthermia [14]. For thermal comfort, it is important to consider the season, since depending on the natural weather, buildings require different heating, ventilation, and air conditioning. Beyond gender, men and women have different criteria for thermal satisfaction [61].

Moreover, secure outdoor gardens and direct access to nature are spatial strategies that support autonomy, reduce agitation, and accommodate wandering behaviors among dementia residents. In addition, the dementia villages consistently adopted residential-scale models rather than institutional ones, reinforcing emotional familiarity among residents with dementia.

Among the "Nature of the Space" patterns, Prospect and Refuge were the most consistently integrated. These patterns support orientation, environmental legibility, and emotional security, all of which are important in dementia care settings. The Mystery pattern should be applied in a controlled manner within dementia care environments. Moderate spatial sequencing, gradual transitions, or curved paths may encourage curiosity

and movement. However, they cannot generate disorientation. Unlike in other architectural uses, dementia care environments require minimizing Risk/Peril patterns to prioritize comfort and safety.

5. Results

When analyzing the characteristics of Biophilic Design with strategies for dementia-friendly facilities, these principles complement each other. In this way, a framework can be developed to connect design strategies for dementia environments with biophilic patterns (Table 6). Some biophilic design patterns can be applied to multiple dementia-friendly designs.

Table 6. Biophilic Design Framework for Dementia Care Environments.

Dementia-Friendly Design	Biophilic Design Patterns	Architectural Strategy
Wayfinding and orientation	• Visual Connection with Nature • Prospect	It should be important to create clear visuals of space with open outdoor areas to achieve spatial legibility, intuitive navigation, and safe dislocation. For example, integrate courtyards with well-defined paths and with opportunities for activities and social interaction.
Environmental Cues	• Visual Connection with Nature	It should be important to create points of interest. For example, integrate natural landmarks such as trees, fountains, and small gardens within the facility.
Safety and accessibility	• Prospect	In outdoor areas, gardens should be designed to provide good visibility and safe, comfortable paths for patients to engage in outdoor activities.
Environmental Comfort	• Thermal & Airflow Variability	Natural ventilation can be acquired through operable windows. Moreover, the integration of courtyards and semi-open transitional spaces can create cross ventilation.
Appropriate Sensory Environmental Stimulation	• Non-Visual Connection with Nature • Non-Rhythmic Sensory Stimuli • Presence of Water	Garden with a variety of plants that have pleasant scents, such as jasmine, lavender, and other pleasant scents. Moreover, with attractive colors and tactile plants. With special care when choosing plants native to the country, which can bring familiarity; Water features that let users see, hear, and feel the water, such as small fountains along the facility, can become focal points for wandering patients.
Human scale	• Refuge	Care units of appropriate size, where patients can feel safe, and that provide spaces for individual and group activities. It can be spaces for meditation, reading, and interaction between them.
Home-like atmosphere	• Refuge	The spaces need to make users feel protected, sheltered, and emotionally secure. This can be achieved through familiar materials and furniture, and residential spatial organization that creates private and collective spaces.
Light and Visual Contrast	• Dynamic & Diffuse Light	Natural light from large windows, skylight, and connections to courtyards, combined with artificial lighting, makes it possible to perceive changes throughout the day and to move around the space confidently and safely.
Mixed functional program	• Connection with Natural Systems	It is important to create spaces for gardening, farming, handcrafting with natural materials, and other activities that foster a connection with nature.
Access to large outdoor areas with vegetation	• Visual Connection with Nature • Prospect	The project's location is extremely important for creating an environment that provides access to outdoor areas. A location with existing natural settings can be helpful for developing the concepts of biophilic design.

5.1. Application of Results

To demonstrate the results, a conceptual design was developed, integrating dementia-friendly design characteristics and biophilic design concepts.

5.1.1. Location

The location was chosen to be inside Seoul. Other options were considered as well, but some selection criteria included the presence of nature and a more distant urban location, where the green space would be an extension of the building. Therefore, the chosen location was the North Seoul Dream Forest (Figures 5 and 6), a space that attracts visitors to appreciate its natural features. North Seoul Dream Forest is a massive park with a 680,000-square-meter green space, surrounded by six districts, and is the third-largest park in Seoul. In addition, it is a complex space where nature and culture harmoniously blend. The Dream Forest Art Center presents cultural and artistic performances, exhibition halls, and an observation tower [62].

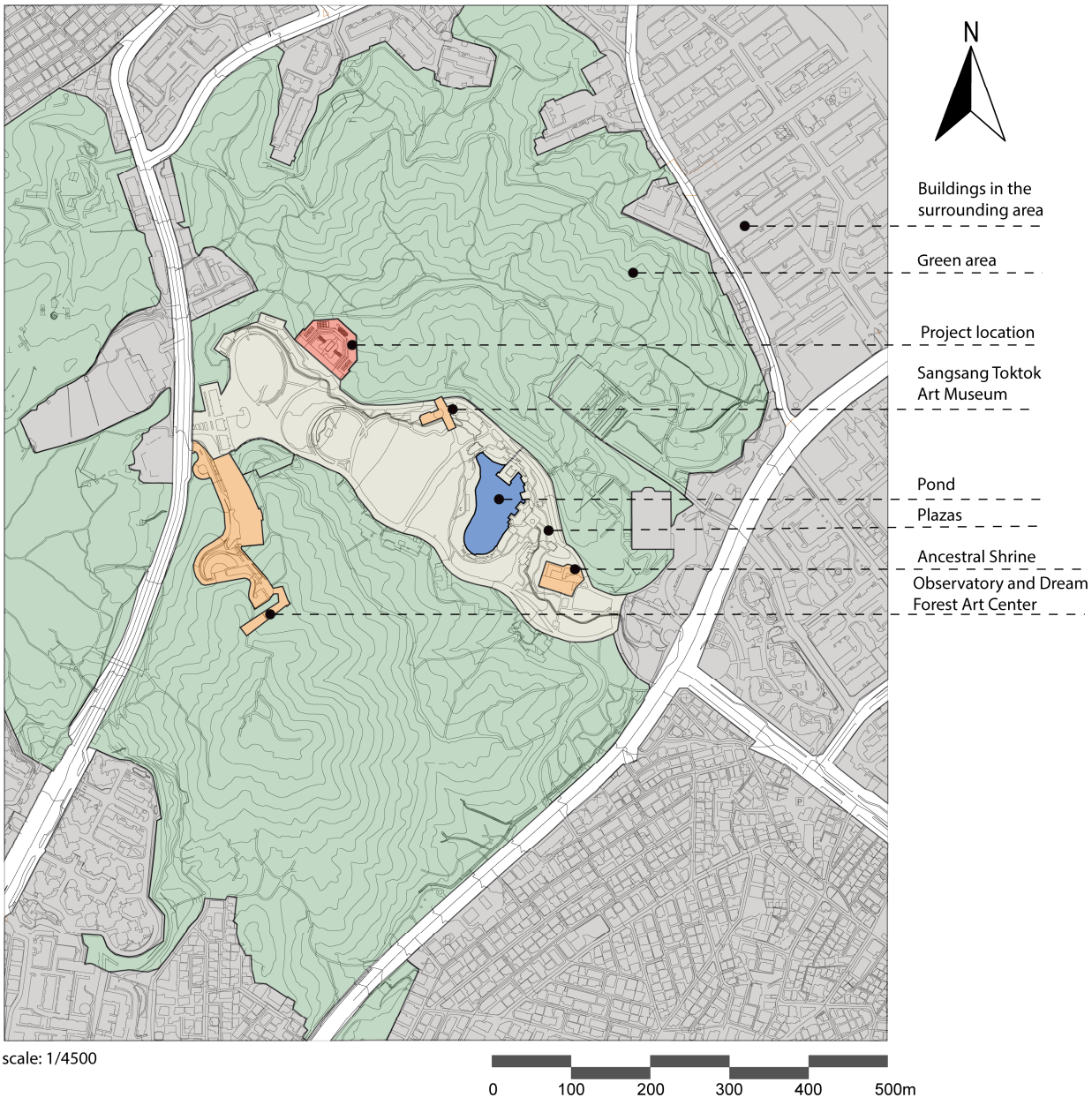


Figure 5. Site Plan North Seoul Dream Forest.

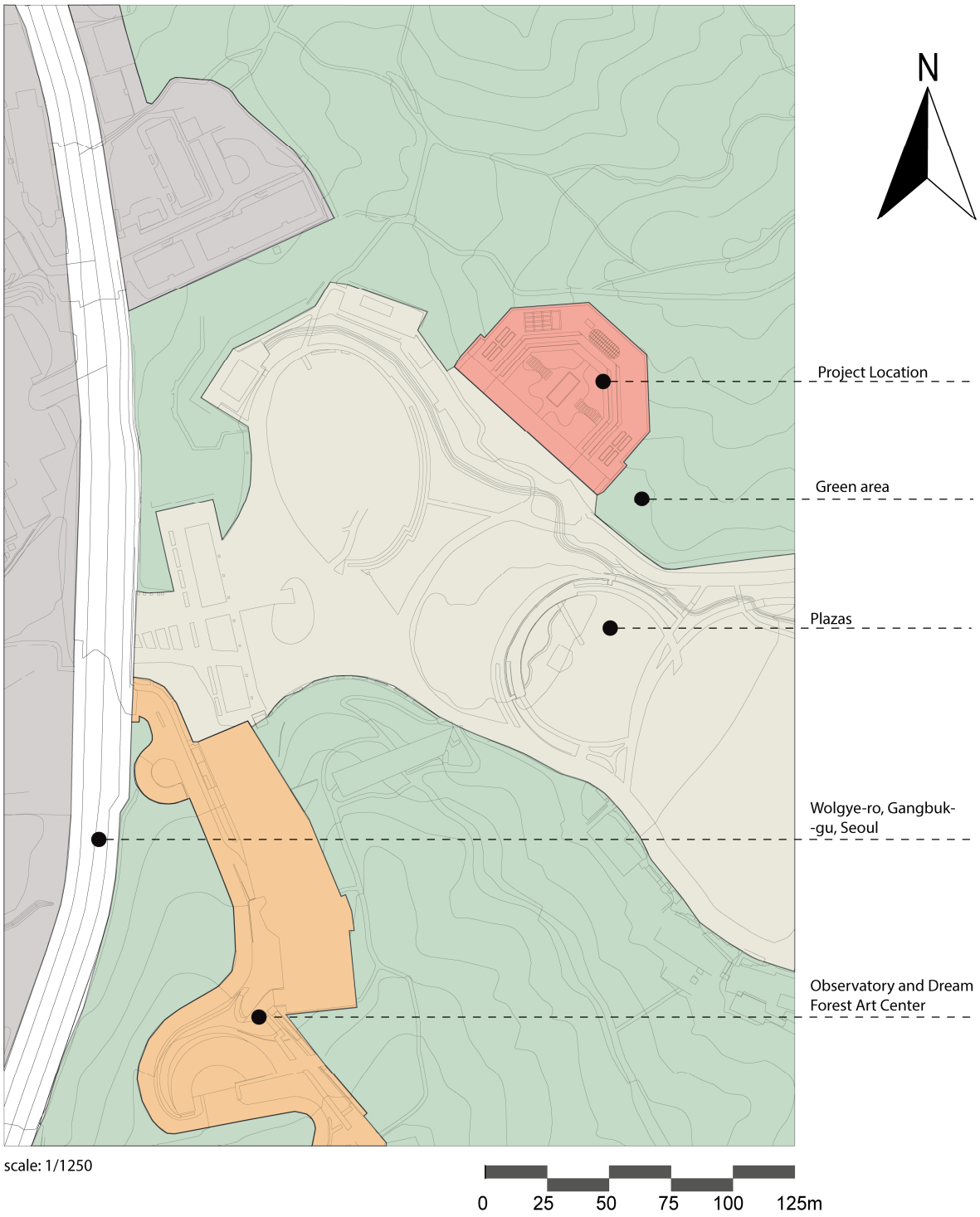


Figure 6. Site Plan Project Location.

The selection of the site within a park was based on the benefits that green spaces can provide to the elderly. Urban green spaces are one way to promote social integration and interaction, as well as outdoor recreation. It can be a significant environment for supporting the well-being of older people and healthy aging by enhancing opportunities to strengthen their physical and mental well-being, helping seniors relieve stress, reduce loneliness, and address depression. In this way, good social relations can have a positive effect; on the other hand, social isolation can limit the quality of life of older people and be detrimental to their physical and mental health [63–65]. Moreover, Ganbuk-gu is classified as an area

with a high concentration of elderly people [66]. Since the cases of dementia increase with age, it is an important location that can help support the elderly population living there.

In conclusion, the criteria for selecting the site were location within the Seoul metropolitan area and a more distant place that provides access to diverse natural features. The park's importance as a public space frequented by a variety of users, which promotes more chances of interaction, its diversity of uses, and its concentration of the elderly population.

5.1.2. Design and Program

One of the design's intentions was to demonstrate that tradition and contemporaneity may coexist. Since the project is located in South Korea, it was important to incorporate traditional architectural features familiar to older adults and to strengthen the connection between the architecture and its users. The hanok is representative of Korean architecture, and some of its fundamental principles served as inspiration.

First, hanok is a living space where nature coexists in harmony with humanity [67]. Hanok structures are oriented to maximize views, light, and airflow. Gardens, courtyards, and outdoor spaces are considered extensions of interior life [68]. Moreover, the concept of chayeong, a borrowed scenery that embodies an aesthetic that respects the inherent landscape and subtly invites inward [69]. These concepts align with the principles of biophilic design, which integrate nature into the built environment, and can lead to positive outcomes for patients with dementia.

In addition, hanok has a dual nature of communal openness and private intimacy, and it also embraces simplicity and natural materials, such as wood [70]. Regarding usage, the facility offers private areas, including rooms with a total capacity of 25 patients. And common areas, such as courtyards, a rooftop with a barbecue area, internal and external gardens, and spaces for group activities, such as painting, crafting, a library, a living room, and a music room. In this way, users can have their own personal spaces while still having opportunities to interact with others. The overall architecture is simple, with wood added to the ramps, simple materials, white walls, and concrete, and transparency through the large windows.

The ground floor (Figure 7) houses most public-use spaces, while the 2nd floor (Figure 8) is reserved for private use. At the same time, it has connections to balconies for all patients' use. The 3rd floor (Figure 9) is split, with half for private use and the other for common use. The ramps connect to the balconies outside, and the rooftop (Figure 10) is also open to the public. Additionally, outdoor areas and rest areas within the buildings are furnished to allow patients to use them comfortably. The ramps outside are well-defined pathways leading to the rooftop; therefore, users can use them to circulate in the outdoor area (Figures 11 and 12).

The ground floor is specifically designed for group activities; therefore, it is a communal space with some important elements. All the circulation has a visual connection with the exterior, where the courtyard is located. It has several environmental cues to help users to orient in space, such as the small gardens within the facility, the trees outside, and a water feature (Figures 13 and 14). It is important to highlight the presence of furniture both indoors and outdoors; in this way, users can use this space to rest or interact with each other. The pathway in the courtyard is well-defined and does not have significant variations. And the restaurant's interior has a visual connection to the exterior.

The 1st and 2nd floors are more private areas with individual units, and the addition of a library on the second floor creates a shared space for the residents. These floors have access to the balconies connected by ramps, which provide another way to experience the facility and maintain a visual connection with the outdoor space.

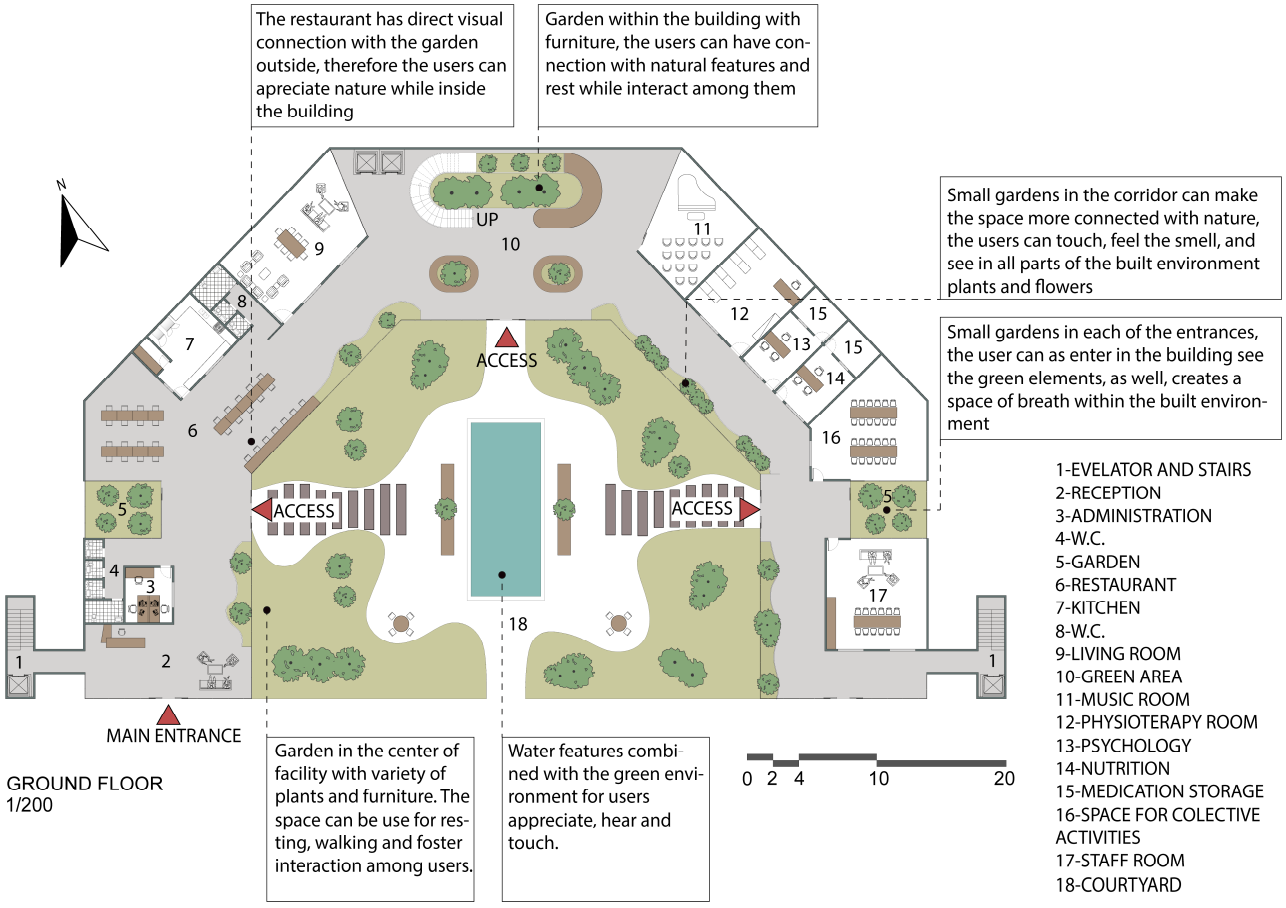


Figure 7. Ground Floor Plan with indication of uses and biophilic design strategies applied indoors and outdoors.

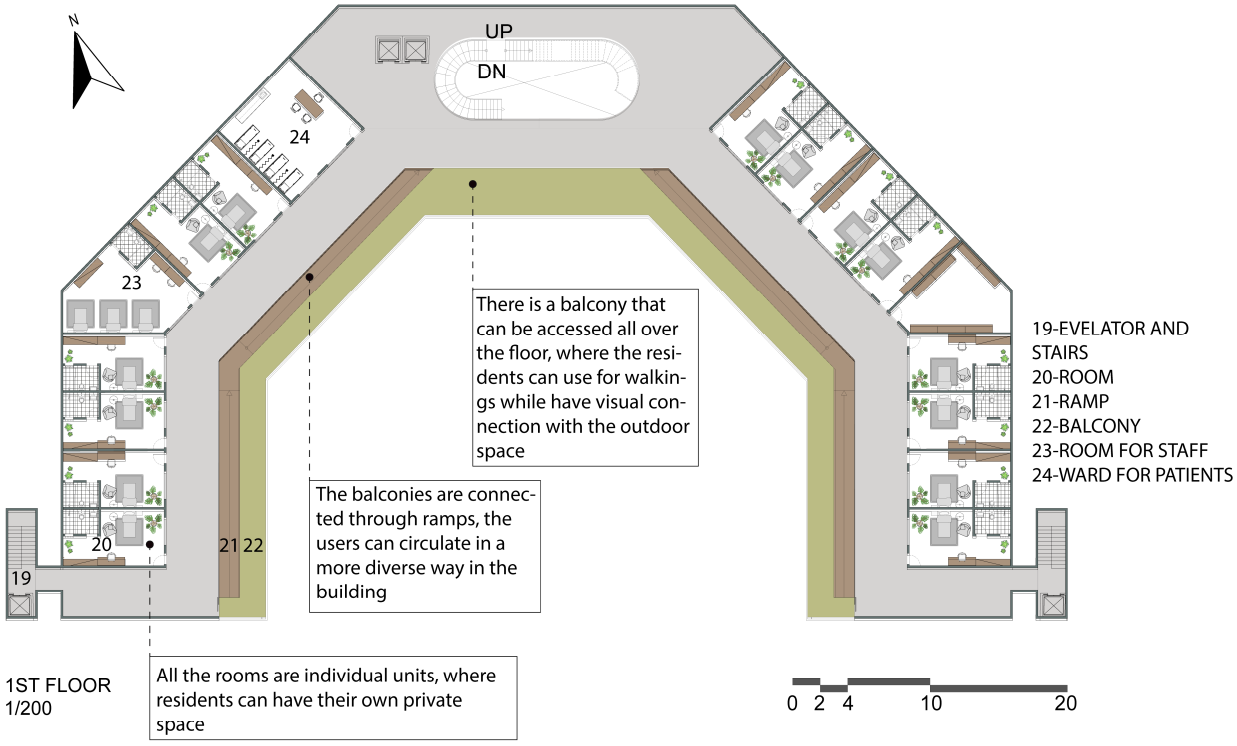


Figure 8. First Floor Plan with room distribution and explanations of the balcony and ramps.

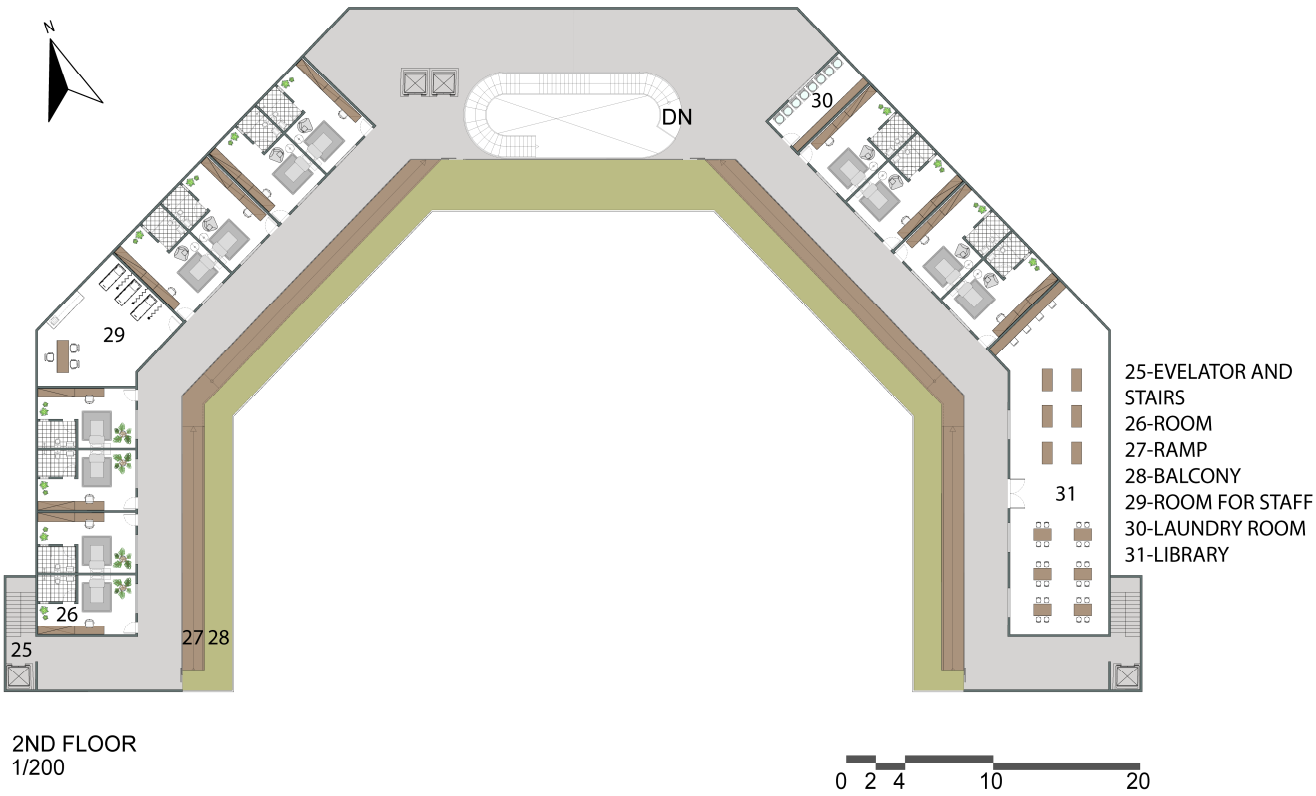


Figure 9. Second Floor Plan with use indications.

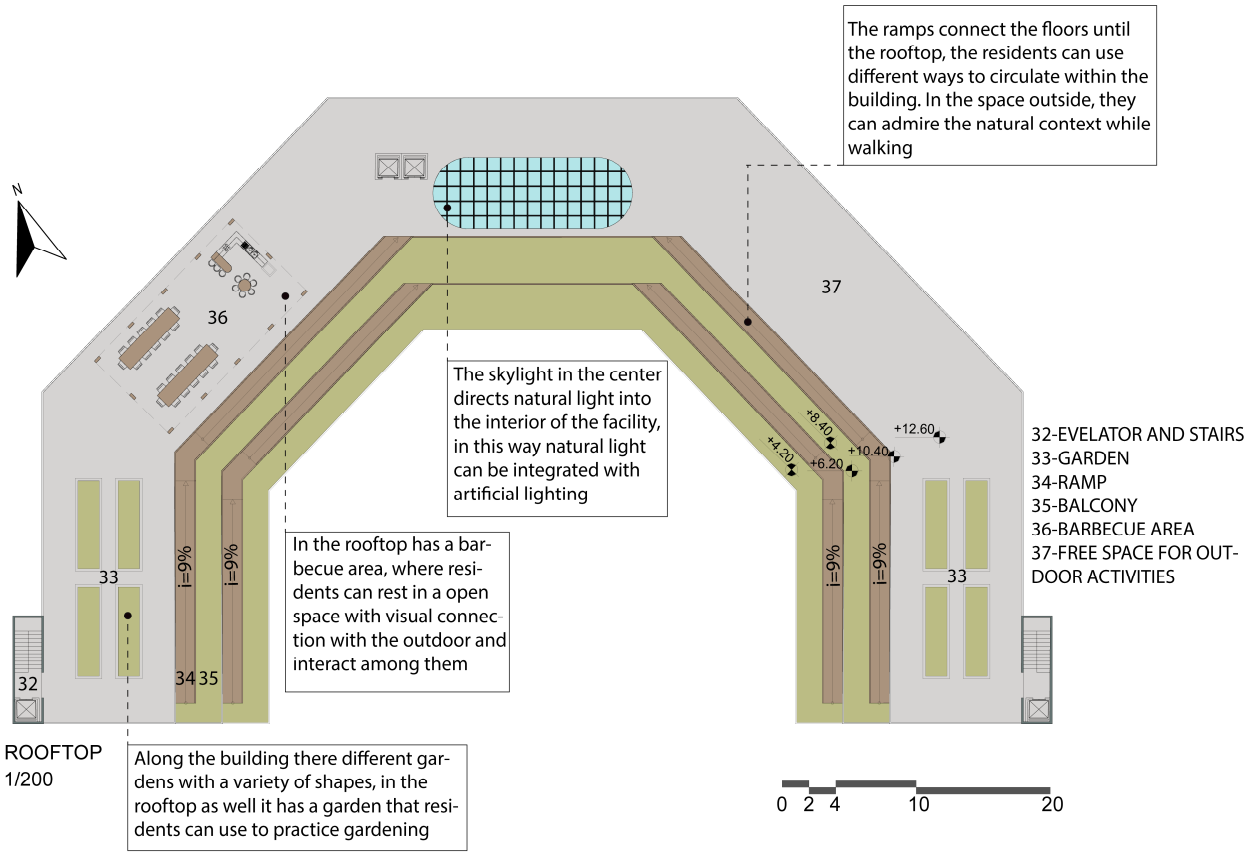


Figure 10. Rooftop with indication of the skylight, barbecue area, and gardens.

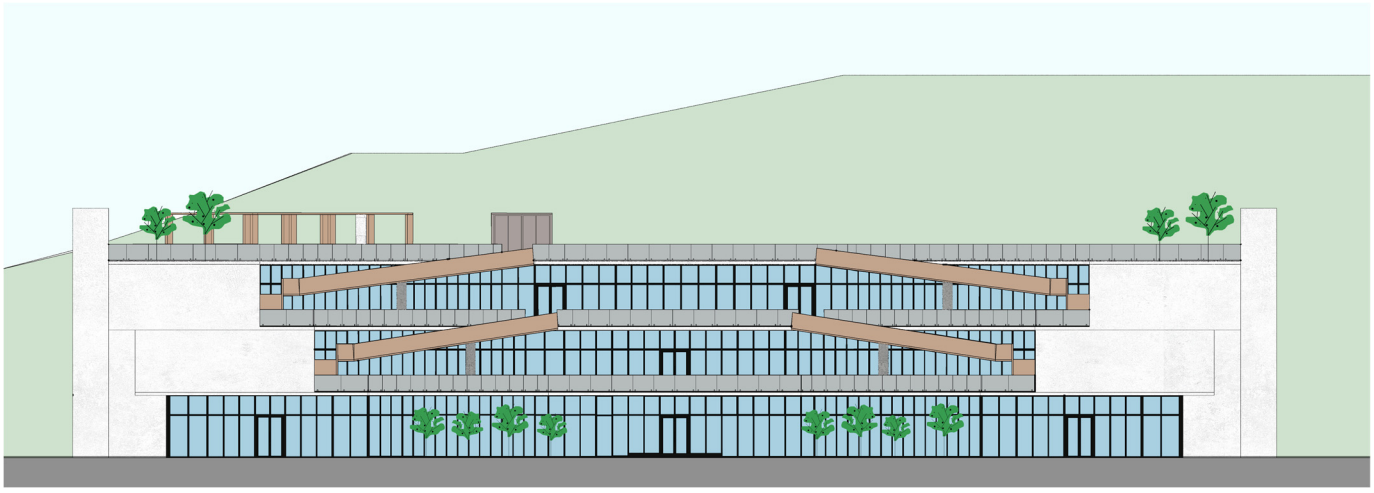


Figure 11. Elevation with the representation of ramps connecting the floors.



Figure 12. Facade and Courtyard.

The rooftop was also used to create garden spaces for gardening practice and a communal area for barbecues and outdoor activities, such as meditation, painting, and yoga, among other uses.

In the proposed design, the main facade faces south. In Korea, the south-facing orientation is preferable for sunlight and daylight considerations, to maximize winter solar gain and minimize summer heat [71].

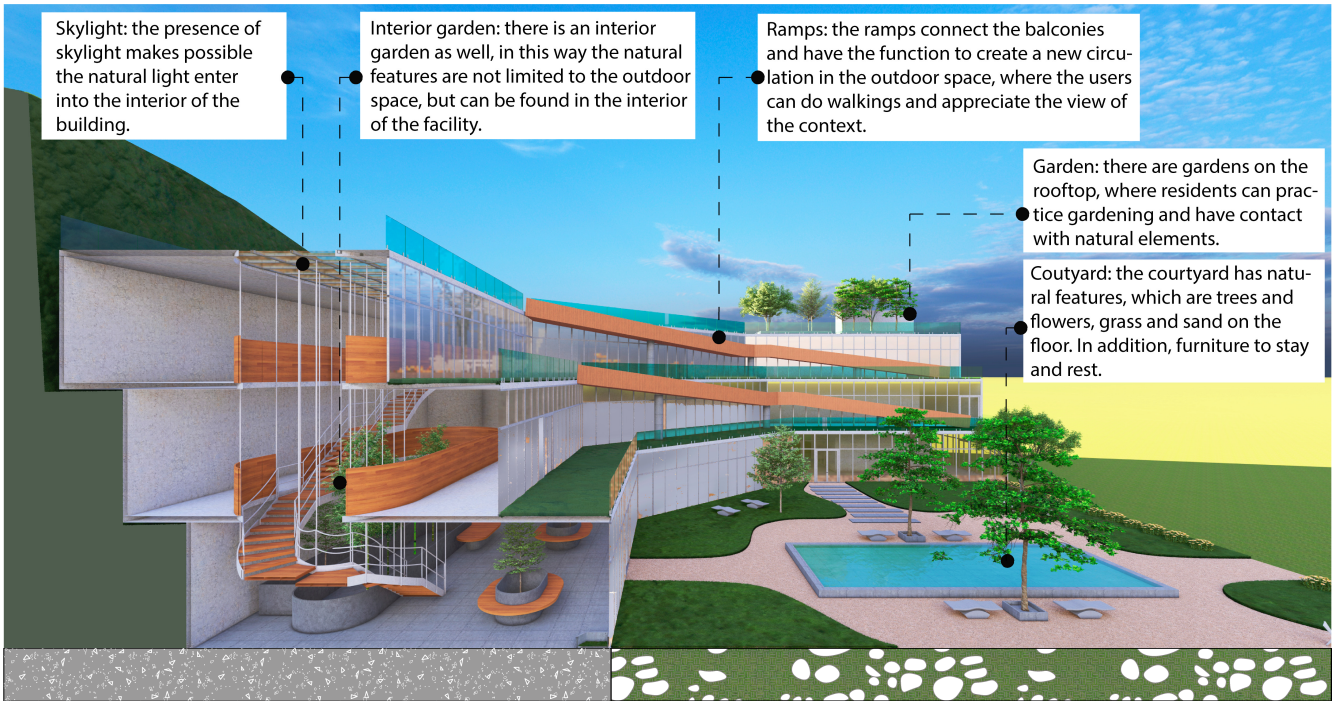


Figure 13. Building Section with explanations about indoor and outdoor spaces.



Figure 14. Rooftop and Ramps.

6. Discussion

With the estimated increase to 15.9% (3.2 million) of elderly individuals with dementia by 2050 in South Korea, the need for more patient facilities has become essential. This study demonstrates that biophilic design holds significant potential to enhance dementia care environments and provide positive outcomes for users. In the Korean context, actions to support patients with dementia have been taken; however, serious questions remain.

Community awareness of dementia, especially among younger people, can help increase the number of medical personnel and improve intergenerational communication in South Korea.

The analysis of the case studies demonstrates that biophilic design in dementia care environments cannot be merely understood as an aesthetic function, but rather as a strategy that helps with therapeutic positive results in areas such as spatial orientation, sensory engagement, reducing agitation, regulating sleep patterns, among other outcomes for the elderly with dementia and cognitive impairment. Among the case studies, a consistent integration of nature can be identified that emphasizes familiarity, autonomy, and emotional comfort.

The findings showed that certain biophilic patterns are more consistent and effective than others when adapted to dementia care environments. In particular, for "Nature of the Space", Prospect and Refuge are relevant to improve spatial conditions. Open visual connections and clear environmental visibility are important for wayfinding, spatial legibility, and reducing disorientation. In the same way, residential-scale spaces, covered areas, and a domestic atmosphere are associated with Refuge, creating an emotionally protective environment with a sense of safety and familiarity.

Multisensory connections with nature through gardens, vegetation, natural materials, daylight, tactile surfaces, and opportunities to experience the outdoor environment contribute not only to sensory stimulation but also to comfort, safety, and memory recall. Another finding is that dementia care architecture requires a more controlled application of biophilic design. The pattern of Mystery, if applied, should be moderate, with gentle transitions that encourage exploration without danger. On the other hand, Risk/Peril should be avoided for safety concerns. Therefore, dementia care environments should prioritize emotional security over excessive environmental stimulation.

The research also draws attention to the importance of cultural familiarity in dementia care environments. Incorporating principles from traditional Korean hanok architecture strengthens cultural familiarity. This approach also reinforces the connection between people, architecture, and landscape. This indicates that biophilic design should not only follow universal healthcare design standards but also incorporate cultural characteristics to reinforce identity continuity.

The developed framework exemplified the connection between dementia-friendly architecture, biophilic design patterns, and corresponding architectural strategies. This research contributes by proposing a dementia correlated reinterpretation of biophilic design principles. Therefore, it offers theoretical and practical contributions through the conceptual design for dementia care facilities in South Korea and other aging societies.

7. Future Research Directions

Although this research is limited, future research could build on the knowledge presented in this paper to address several topics. For example, it could analyze life-cycle costs for dementia care facilities, post-occupancy costs for biophilic dementia care facilities, and post-occupancy evaluations focusing on staff workload and resident well-being, through built case studies or simulation-based methods. Life-cycle cost analysis and maintenance assessments could provide quantitative estimates of the long-term benefits of biophilic design strategies. Post-occupancy evaluations involving residents, residents' families, caregivers, and facility managers would clarify how biophilic environments influence staff work experience and operational efficiency, as well as the effects of the natural environment on patients. In the Korean context, comparative studies of public and private dementia care facilities could inform policies to develop economically sustainable biophilic healthcare architecture.

Author Contributions: Conceptualization, K.V.D.O.M. and J.P.; Methodology, K.V.D.O.M. and J.P.; Investigation, K.V.D.O.M.; Writing—original draft, K.V.D.O.M.; Writing—review & editing, K.V.D.O.M. and J.P.; Visualization, K.V.D.O.M.; Supervision, J.P. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Data Availability Statement: The original contributions presented in this study are included in the article. Further inquiries can be directed to the corresponding author.

Acknowledgments: The authors would like to thank the members of Humans, Environment and Architectural Lab (HEAL) at Ewha Womans University for providing research advice during various stages of the paper.

Conflicts of Interest: The authors declare no conflict of interest.

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