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RESTORATIVE DESIGN APPROACHES IN ASSISTED LIVING FACILITIES FOR ELDERS: REVISITING BIOPHILIA HYPOTHESIS AND UNIVERSAL DESIGN PRINCIPLES

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Gülşah DOĞAN KARAMAN

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ETHICAL STATEMENT

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Gülşah DOĞAN KARAMAN

26/05/2021

RESTORATIVE DESIGN APPROACHES IN ASSISTED LIVING FACILITIES FOR ELDERLY PEOPLE: REVISITING BIOPHILIA HYPOTHESIS AND UNIVERSAL DESIGN PRINCIPLES

(M Sc. Thesis)

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ABSTRACT

Due to the changing family structure and needs, alternative accommodation and living options have emerged for the elderly. One of these options is assisted living facilities, which were remembered with adverse conditions in the past. This study focuses on the potential of assisted living facilities to create environments that will positively affect the elders' wellbeing and provide an accessible and comfortable place. For this purpose, the thesis aimed to prepare a restorative assisted living facility design guide by evaluating the biophilic design inspired by nature with its effects on human health and the universal design that will provide equal access and living conditions. The research has determined a knowledge gap in the literature in transferring the biophilic and universal design from theory to practice. For this reason, up-to-date green building rating tools (GBRTs), inspired by nature and aiming for a sustainable environment, were examined, and three examples of green building standards were selected that address biophilic and universal design. The credits of the certificates related to biophilic and universal design and the related requirements are compiled with the thesis. A total of six case studies of assisted living facility projects, three of which received the green building certificates, and the other three with biophilic and universal parameters, which are qualified and awarded, were selected. These reviews discussed the provision of biophilic and universal design in assisted living facilities and how they can be achieved with images and explanations. In the light of the examined case studies and green building certificates, how each biophilic and universal design parameter will be applied to assisted living facilities is explained in the evaluation of findings section. A design guideline for assisted living facilities was created within the scope of the results and sample projects. These findings will enable assisted living facilities to be designed in the future to create a restorative potential on behalf of the users. In addition, the thesis is potential research for biophilic and universal design criteria in green building certificates created in Turkey.

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YAŞLILAR İÇİN HUZUREVLERİNDE RESTORATİF TASARIM YAKLAŞIMLARI: BİYOFİLİK TASARIM VE EVRENSEL TASARIM PRENSİPLERİ ÇERÇEVESİNDE HUZUREVLERİNİN DEĞERLENDİRİLMESİ

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ÖZET

Değişen aile yapısı ve ihtiyaçlar sebebiyle günümüzde yaşlılar için geçmişe göre alternatif barınma ve yaşam seçenekleri oluşmuştur. Bu seçeneklerden biri de geçmişte olumsuz koşullar ile anılsa da günümüzde olumlu örnekler bulunduran huzurevleridir. Bu çalışma, huzurevlerinin yaşlılara erişilebilir ve konforlu bir alan sunmaya ek olarak, sağlıklarını olumlu etkileyecek ortamlar yaratma potansiyelini konu almaktadır. Bu amaçla, insan sağlığı üzerindeki etkileri ile doğadan ilham alan biyofilik tasarım ve yaşlılara eşit erişim ve yaşam koşulları sağlayacak olan evrensel tasarımın birlikte değerlendirilmesiyle yaşlılar için restoratif bir huzurevi tasarım kılavuzu hazırlanmak istenmiştir. Araştırmada, biyofilik ve evrensel tasarımın teoriden pratiğe aktarılmasında literatürde bilgi açığı olduğu tespit edilmiştir. Bu sebeple, doğadan ilham alıp sürdürülebilir bir çevreyi amaçlayan güncel yeşil bina sertifika sistemleri incelenmiş, biyofilik ve evrensel tasarıma değinen ve yeşil bina sertifikalı üç sertifika örneği seçilmiştir. Bu sertifikaların biyofilik ve evrensel tasarımla bağlantılı kriterleri ve bu kriterleri sağlama koşulları tablolar halinde bir araya getirilmiştir. Üçü yeşil bina sertifikalarını almış olan, diğer üçü ise biyofilik ve evrensel parametreleri taşıyan, ödül almış, nitelikli olmak üzere toplamda altı örnek huzurevi projesi incelenmiştir. Bu incelemeler, biyofilik ve evrensel tasarımın huzurevlerinde sağlanma durumu ve nasıl sağlanabildiğini görseller ve açıklamalarla ele almıştır. Bulguların değerlendirilmesi bölümünde, incelenen huzurevleri ve yeşil bina sertifikaları ışığında, her bir biyofilik ve evrensel tasarım parametresinin, huzurevlerine nasıl uygulanacağı aktarılmıştır. Çıkan sonuçlar ve örnek projeler kapsamında huzurevleri için bir tasarım yönergesi oluşturulmuştur. Bu bulgular ileride tasarlanacak ya da tadilat edilecek huzurevlerinin restoratif bir potansiyel oluşturmalarına imkan sağlayacaktır. Ayrıca araştırma, gelecekte Türkiye'de oluşturulan yeşil bina sertifikalarındaki biyofilik ve evrensel tasarım kriterleri için bir potansiyel araştırma niteliğindedir.

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SYMBOLS AND ABBREVIATIONS

In this study, the used symbols and abbreviations are explained below.

Symbols	**Definition**
%	Percentage
ºC	Celsius Degree
%	Percentage
CO_2	Carbon Dioxide
kWh	KiloWatt Hour
<	Less than
>	Greater than
cm	Centimeter
m	Meter
m²	Meter square

Abbreviation	**Definition**
ABA	Architectural Barriers Act
ADA	Americans Disabilities Act
ART	Attention Restoration Theory
DGA	Departmental Gross Area
et al.	and others
etc.	et cetera
e.g.	for example
GBRT	Green Building Rating Systems
HFR	Halogenated Flame Retardants
HVAC	Heating, Ventilation and Air-conditioning
IWBI	International Well Building Institute
LBC	Living Building Challenge

Abbreviation	Definition
LEED	Leadership in Energy and Environmental Design
ppm	parts per million
SRT	Stress Reduction Theory
UD	Universal Design
UGR	Unified Glare Rating

1. INTRODUCTION

Socio-economic developments and raised living standards introduce living longer than before in developed and even developing countries, and the researches reveal that the lifespan of people is increasing over 75 years (Crews & Zavotka, 2006). The long lifespan increases the population of elderly and disabled people (Afacan & Erbug, 2009). Changes in the family structures, the busy pace of family members, and children's working and living opportunities in different cities or even countries than their parents have caused the elders' accommodation problems. Older adults started to choose to stay in the assisted living facilities to provide their care, live a more comfortable life, be more socially active, spend more time with their peers, be healthy, or protect their health.

The accommodation places for elders as care homes or assisted living facilities were considered physical care facilities that do not increase their occupants' living standards before the 1970s; however, they turn into potential restorative care places (Rejeski & Brawley, 2006). The study aims to create a restorative design approach that is comfortable, accessible for the elderly, prevents health problems, and helps the existing diseases heal. In light of the stated information, the thesis is started with how to follow the design of buildings that can solve the accommodation problems of the elderly and support the residents' wellbeing and support physical differences depending on congenital and age-related differences. Based on the restorative effects of nature on humans, biophilic design has been researched; and the proven physical, psychological and sociological positive effects of the biophilic design are explained in the literature review section. During the research process of biophilic design examples, there are studies on hospitals and childcare centers. However, in examining the biophilic perspective in elderly care centers, it was found to be incomplete in the literature.

If the healing power of a place is to be mentioned, it is necessary to make sure that the basic requirements of the design are met first, as in Maslow's bottom triangle, the place is used without any difficulty and without separating the users for the primary access, perception or usage issues. There will inevitably be physical differences in the places designed for the elderly depending on age or congenital. For this reason, compliance with universal design principles, which aim to provide equal opportunities to all users without discriminating against anyone, is a design method that provides solution suggestions in this regard. It is

inevitable to meet the primary physical space and usage needs of the elderly in their living environment. In the assisted living facilities, physical needs vary depending on age, and it becomes inevitable to consider the diversity in the use of spaces. It has been determined that biophilic design and universal design should be evaluated for a restorative design approach for the elderly.

Biophilic design argues that human beings and nature are inextricably linked. There are three biophilic design attributes identified and investigated in the literature section. The concept and general approach of the biophilic design attribute proposed by S. R. Kellert, Heerwagen, and Mador (2008) are explanatory; however, the testing qualities have difficulty transfer determined in its reflection from theory to practice. Five principles of biophilic design proposed by Hildebrand (2008) has an essential place in expressing and shaping the biophilic design, but later on, 14 patterns of the proposed biophilic design were added on top of this approach, making it more comprehensive. Nonetheless, among the examined biophilic design attributes, 14 patterns of the biophilic design proposed by Browning, Ryan, and Clancy (2014) were the most appropriate in transferring from theory to practice.

The literature section determined that the seven parameters of universal design were determined by Mace et al. and did not have sufficient architecture scope. In addition, during the literature review, it was determined that there is open-ended information in the transformation of biophilic design from theory to practice and that there is not enough data in its adaptation to place. It is thought that the determination of the most evident criteria in these areas will be achieved by evaluating the existing green building rating tools that connect nature with biophilic and universal design parameters. For this reason, it was decided to examine the GBRTs in the context of biophilic design and determine the evaluation criteria within the scope of 14 patterns. In selecting green building certificates, certificates that include biophilic design in the current evaluation criteria or refer to biophilic design in pilot credits have been examined. Among the selected certification systems, those certified in assisted living facilities were included in the study. According to the biophilic and universal design parameters, this study has been evaluated within the scope of LEED, WELL, and LBC certificates.

Later, to evaluate it within the scope of biophilic and universal design, assisted living facilities examples from each of these three certification systems were selected. In addition,

three other assisted living facilities that meet biophilic and universal design parameters but do not have certification were selected. A total of six selected facilities were analyzed in tables with biophilic and universal evaluation criteria.

In the fifth section, examining the case studies within the scope of biophilic and universal design criteria were discussed, and the design methods of these parameters that exist in assisted living facilities were determined. In addition, fourteen biophilic and seven universal design parameters in three green building certificates were tabulated individually as parameters, and it was revealed with which requirements each parameter could exist. In this section, biophilic and universal design parameters, which will have a restorative effect on users in assisted living facilities and have positive effects on people physically, physically, and socially, which are supported by research, are examined together with the relevant requirements in green building certificates, and the results obtained from the project examples are included in the findings.

The study aims to shed light on transferring the biophilic design from theory to practice, guide the existing green building certificates in Turkey, and serve as a guidebook for assisted living facilities designs or renovation of existing facilities. Considering the biophilic design and universal design principles, the assisted living facilities promise a living environment that approaches the ideal psychological, psychological and sociologically supportive environment for the elders.

The motivation of the study

The thesis was shaped by empathizing with the elderly who could not connect with families in assisted living facilities during the pandemic period and did not connect with the outside world. When I examined the existing nursing homes and assisted living facilities in Ankara, the city where I live, I found that they are generally located in an apartment layout and do not connect with nature, and some of the structures are not ergonomically suitable for the elderly. Considering that people spend 90% of their time indoors with recent research, the world of elders living in these facilities was built on these places. The question of how to design places that will support the wellbeing of the elderly, connect them with nature in the interior, and positively affect them in psychological, physiological and sociological terms constituted the motivation of the thesis.

Aim of the study

The study aims to bring a suggestion to guide an assisted living facility that supports the elders' well-being, establishes a link between nature and interiors, has positive effects on residents in sociological, physiological, and psychological terms with biophilic design principles. Moreover, the study aims to maintain the elders' daily lives in facilities without access and usage problems from the design and create a proposal for an ideal assisted living facility with universal design parameters that aim to offer equal opportunities for users. For this purpose, in the literature review, biophilic and universal design parameters were promising in theory but lacking practice. The green building rating tools were determined, and the certification requirements that can be applied in the biophilic and universal context in assisted living facilities were analyzed and adapted into the guidebook for a restorative assisted living facility design.

Methodology of the study

Due to the identified lack of transferring the biophilic and universal design from theory to practice in the literature section, green building rating tools (GBRTs), including credits related to biophilic and universal design, have been examined. The GBRTs with certified assisted living examples among those who meet these criteria are evaluated in the thesis. Three selected GBRTs as LEED, WELL, and LBC, and their credits associated with biophilic and universal design parameters were analyzed, and the intersections that occur in this context are tabulated. The assisted living facility examples that received these certificates were examined as case studies with biophilic and universal design criteria, and tables created were supported with visuals from the facilities. In addition, existing or non-existent parameters are determined and interpreted in the table. Three examples of award-winning assisted living facilities without containing these certificates but whose design conforms to universal and biophilic design criteria were also examined. The six case studies of assisted living facilities examined afterward explained how to provide fourteen biophilic design and seven universal design parameters in assisted living facilities from theory to practice. Moreover, the requirements determined in the green building certification system were examined for each parameter, and a design guide for an assisted living facility with a restorative approach was created for users and designers.

Limitations of the study

Since the thesis study was carried out during the pandemic period, the study, which was planned to include the questionnaire to be conducted with the elderly in the nursing homes in Ankara, could not be carried out due to the ban on access to nursing homes and the health concerns of the health and nursing home management. As a sample project, an example of assisted living facilities with a green building in Turkey has been researched, and no example has been found in this area. For this reason, successful projects abroad, which received a green building certificate and did not have an architectural award, were exemplified in the study.

Structure of the study

In the literature review section of the thesis, the restorative design and the theories it is supported by are defined. Afterward, universal design and its even parameters of universal design and universal design have been examined. Later, the biophilic design was defined, the relationship between nature and humans and the positive effects of this relationship on human health were explained. Biophilic design approaches were examined, and fourteen patterns of biophilic design by Brown, Ryan, and Clancy is chosen to apply to the thesis due to the suitability of transferring from theory to practice application.

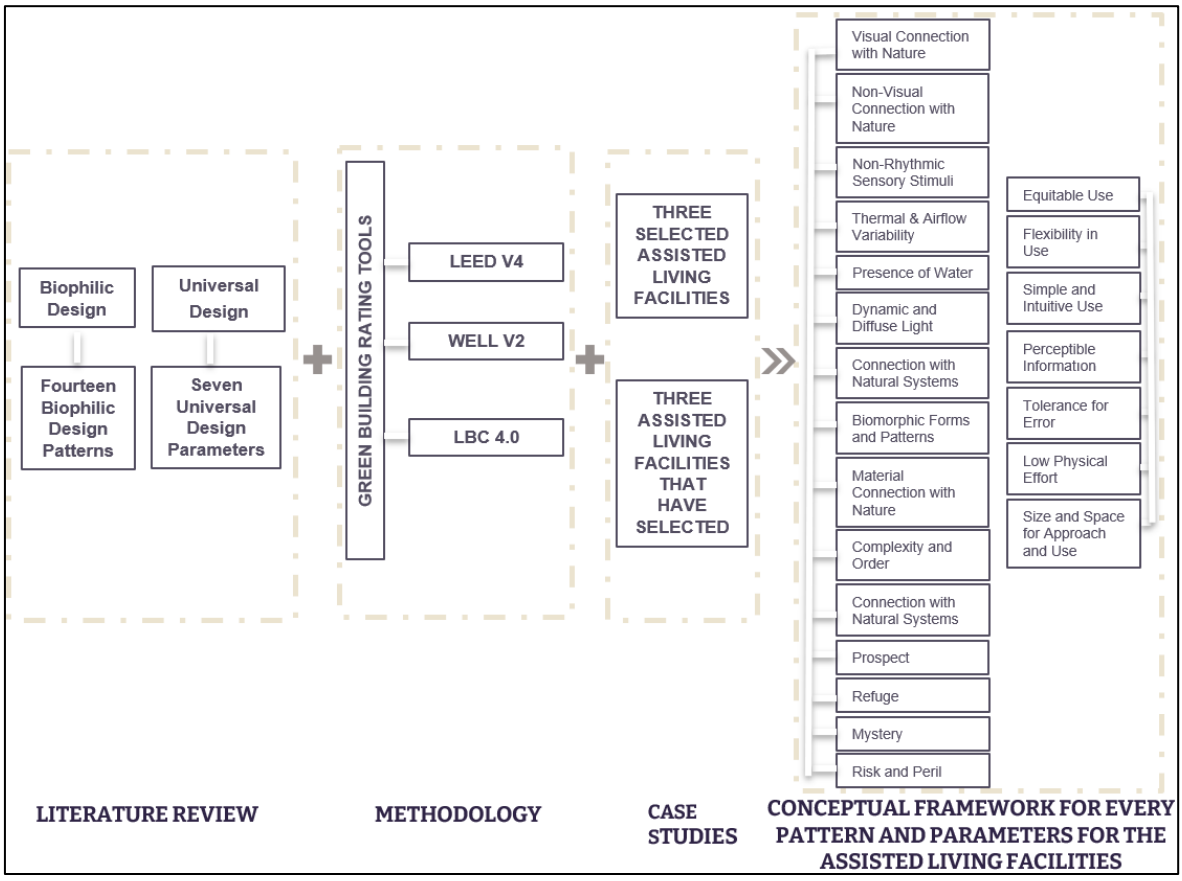
In the material and methodology part of the thesis, the GBRTs were examined, and three rating tools named LEED, WELL, and LBC with credits linked to biophilic and universal design parameters were examined. The samples examined from these certificates have been their most up-to-date versions. In each of these certificates, credits and requirements related to biophilic design and universal design are examined in tables. At the end of the chapter, the parameters certificates meet examined with an evaluation table of the three certificates together.

The fourth section of the thesis examines six assisted living facilities according to the biophilic and universal design parameters. Three case studies from the GBRTs are mentioned in the third section, and three award-winning assisted living facilities with biophilic and universal design parameters were examined. At the end of each assisted living examination, the facility's biophilic and universal design values are presented as a table with

a sample image from each pattern and parameter. At the table, an explanation section prepared explains how these parameters are supported or what kind of deficiencies are found.

In the thesis, the methods of achieving biophilic and universal design in assisted living facilities were determined, and results are prepared as substances due to six case study examinations. In the light of the information obtained from the three GBRTs verified, a separate explanatory table was prepared for each of the 14 parameters of biophilic design, and it was explained with the requirements these parameters would be met. Likewise, for the seven parameters of universal design, the results from these three certificate credits are presented with tables explaining how each parameter will be provided. The thesis is a guide for applying biophilic and universal design in assisted living facilities in transferring specific parameters from theory to practice.

Table 1.1. Thesis framework diagram



2. LITERATURE REVIEW AND THEORETICAL FRAMEWORK

In this section, the concepts of "restorative design," "universal design," and "biophilia" have been explained to constitute the main backbone of the study. They are examined and defined as the first steps of the study, which was initiated to search for the solutions to some architectural problems encountered in assisted living facilities in a solution set at the intersection of universal design criteria and the biophilia hypothesis. These concepts have been searched in the literature and formed a basis for the thesis's field study with the established conceptual framework.

2.1. Restorative Environment Design

Environmental design roots back to the time when people start to build. The basic need of a place is to have a shelter for people with walls and a roof to protect them from simplistic conditions such as rain, wind. The design that provides very primitive needs is called a protective environmental design. Besides the bare necessities, instorative environment design concerns humans' improved needs as easy access opportunities like the presence of water supply in houses and wayfinding techniques. The instorative environments increase the mood of the users without a restoring mission. Natural settings have instorative effects on people who do not have any fatigue responses or high stress levels Hartig, Evans, Jamner, Davis, and Gärling (2003). Healthy and unstressed people benefit from these environments. Different from the other two domains, restorative environments concern more than basic needs and practical ways. It focused on enhancing the physiological and psychological conditions of humans with environmental design settings.

Difficult working conditions, exhausting pace, a stressful work environment, negative situations encountered in daily life, and experienced health problems cause people's physical, social, or psychological functions to decrease. To eliminate this decrease and maintain their capabilities effectively, people need a restoration process. Hartig explains restoration as "the process of renewing, recovering, or re-establishing physical, psychological, and social resources or capabilities diminished in ongoing efforts to meet adaptive demands" (Hartig *et al.*, 2003).

The restoration process is provided by discourses, and a physical environment act as a restorative source. For the Oxford Dictionary (URL-1), one of the meanings of "restorative" is possessing the power to make someone feel healthy and strong. Restoration mentions the mental and functional recovery in specific environments (Van den Berg, Joye, & Koole, 2016). The psychological and physiological well-being of people has an undeniable relationship with physical environments. Records show that people spent %90 of their time in indoor spaces (Klepeis *et al.*, 2001). Due to the vast production, fast consuming society, and exponentially increased number of people, the built environment mainly focuses on profitable short-term solutions that are not centered on extensive human needs. The built environment focused on the basic human needs as protective with walls, roofs, or be instorative with ideal heat, water; however, a properly designed environment has a potential therapeutic effect on people experiencing the environment.

The restorative environment supports a restoration perspective that takes its roots from environmental psychology. There are mainly two theories on the restorative environment within its field, which are Attention Restoration Theory (ART), proposed by Kaplan and Kaplan (1989) and Stress Reduction Theory (SRT) by Ulrich (1993).

2.1.1. Attention Restoration Theory

Attention Restoration Theory (ART) focuses on the connection between natural environments and attention recovery. The theory explains two types of attention, which are voluntary attention and involuntary attention. Voluntary attention requires people to focus their attention on something and block out undesirable stimuli taking mental processes. This mental process needs an effort that leads to mental fatigue (Kaplan, 1995). Directed attention provides the elimination of distraction and focuses on the intended task, which helps to distinguish significant stimuli from insignificant ones (Kaplan, 2001). The tasks require new information to learn, fixing an object, or watching a video. The intense involuntary attention leads to directed attention fatigue. The fatigue of directed attention causes slow responses and nervous, antisocial, offensive attitudes. Involuntary attention is done spontaneously, not need any effort. Patterned, being in motion and exciting things leads to involuntary attention. The attention is gained by stimuli in the environment, such as watching a natural setting, looking at the fire's flow, and listening to a bird's singing.

ART comes from the theory that the fatigue of directed attention capacity leads to mental fatigue. It shows examinations of divergent environments which have raised the directed attention capacity of the human. Moreover, ART recommends frames and conditions that support mental fatigue recovery. Four attributes maintain restorative settings: fascination, being away, compatibility, and extent (Kaplan & Kaplan, 1989).

Fascination attributes explain that fascinating conditions that people find interesting create involuntary attention. The involuntary attention process provides a resting state for fatigued directed attention and presents a restorative environment. The other attribute, 'being away,' means taking away from the regular tasks that list the voluntary attention process. Being away period maintain physically or mentally; the necessary part is moving away from methods that occupy and tire the mind. Taking a walk in nature or focusing on natural stimuli in the built environment provides a psychological escape from everyday thoughts tiring the mind. The third attribute, "compatibility," refers to the need for harmony between the people's tendency, the necessities forced by the environment, and the environmental base to support the intended activities. The last attribute is the 'extent,' referring to adequately generous in a harmonious content environment and sensed as a whole in another world (Kaplan & Kaplan, 1989). It connects the mind to the environment involuntarily and gives comfort to the directed attention, defining an environment with connectedness. A jungle environment is an example of an extent. In attention restoration theory, Kaplan and Kaplan (1989) suggest that the natural environment has a crucial power in restoring directed attention. The natural setting compensates for the four needs of ART.

2.1.2. Stress Reduction Theory

The environmental design aims to provide people a built environment that increases their life quality. On the other hand, the built environment generates stressors intimidated by people's ability to restore mental fatigue and stress (Kopec, 2006). When people's environmental perception is not equal to their adaptation capacity, psychological stress emerges, threatening health (Ulrich, 1986). Stress Reduction Theory brings into focus the reducing effect of natural environments on physiological stress. Unlike ART, Stress Reduction Theory (SRT) cares about reducing stress rather than restoring attention.

In environmental settings, affective responses are not intervened from cognition. It is operated by the unconscious, self-acting, and fast mechanism that people instantly love, hate, like, or dislike. These quick reactions are argued to be established from human adaptation history. The organism prompt to take rapid actions for its survival and wellbeing (Ulrich, 1983). Viewing a nature scene arouses a sensual response quickly, like, dislike, fear, or interest. The person could not prepare his or her judgment consciously. The restoration process declares physiological and emotional parameters like muscle tension, heart rate, and blood pressure in the SRT.

Stress reduction theory and attention restoration theory have different perspectives; however, they support each other in determining the restorative environment parameters. The focus on the restorative environment's stress stems from if people repeatedly encounter burdens, it reverberated as lower physical and physiological health conditions. These results produce the adaptation collapse to the environment. Attention restoration theory focuses on attentional fatigue, and stress reduction theory concentrates on psycho-physiological stress recovery; consequently, both theories propose natural environments' restorative effects on humans (Nilsson *et al*., 2010). With the involvement of the theories, there searched for coping solutions for the faced problems. The theories claim that people cope with high demands with optimal environmental sources (Heerwagen & Gregory, 2008; Wilson, 2008)

Table 2.1 has shown the explored effects of various studies on human wellbeing and nature connections on attention and stress. In parallel with the research on the table, attention restoration and stress reduction theories claim that human health has a strong link with architecture, directing humans' everyday living conditions.

Table 2.1. Nature effect and restorative environments (Söderlund, 2019)

The Subject of Research	The Resulted Profit
The research on the health impact of looking at a landscape (Velarde, Fry, & Tveit, 2007)	Stress recovery Mental fatigue recovery
The effect of a window view inside a room on postoperative recovery (Roger S Ulrich, 1984)	Reduction of stress
The impacts of seeing flowers for the office workers as psychologically and physiologically (Ikei, Komatsu, Song, Himoro, & Miyazaki, 2014)	
In twenty-four different forest, the physiological impact of being in the forest is tested (B. J. Park, Tsunetsugu, Kasetani, Kagawa, & Miyazaki, 2010)	
The effect of green spaces inside the city on reducing the stress level (Tyrväinen et al., 2014)	
The research focusing on the restorative effects of nature and create a unifying framework (S. Kaplan, 1995)	
The connection between stress reduction with architecture and fractals investigated (R. P. Taylor, 2006)	
The viewing impact of urban forests psychologically and physiologically (Tsunetsugu, Miyazaki, & Sato, 2007)	
Recovery time relation with and without flowers in the rooms of patients taken to their rooms after abdominal surgery (S.-H. Park & Mattson, 2008)	
Essay: Evidence-Based Healthcare Architecture (R. Ulrich, 2006)	Reduction of stress and pain
The restorative effects of gardens, determining the restorative effects of natural and mixed built types of scenes (Ivarsson & Hagerhall, 2008)	Attention restoration
The choice and perception effect of using green in residential structures (White & Gatersleben, 2011)	
The cognitive effects of connection with nature (Berman, Jonides, & Kaplan, 2008)	

2.2. Universal Design

In 1985, the universal design was first used in America to appeal to a broader range of people (Mace *et al.*, 1985). Then there are several definitions used for the universal design. Still, in 1991 it was defined again by Mace after years as "the design of products and environments to be usable to the greatest extent possible by people of all ages and abilities. The universal

design respects human diversity and promotes the inclusion of all people in all activities of life" (Mace, 1998). Moreover, there are other definitions as "the process of embedding choice for all people in the things we design" (Salmen, 2011). It means that universal design creates choices for people as alternative approaches and flexibility.

The ratings of disability increase by age, and older peoples' body responses weakened within the years. Thinking the whole process of life while the design process has uttermost importance. All people that shared the same environment must be considered regardless of their age, ability, and body proportion (Null, 2013).

Within the human body's different conditions and functioning, accessibility is crucial for creating similar conditions for various necessities. Considering this issue, a group of scientists decided to determine different human needs to guide accessibility in the space. Accordingly, these experts from multiple fields identified seven principles to provide universal design.

2.2.1. Seven Principles of Universal Design

To guide the designers, in the Center for Universal Design at North Caroline State University, there developed the principles of universal design by a leadership group of design branches as architects, environmental design researchers, engineers, and product designers (1997). The principles are listed as:

i. Equitable Use
ii. Flexibility in Use
iii. Simple and Intuitive Use
iv. Perceptible Information
v. Tolerance for Error
vi. Low Physical Effort
vii. Size and Space for Approach and Use

Equitable Use

The design should be useful for people that have different abilities and do not make any disadvantageous situations. The different functioning of the body from person to person should not affect the user's participation and not stigmatized anyone. The design maintains the exact meaning of security for all the user groups. Entrances that do not have a step through the interior are examples of the equitable use of the space. Also, full-length door handles provide comfortable use for different body scales and heights of people. Pool ramps maintain a comfortable service for children and people that have moving limitations. Figure 2.1. shows the desk that has level differences to allow every user to reach equally.

Figure 2.1. Nurse Station Desk that allows different conditioned users to communicate with ease (Eastman, 2013)

Flexibility in Use

Flexibility in use refers to the design that should assist in a broad span of people's choices and capabilities. Supplying alternative ways and methods for usage is necessary to provide flexibility in the places. Providing grab bars and seating areas in the showers supports flexible usage, as in figure 2.2. Using stairs and ramps allows users to choose the most suitable option for their body condition in places with slope differences. Using railings in necessary environments at two sides of the area assures left and right-handed users an opportunity (Wolfgang & Korydon, 2010).

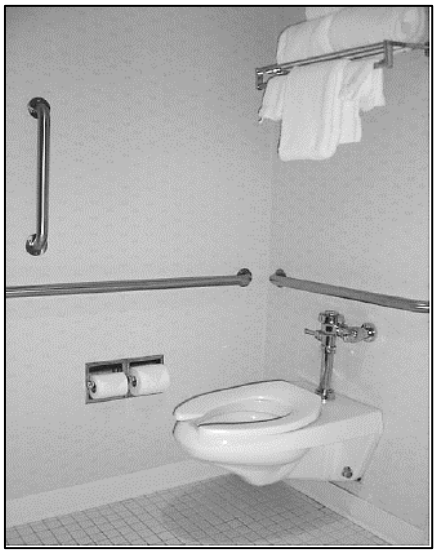


Figure 2.2 Vertical and Horizontal Bars (Wolfgang & Korydon, 2010)

Simple and Intuitive Use

The design should be comfortable and uncomplicated to determine the detriment of the user's familiarity, information, and attention level. Avoiding needless complexity is a vital feature of the principle. Taking feedback before and after the tasks is essential to design accordingly with the pattern. For instance, control switches that allow the user to understand the function at a glance provide a simple and intuitive use. Clear and basic directional signs printed in high contrast provide high intelligibility results. Designing particular parking areas and entrance makes it easy for users to navigate and access the building. Figure 2.3. shows the design that easy to understand and tactile preferences (Wolfgang & Korydon, 2010).

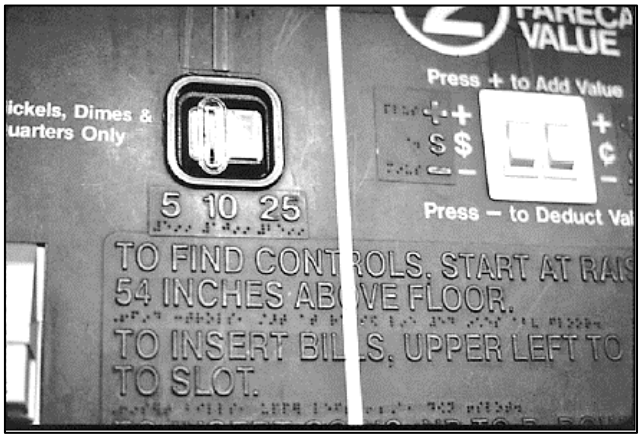


Figure 2.3 Providing different options for users to understand the instructions (Wolfgang & Korydon, 2010)

Perceptible Information

Separate from the people's sensory ability or environmental circumstances, the design corresponds to essential instructions beneficially to the place's user. Operating several methods using variable senses like sight, touch, hear to give the necessary information to the user. Using the contrast between the information and its surroundings easily separates the others' needed information (Wolfgang & Korydon, 2010). Differentiating the spaces with colors, using contrast elements and colors in floor materials (Figure 2.4.), sensory lighting controls, and smoke detectors are examples of perceptible information principles.

Figure 2.4. Using contrast colors in the floor materials create perceptible information (Eastman, 2013)

Error Tolerance

The design decreases the danger and prohibits unexpected situations. The materials' regulation follows vital occurrence, risk, and supply caution for hazardous components and threats. Using firm materials that are nonslip on the floor to prevent falling in the places and using a sprinkler system in the kitchen creates tolerance for errors (Wolfgang & Korydon, 2010). Figure 2.5. shows the safe material choice for the flooring.

Figure 2.5. Using safe material on the floor as carpeting prevents damages balance control problems (Regnier, 2003)

Physical Effort

The design should provide minimum wasted effort, free from constraints, and adequate exhaustion. Permitting the people to keep their body positioned neutral and reduce recurring actions creates sufficient physical effort (Wolfgang & Korydon, 2010). For instance, using remote controls for the doors and windows or easily grasped handles and appropriately planned reaching distances for everyone is exemplary for the principle (Figure 2.6.).

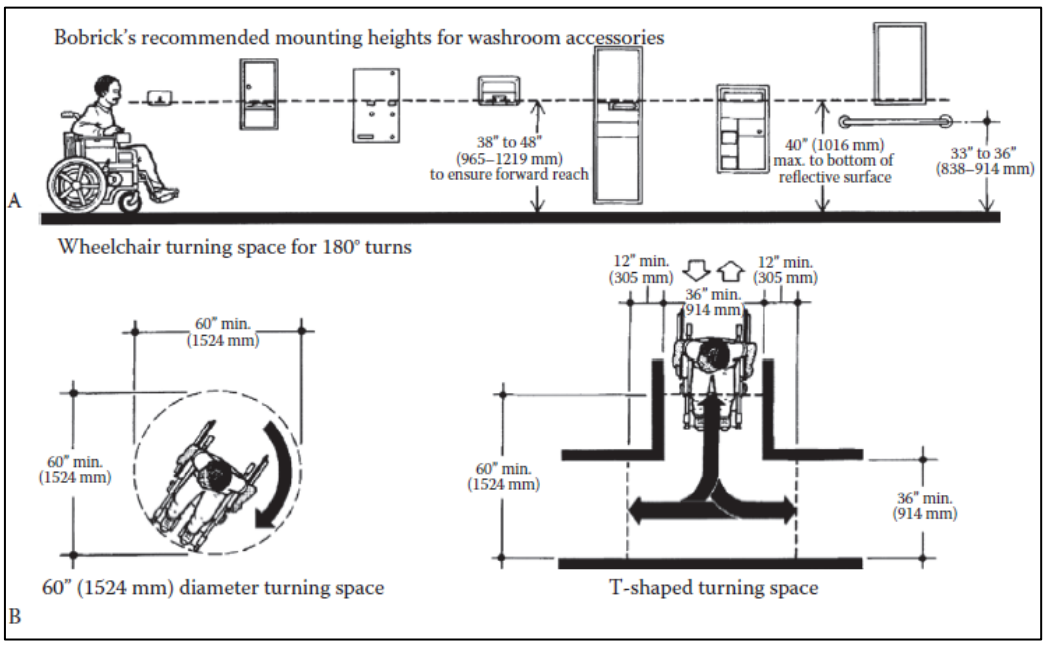


Figure 2.6. The perspective of a wheelchair user and appropriate dimensions (Null, 2013)

Size and Space

Without considering standard physical conditions, posture, and body sizes, enough space and size are provided to the user for access and use (Connell *et al.*, 1997). Supplying optimum sight perspective for the significant elements and providing easy reach options for standing or seating users without discrimination makes enough spaces for assistive devices contribute to equal usage. For the kitchens and bathrooms, considering the adequate turning space for the wheelchair and using multiple counter heights in the kitchen provides acceptable use of chances for the people (Figure 2.7.).

Figure 2.7. Multiple heights of countertops (Null, 2013)

Universal design is about designing for all; it is a barrier-free design that affects peoples' health, physical, and social conditions. It is also ensured to solve minority' problems, which sometimes are not even noticed by the majority. The seven principles were created for reaching the most remarkable diversity of people. The universal design strategies can be applied through the design process, adapted to the existed designs. Also, the strategies can be taught to designers, and they can be made to consider these criteria in their future designs.

2.3. Biophilic Design

Biophilic design's essence comes from the changing situation within humans' approach to the built environment (Heerwagen & Gregory, 2008). It is possible to see the human connection with nature in the built environment with traditionally used materials in history. These spaces are designed respectfully to their environment and patterns that reflect nature. Today, with industrialization and technological developments, fast and multi-built systems

are used in architecture. Moreover, there are intense migrations from rural areas to the cities, and these situations force people to live in a concrete world; the modern world takes people out of nature.

Humans are forced to live in a mechanized world; however, they have emotional, psychological, and biological needs. Edward Wilson argues that humans' evolutionary base that the contemporary world could not replace human and natural environment togetherness. Within the time, the genes are transferred from a generation to another and come forward in new settings in atrophied versions (Wilson, 1993). Stephen Kellert explains the situation "What we require now is a new realization of how much our health and wellbeing continue to rely on being a part of rather than apart from nature" (Kellert, 2012). There is "three conceptions of human-beings proposal" proposed by Salingaros and Masden, which are explained as:

> "1. Abstract human being: humans are regarded as a component in a mechanical world.
> 2. The Biological Entity – the human being is an organism made of sensors that interact with its environment.
> 3. The Spiritual Being – humans are something more than a biological neural system, connected to the universe in ways that other animals are not" (Salingaros & Masden, 2008).

People are usually considered abstract human beings in the modern world in modern architecture, and they have not adopted these psychologically, physically, and emotionally ignored cities. This inability to adapt to the contemporary world created mental health problems and current world stress on humans (Nesse, Williams, & Mysterud, 1995). As a solution suggestion, sustainability is an intersection set of economic, environmental, and social values. However, the green building design focuses on ecological values as try to lower the carbon footprint, take care of the material value, and consider the economic aspects as the return of the investments in design as calculating the financial turn of the photovoltaic panels, turbines, and solar systems. Sustainable design movements try to minimize the adverse effects humans create on nature and find solutions without harming the world. A certificate system is mainly known in sustainable design named Leadership in Energy and Environmental Design (LEED). The criteria for getting the certificate are caring for the economic and environmental aspects; however, they pass over social dimensions.

Sustainable designs prioritize environmental-based solutions, but there is a missing link between humans' inner psychological, physiological and evolutionary needs and nature.

The biophilic design focuses on humans first to provide restorative design solutions. Biophilia is not a metric-based design, prioritizing the values-based design (McDonough, 2019). The metric-based design prevents ratio and system errors in design; however, values-based design mutually benefits nature and humans, and nevertheless, it appears restorative. Biophilic design aims to scientifically observe the interaction between humans and the environment and create a solution for people to design and maintain a better living environment.

2.3.1. Nature-human relationship

Nature and human relationships have changed over time. The idea of being a part of nature has turned into a separation from nature. The anthrocentric term was firstly used by Lamb to illustrate the humans who see themselves above nature. In contrast to that view, the bio-centric term is used for people who value themselves as equal with other life forms and nature (Lamb, 1996). Today, the human's self-centered attitude with the definition of shallow ecology, that is, the view of itself as the top link of the whole system, and the belief that it can use everything in its way following its interests, leaves permanent damage to the environment. These irreversible damages to nature remind people of the perfection of the seamless cycle of nature in itself and its waste-free functioning. No matter where technology has reached, the inspiration and solutions received from nature are not exhausted; conversely, as we go into details, the connection rises with the division into sub-branches. Deep ecology also treats nature and humans as a connected whole. Like shallow ecology, it does not deal with humans and nature separately; it thinks as parts of a whole (Capra, 1996).

Like the deep ecology's main idea, biophilia term is firstly described by the psychoanalyst Fromm as "the passionate love of life and of all that is alive" (Fromm, 1964). Then, the biologist Edward Wilson interprets the term "*innate tendency to focus on life and lifelike processes*" (Wilson, 1984). It is the "inborn affinity human beings have for other forms of life, an affiliation evoked, according to circumstances, by pleasure, or a sense of security, or awe, or even fascination blended with revulsion" (Wilson, 1993). These descriptions explain

people's behavior as feeding pets, growing plants, enjoy just looking, or spending time in nature.

2.3.2. The beneficial effects of interaction with nature on human health

Environmental design has an essential factor that affects the users on psychological, physiological, and emotional levels. Some studies examine the human and its environment connection and their effects on them. For example, one research concluded that curving contours in design decrease the early flight and fight response rather than hard-edged architecture. This response to hard-edged architecture increases when people encounter it in a place where they feel stressed hospital-like environments (Nanda, Balde, & Manjunatha, 2013). Flight and fight response is also an acute stress response; it is a body reaction when the brain realizes a harmful attack or threat. The research shows that it is preferred to use curving contours in care center design to prevent stressful environments. Another research on greenery in environmental design concludes that the increase in green spaces decreases the violence and crime rates in the area and increases the environment's relationships (Kuo & Sullivan, 2001). Also, another research is done in a low-income environment in public housing estates. It results that greenery in the living environment reduces the residents' mental fatigue and facilitates their hard life struggles (Kuo, 2001). The people living in care facilities are inclined to have mental problems because of feeling lonely and health problems that come with age and emotional support. The research results lead to the care centers' design; using green elements effectively increases the care center users' physical and mental health conditions. Studies have shown that just viewing nature from a building has a balancing effect on heart rate, blood pressure and reduces stress level (Ulrich, 1991), and just seeing nature pictures improve mood, working memory, and cognitive functioning (Berman, Jonides, & Kaplan, 2008).

The Biophilia hypothesis is theoretically new but practically roots back to the existence of the human. As understood from the definitions, it is the connection between nature and humans, which acts as a separate phenomenon in today's system. Unlike in historical times, today, people spent most of their time inside the buildings (Cramer & Browning, 2008; Joye, 2007). Stephen Kellert evaluates the biophilia hypothesis within a built environment that has been discussed in architectural features (Kellert, 2008). In the built environment and architecture, the landscape and building design take nature as a problem, which some people

have to deal with or not consider (Kellert & Calabrese, 2015). research conducted about the effect of nature and urban greenery for people concludes that moving to greener, more connected to nature settings has positively affected the public's mental health (Alcock *et al.*, 2014).

Additionally, being in nature and being near a natural environment also positively affect human psychology (Ulrich & Parsons, 1992). It shows today that people must deal with the isolation of nature by combining new methods to improve their living standards and mental health. One reason for this isolation is mass production and fast-moving consumer society; however, the design is a tool to reduce the negative impacts and fix the problem. A study carried out shows that water and green in the living environment leads to being healthier than the contrary conditions (de Vries *et al*., 2003)

Table 2.2 shows a research list that shows the connection between the natural system and its effects on humans. It shows that connection with natural systems has an immense psychological, psychological, and social effect on humans.

Table 2.2. Human-nature connection researches (Söderlund, 2019)

THE SUBJECT OF THE RESEARCH	CONNECTION OF NATURAL SYSTEMS	THE EFFECTS ON HUMAN
The positive effects of green office design over lean offices with three sample space investigation (Nieuwenhuis, Knight, Postmes, & Haslam, 2014)	Natural View	Increase in the capacity of attention
Two laboratory settings with four pots of plants and without plants in the interior space (Raanaas, Evensen, Rich, Sjøstrøm, & Patil, 2011)		Increase the attention restoration process
The recovery effect of window view after surgery (Roger S Ulrich, 1984)		Rising recovery ratings
The connection between stress reduction with architecture and fractals investigated (R. P. Taylor, 2006)	Fractal Patterns	Stress reduction
Jackson Pollock's Fractals effects on physiology and perception (R. Taylor, Spehar, Hagerhall, & Van Donkelaar, 2011)		Pleasing as in aesthetical conditions
High-Rise Structure and sustainability connection under environmental psychology subject (Wener & Carmalt, 2006)	Natural lighting	Stress Reduction
The positive effects of green office design over lean offices with three sample space investigation (Nieuwenhuis et al., 2014)	Air quality	Expand the productivity level
Student Performance relations with the classrooms include plants (Daly, Burchett, & Torpy, 2010)		Expand the positive mood
The choice and perception effect of using green in residential structures (White & Gatersleben, 2011)	Vertical Walls	Restoration on psychology, aesthetically pleasing

2.3.3. Biophilic Design Parameters

Biophilic design is firstly interpreted as using greenery in the buildings; however, it has more than green, such as the system that inspires natural forms and designs that take lessons from nature, natural patterns, and view. It is a way of design that reduces the human's environmental impact in an innovative way that establishes a link between humans and nature. It is possible to see biophilic patterns in the well-known, respected buildings in the world with the essence of nature inside (Heerwagen, Loftness, & Painter, 2012). The human need for natural connection is evident from the previously explained research and theories; the question to focus on here is how to create places that respond to people's needs in the built environment.

There are different approaches to apply biophilic design theories in architecture. Therefore, researchers try to categorize these approaches into design principles. The known researchers and their attributes are:

- Five biophilic design principles by Hildebrand (2008)
- Six elements and under them seventy biophilic attributes by Kellert *et al*. (2008)
- Fourteen biophilic design patterns by Browning *et al.* (2014)

Five Biophilic Design Principles By Hildebrand (2008)

Grant Hildebrand, an architectural theorist that focuses on the survival-based instincts of humans and the biophilia connection. He argues that humanity has a survival instinct that comes from the older times with humans genetically. He researched the survival-based five main principles of Prospect, Refuge, enticement, peril and complex order (Hildebrand, 2008).

Prospect and Refuge theory is an adaptation that comes from Appleton's principles as he argues that people needed refuge in the primitive periods of humanity. Because of the wide-open areas like in the African savannah, people are afraid of the attacks of the other livings, climatic changes, and conditions. Therefore, they need a place where they could feel safe. That attitude was the basis of today's people's mental structures due to the evolutionary process. Refuge theory claims that humans' centuries of survival instincts have shaped today as well. They needed safe shelter, but they have to control the immediate areas as well. The control mechanism comes with an opening, which they prefer to view an extended span area to manage the threads for them (Hildebrand, 2008). Also, the view makes them notice the food and drink opportunities from outside.

The prospect theory is coming from that point of view. Appleton argues that the sitting places, the back of the people are close, and the front is wide open are preferred by people as in the parks because of the brain's historical codes (Appleton, 1975). Hildebrand advocates that today, that principle is also seen in houses where the concrete walls are taken to the user's back in sitting units and have wide openings with windows to create prospect and refuge effect (Hildebrand, 2008).

The enticement principle is intertwined with curiosity, the desire of humans to explore nature. The biophilic places designed with the prospect and refuge principles allow the user to examine the view without viewed totally from the outside; observe without observed that easily. It is argued that this tendency is coming from humans' instincts to observation, and exploration gives them a chance to encounter opportunities that increase their survival probability. Applying the enticement principle in architecture could be done by framing the users' view, creating contrast effects with light to ensure the desired area come to the fore, using the light levels as darker to brighter with the flow of the movement, light and shadow effects, and linked them with spaciousness (Hildebrand, 2008).

The fourth principle, peril, is used for the mix of the risk and the mystery. It creates curiosity in mind. It can be achieved in buildings, for instance, with balconies, glass floors, tall buildings as skyscrapers, crossovers. The theory defends that these possible risks impress the user (Hildebrand, 2008).

The complexity provides various elements and details. Nevertheless, order gives it a rule, an edit, and alignment, a pattern as in nature. As the fifth principle, complex order accommodates different aspects, gives power as an order or pattern that provides the chaos's order. In architecture, it could be maintained by including various materials, colors, textures, and surfaces into the design: but the aim is to catch the order in the complexity to distract the mind. While people are genetically predisposed to appreciate complex and regular sounds like music, they consider sounds made up of a disordered mess as noise; Likewise, in architecture, Hildebrand claims that providing this complexity and order in space and material can be consciously or unconsciously differentiated (Hildebrand, 2008).

Kellert's Six Elements and Seventy Attributes

There is a conference prepared in Rhode Island in 2006 to discuss the hypothesis of biophilia. Various field representatives are attained from different world regions, and they debate on academic, governmental, and financial aspects of biophilic design. These discussed subjects and solutions are gathered in a book by Kellert named "Biophilic Design: The theory, science, and practice of bringing buildings to life." It is suggested that sustainable solutions and strategies have a society that lives in harmony with nature with life satisfaction (Heerwagen & Gregory, 2008). They use biophilic design as a language to Stephen Kellert,

gather the ideas, and list two main categories in biophilic design: organic and vernacular design (S. R. Kellert, 2005). Under organic and vernacular design headings, there are six categories as subheadings. These six headings include seventy features.

The organic category is defined as the building form and shapes that connect humans with nature with three types of links: symbolically, indirectly, and directly. Symbolically, the depiction of nature into architecture is the nature-shaped ornaments, images, pictures, and nature-inspired forms. The indirect dimension is used natural elements with the human touch effect. For instance, the houseplants with pots, the grass with need of human care. The direct dimension is without human contribution, and nature operating systems connect with humans as light and air (S. R. Kellert, 2005).

The second main category, the vernacular design, is explained by connecting with its environment, location, and point of culture. The vernacular character maintains the spirit of the place. The success is reached by the architecture that has a meaning with its place. The purpose is created with the environment and speaks with its tradition, time, and people (S. R. Kellert, 2005). Under the vernacular design category, four elements are necessary: a social and cultural tradition of the place, avoiding placelessness, the ecology of place, a historical and biogeographical context that intertwined ecology and culture.

Environmental Features: In the living environment, human life's most crucial feature is air and water. Using water as a design element affects the human mental condition positively. Studies show that various settings of nature with orchards, water, valleys and terraces have a therapeutic effect on humans (Selhub & Logan, 2012). Benefitting from daylight is also essential for people. Interaction with animals reminds humans that we are part of nature and maintaining the human-nature bond. Besides, the studies show that plants inside the living area provide humans be more efficient and peaceful. About another environmental feature, people prefer to use natural materials and materials inspired by raw materials in their environments like wood and stone. Studies show that wooden surfaces promote healing in contrast with steel, aluminum, or plastic surfaces (Sakuragawa, Miyazaki, Kaneko, & Makita, 2005). Fire gives the place a warm feeling; unpredictable movements of flames add dynamism to the area. Also, it is used for cooking and heating. Using landscape and geology parameters in design leads to an understanding of the ecological environment and forms a

balanced nature and human contact. Kellert categorizes twelve environmental features as directly experienced features shown in table 2.3. (S. R. Kellert, 2008).

Natural Shapes and forms: The architectural forms inspired by the natural form from the historical structures to today's designers have been open to re-explanations and then applied to the design world (Bahamón, Pérez, Pérez, & Campello, 2008). From the historical structures, botanical motifs as flowers and leaves and animal motifs have been used as an ornament. These shapes attract humans aesthetically. The forms that refer to natural materials, sky clouds have curved shapes without a corner; however, sharped-edged forms are used popularly because of the ease of their production. Biomimicry is mimicking natural functions into design elements. It takes the working process of a natural system and applies it to technology, human-made solutions. While supporting biomimicry, Schauberger believed that "*the task of technology is not to correct nature, but to imitate it*." (Alexandersson, 1990). The biomorphic and geomorphic forms are used as an inspiration point for human-made conditions. There are eleven attributes of natural shapes and forms listed in table 2.3.

Natural Patterns and Processes: In nature, we can find the variable of sensory experiments as hearing, seeing, smelling, tasting, and touching. These experiences and natural stimuli affect humans and create experiences that make people feel alive. The information richness in nature creates human thinking, interacting, and problem-solving skills active and keeps the attention alive. A central focal point is essential in design because it defines the place and promotes wayfinding. Dynamic balance and tension could be provided with contrast colors, height differences, and open closed spaces. It ensures keeping the place alive. Repetition at different scales and self-similarity combinations make the fractals (Ruskin, 2010). Fractals are very common in nature, as in leaves, honeycomb, flowers, but they are also used in the design. Some architects today try to use the fractal system in their design. As Jean Nouvel quoted about the fractals, "I hate buildings which look as if they have been scaled up from a model. I am interested in the fractal approach, which, in every step of the architectural journey, allows one to perceive every small element present and to pay attention to details. Throughout the process, I want to develop this work on the depth of field." (Lucan, 2000)

The fractals act as an advisor for the imagination and allow people to understand better what they see and sharpen consciousness and awareness (Short, 1991). Moreover, fractals have an aesthetically pleasing effect on humans (Taylor *et al.*, 2011). The transition between different purposed rooms can be provided by binding elements as arches, doors, tunnels, or bridges in transitional spaces. As human beings, nature is under time impact. Everything in nature has the impact of time and carries the influence of time. The patina of time or traces of time increases the sense of belonging. The fifteen biophilic design elements included in the category of natural patterns and processes are shown in Table 2.3.

Light and Space: Natural light has all colors inside it and affects human productivity and psychology positively. Light and shadow give an effect to emphasize or help things to distinguish from one to another. Reflected light balances the glare of light, and creating a softness effect, prevents eye fatigue. Light pools as the light leaking from the trees are used as an assistant to navigating, wayfinding. Warm light gives a sense of being safe and tranquil spatial diversity increase human mental and emotional activity. Natural light provides place dynamism with its color and intensity change during the day. The inside-outside spaces need to connect the interior with the exterior with atriums or interior gardens to feel the natural balance and harmony (Kellert, 2005). Twelve elements of light and space are listed in Table 2.3.

Place-based relationship: The ecology and culture togetherness in a geographical context is explained by Kellert with an emphasis. It is believed that this togetherness provides the spirit of the place and the place attachment. There are projects without making the slightest change, have the same appearance in every part of the world. They need to be considering the place relation with such as material, light, direction, topography. This sameness and ignoring the region and conditions cause placelessness. The disconnection between the place and the building causes the demolishment of environmental sustainability and the disconnection of human-nature relations (Kellert, 2005). Eleven elements of place-based relationships are shown in Table 2.3.

Evolved human nature relation: Humans' basic needs protect themselves from the possible dangers of the environment without isolating themselves, which provides human triggers against the potential threat. Complexity and order are found in nature commonly, but it is hard to achieve in design (Kellert, 2005). As it is quoted, "*Complexity alone is chaos; there*

is substantial evidence that we are genetically programmed to respond positively to complex order" (A. Sussman & Hollander, 2015). Excitement and curiosity are triggered by each other and contribute to the design by increasing the creativity effect. Twelve attributes of evolved human nature relationships are listed in Table 2.3.

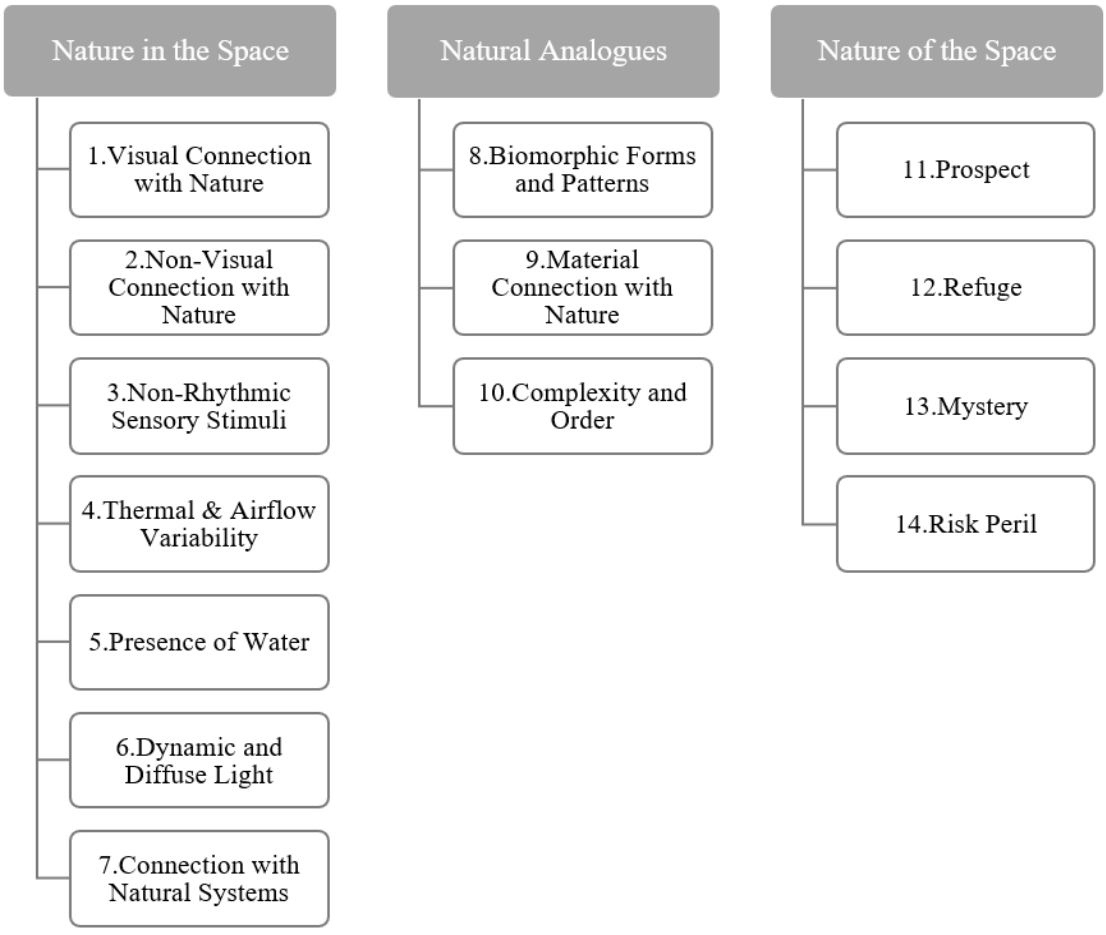
Table 2.3. Attributes of biophilic design (Kellert, 2008)

Environmental Factors	Natural Shapes and Forms	Natural Patterns and Processes
Color Air Water Animals Natural materials Views and visits Facade greening Geology and landscape Habitats and Ecosystems Fire Sunlight Plants	Simulations of natural features Biomorphy Geomorphy Biomimicry Animal motifs Botanical motifs Tree and columnar support Shells and spirals Egg, oval and tubular forms Arches, vaults, domes	Bounded spaces Transitional spaces Linked series and chains Integration of parts to wholes Complementary contrasts Dynamic balance and tension Fractals Patterned wholes Central focal point Growth and efflorescence Age, change and the patina of time Information richness Sensory variability
Light and Space	**Place-Based Relationship**	**Evolved Human-Nature Relationship**
Filters and diffused light Light and shadow Reflected light Light pools Warm light Light as shape and form Spaciousness Spatial variability Spaces as shape and dorm Spatial harmony Inside-outside spaces Natural light	Geographic connections to place Historic connections to place Ecological connection to place Cultural connections to place Indigenous materials Landscape orientation Landscape features that define building form Integration of culture and ecology Spirit of place Avoiding placelessness	Prospect and refuge Order and complexity Curiosity and enticement Change and metamorphosis Security and protection Mastery and control Affection and attachment Attraction and beauty Exploration and discovery Information and cognition Fear and awe Reverence and spirituality

Kellert's Fourteen Biophilic Design Patterns

The research that is published in 2008 by Kellert is a detailed introduction to biophilic design. Still, too much parameter is not so clear to control and obtain in architectural design. In the built environment, there is a need to improve and compile the substances for a design that improves health and wellbeing. It acts as a bridge to the theory and practice of biophilic design. Proceeding on the path that Kellert opened, Ryan, Browning, and Kellert published a booklet in 2014 named "14 Patterns of Biophilic Design: Improving Health and Wellbeing in the Built environment" that Terrapin Bright Green supports and it aims to assist and inform the process of design. The fourteen patterns are prepared in the light of the compilation of information provided by Roger Ulrich, Stephen Kellert, Rachel Kaplan, Stephen Kaplan, Christopher Alexander, Judith Heerwagen, and research done interdisciplinary (Figueiro et al., 2011). The fourteen patterns consist of three primary headings: Nature in the Space Patterns, Natural Analogues Pattern, and Nature of the Space Patterns are shown in Table 2.4..

Table 2.4. Fourteen patterns of biophilic design categorization (Browning et al., 2014)



Nature in the space pattern

The pattern refers to existing bonds with nature into space or place that could live directly or provide a temporary or physical existence. Natural elements create it, such as breezes, scents, animals, plants, water. The water tanks, aquariums, fountains, green roofs, plants that grow in pots, and living walls (Figure 2.8.) are examples of nature in the space pattern. The increase of the sensory effects that are provided with natural elements supports the formation of the pattern. The pattern has seven sub-headings, as shown in Table 2.4.

Figure 2.8. An example of nature in the space pattern with living walls (URL-2)

1.Visual Connection with Nature: Several studies have been done to prove the effects of a natural perspective on human health and wellbeing. Just viewing a forest scene after an impact that stresses the mind, it is noticed that the body turns into the relaxed mode with the heart rate and the brain (Tsunetsugu, Miyazaki, & Sato, 2007). Also, there is a difference between seeing a view from a window or a digital platform because of the movement; when the viewer moves, the sight changes from a window, providing variations (Kahn et al., 2008).

The considerations should prioritize nature's objective view to obtain a visual connection with nature in design; if it is not possible, the analogous, simulated views of nature are preferred. The interior connection with natural scenery is also considered with a sitting unit to unblock the picture with the sitting position. The possibility of exercise near the green areas is also an essential aspect because of the health benefits. The biodiversity should be valued more than the size of the land. The courtyards designed as a green space or green

connected façade design (Figure 2.9.) are vital to exemplify the critical use of visual connections with nature.

Figure 2.9. Example of visual connection with nature (URL-3)

2.Non-Visual Connection with Nature: Haptic experiences as touching, smelling, hearing, or tasting also connect with natural systems. It is proven that these sensory experiences with nature as the sound of water, birds chirp, gardening, and natural materials in place (Figure 2.10.). It is established that these sensory experiences reduce stress hormones and systolic blood pressure (Ulrich, 1991). Moreover, it positively affects sereneness, inner peace, and mental health (Park, Tsunetsugu, Kasetani, Kagawa, & Miyazaki, 2010; Tsunetsugu, Park, & Miyazaki, 2010).

Figure 2.10. Example of haptic experience with falling water (URL-4)

3.Non-Rhythmic Sensory Stimuli: The non-rhythmic sensory stimulus is the ones that happen without a human estimation as the movement of the leaves, the smell of the flowers that

comes with a soft breeze, the flowing water or sea waves, the jump, or movement of an animal, movement of fire (Figure 2.11.). Human-made places without any estimated actions create boredom and mind distractions. Non-rhythmic sensory stimuli affect refreshing the mind and reduce mental fatigue and physiological stress (Browning et al., 2014). It positively impacts the nervous system activity, blood pressure, and heart rate (Kahn Jr et al., 2008; Park et al., 2010).

Figure 2.11. Fire and viewing the unpredictable movements of nature provides non-rhythmic sensory stimuli (URL-5)

4. Thermal & Airflow Variability: Thermal and airflow variability is preferred with a few temperature changes, slight airflow felt on the skin, and relative humidity. Natural ventilation in place, as with cross ventilation and mechanical windows, as shown in Figure 2.12. are among the preferred systems. These thermal and air variables create a refreshing feeling of the atmosphere. Different researches prove its positive effects on productivity, well-being, and comfort (Heerwagen, 2006; Tham & Willem, 2005). It also impacts the concentration on a task and increases attention (Hartig et al., 2003; Kaplan & Kaplan, 1989).

Figure 2.12 An example of thermal and airflow variability (URL-6)

5. Presence of Water: The water presence affects humans with touching, seeing, and hearing sensory experiences. Unpolluted or clean water is preferred, and it affects health positively and creates a tranquil effect. It also decreases the stress level and lowers blood pressure; it helps keep the memories in mind and increases focus and attention (Biederman & Vessel, 2006). It is preferred highly for the visually and sound, and people create positive emotions (Barton & Pretty, 2010). It could be applied in the design, such as fountains, water walls, aquariums, and a visual connection with rainfall and the inner courtyard pool, as shown in Figure 2.13..

Figure 2.13. An example of the water presence (URL-7)

6. Dynamic and Diffuse Light: The effect of dynamic and diffuse light constitutes the awareness of time flow and creates positive emotional responses and a more efficient

working and focused environment. The efficient natural lighting environment in offices provides higher productivity levels, and the shops that use natural daylight at a required level have more product selling potential. For the study environments, research shows that in a classroom that is sufficiently illuminated by the natural light, students have a more positive psychological mood; it shows that they have fewer dental decay problems that the classroom has not got enough sunlight (Nicklas & Bailey, 1996).

With the natural light, the circadian system functioning has a crucial impact on human health. The changing colors of sunlight affect humans' daily functions, blood pressure, heart rate, and body temperature. It also restrains the monotony and prevents the discomfort of the eye. For instance, the blue ingredient of light that occurs at night releases melatonin hormones, the melatonin and serotonin hormone levels affect the mood; circadian lighting is also a valuable tool for the places that the user spends long hours to focus and consciousness (Browning *et al.*, 2014).

The layering of light maintains a preferred environment that uses diffused and task light following the place's need. Diffused lighting creates soft background lighting, which needs to be used as a task light to the place's attention-required areas (Clanton, 2014). Figure 2.14. shows the use of dynamic and diffused light in an interior design. The light and shadow effects also have conditions that affect people. The changing shadows through the day, the reflected light through a water element to the wall or space, and their movement create a fractal effect on the mind that pleases the mind (Browning *et al.*, 2014).

Figure 2.14. Example of dynamic and diffuse light (URL-7)

7. Connection with Natural Systems: Connection with the natural system is obtained by understanding and involving a functioning system of nature with humans. For instance, witnessing the leaf fall off a tree, blooming of the seasonal flowers seen from a window or the indoor plants, watching a birds' nest adhesion, and seasonal color changes in nature (Figure 2.15.). A view through nature from the interior is providing the primary connection with the natural system and people and using the natural elements with the human-made systems as collecting rainwater and using it in the garden, which helps us to understand the functioning of the biological systems and integrate it into our living environments.

Observing the natural cycle of the material with time as wood, leather, or stone, preserving the moon's cycles, and noticing the aging effect of an animal or life cycle are examples of humans' connection with systems of nature. The responsive design that changing its form or function according to the natural parameters as temperature, wind, light is the desired parameter for the pattern, which leads to an understanding of the mechanism and acting in harmony with nature. Also, interactive activities and opportunities with nature as seasonal cooking activities, planting spaces are a healing effect on patients, the elderly, and children (Browning et al., 2014).

Figure 2.15. The figure shows the place that has the opportunity of observing nature with the seasonal changes (URL-8)

Since historical times, nature affects designs with analogies, materials, forms, sequences, and objects. It applied design with furniture ornamentations as carvings of natural elements such as leaf, flower, animal, seashells. Sometimes it is used in abstractions and symbols, exemplarily olive branch as peace or religious symbol, the lion as a power. Modernism prevents ornaments; however, it respects the material nature and advocates the honest use of materials as biophilic design supports. Fabrics with distinctive textures, natural stones, and wooden design elements strengthen the places' biophilic design effects (Cramer & Browning, 2008).

The forms in nature have softened curves, rounded, curved, without angular shapes. Because of mass production's effortlessness, the right-angled, ninety-degree angled, pointed cornered forms are produced. However, human movements and ergonomics are curved. Curvilinear or softened-edged forms are more suitable for human nature. Forms are also affecting social psychology. Pointed cornered shapes draw people into more aggressive behavior (Day, 2004). Natural analogs pattern heading encompasses three patterns, as shown in Table 2.3.

8.Biomorphic Forms and Patterns: In design, the biomorphic forms and patterns create a symbolic connection with nature with the help of substances as patterns, textures, or contours seen in nature. The natural forms also have a psychologically pleasing effect. Natural forms create a fascination effect on the mind and create a more conscious mood to life (Selhub & Logan, 2012). Architectural forms that are mimicking natural soft edges are refreshing the mind as in nature. People have a preference visually for natural, organic, biomorphic forms; the brain knows they are not alive, but they have accepted representations of being alive, life symbolically.

Within the design, it is common to see the design elements as plant patterns, animal skin textures, carvings effect from natural patterns, and contemporary. These patterns have repetitive but have differences with little changes. Humans should see fractal rather than Euclidean geometric forms (Kellert *et al.*, 2008). Moreover, fractal-like geometries used in design create the effect of nature with a generative process that creates similar emotional responses in the human body (Harris, 2012). Fibonacci series and the golden ratio are common ways of creating patterns in nature, which are the hidden ratios between two or more elements. Fibonacci series (0, 1, 1, 2, 3, 5, 8, 13…) are seen in leaf patterns and golden ratio (f = 1.618; 3/5 5/8 scales) in spirals of seashells. John Ruskin states that the number of

elements or objects connected with gradual change for the character's vision creates a success of the continuity law (Ruskin, 2010). However, overuse of the patterns and forms leads to visual toxicity, unsuitable for the built environment. It is suggested to apply the biomorphic forms and patterns in just 2 or 3 dimensions or planes, such as the floor and a wall (Browning *et al.*, 2014). The pattern is used, such as furniture, window details, balconies, structural forms, wallpapers, panels, and columns, as shown in Figure 2.16..

Figure 2.16. An example of biomorphic forms and patterns (URL-9)

9.Material Connection with Nature: Under conditions suitable for the material, the material connections with nature as furniture, building material, decoration objects, or natural colors affect cognitive psychology. A study that researches wood ratios on interior walls and their effect on human psychology response shows that if the room's one-half rate is with wooden walls, people feel comfortable in the area and diastolic blood. On the other hand, when the wood ratio of the walls increases by ninety percent, it is seen that the people turn into a more highly cognitive performance as in spa environments, which becomes highly restorative conditions (Tsunetsugu et al., 2007).

The colors are also affecting human psychology and performance. For example, the green color that mostly finds in nature positively influences creativity tasks, but research shows that it does not affect the analytical results (Lichtenfeld *et al*., 2012).

The material connection could be achieved in the design process using wooden or stone flooring or wall elements, furniture, structural elements, and traditional natural materials used as straw bales, cob structures, or bamboo structures and walls (Figure 2.17.). It is essential to prefer raw materials over synthetic ones because humans' receptors can easily distinguish the natural and artificial variations (Browning *et al.*, 2014).

Figure 2.17. Building constructed with natural materials like mud and bamboo (URL-10)

10. Complexity and Order: The pattern aims to balance a confusing complexity and a simple layout; it constitutes order in complexity. The pattern improved from the experiments on human preferences. An investigation done with young animals results in the complexity of the environment rapidly raising the brain capacity; their intelligence test performance results in more advanced solutions (Salingaros & Masden, 2008). Additionally, the brain does not realize the blank surfaces; it focuses on occupancy (Ann Sussman & Hollander, 2014). People prefer a level of complexity rather than simplicity because of the desire to use their capacity for information processing (Vitz, 1966). Complexity and order balance create a stress-reduced effect on humans psychologically and perceptually (Browning *et al.*, 2014).

The design conditions with complexity and order pattern have been maintained using fractal geometries, a pattern with a self-replicating system with magnification, which gets increasingly smaller (Figure 2.18.). Research shows that people prefer low fractal dimension and high randomness, and when people are exposed to the fractals, their stress level decreases, and they feel relaxed (Hagerhall *et al.*, 2012). The number of fractals elements is

crucial; using three iterations rather than two is a more robust solution. Fractal element scale differences are easily applied in today's technology in computational design. The midrange ratio is preferable as between D=1.3 and 1.7. It is essential to create a balance of the complexity n the place. Highly used fractals form a counter effect as they made an uncomfortable environment and lead fear to the area's user. The misused of the fractals and complexity also responses as boredom and disinterest for the people. Moreover, it is crucial to evaluate the site area's existing parameters and conditions to design complexity and order in harmony with its environment (Browning *et al.*, 2014).

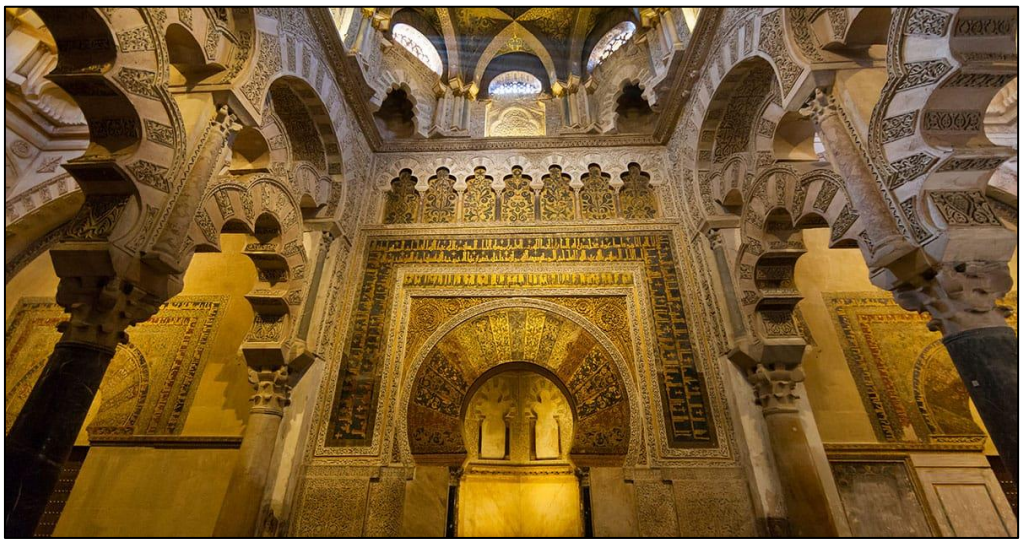


Figure 2.18. Cordoba Mosque in Spain shows the complexity and order (URL-11)

Nature of the Space

The pattern indicates the configurations of space patterns that connect with nature. It shows humans' inner will or learned desire to explore the surrounding environment that includes the mystery and danger, or internal phobias to nature and safety solutions that come within it. There are four patterns under Nature and Space Heading as Prospect, Refuge, Mystery, Risk and Peril.

11.Prospect: Prospect is a wide-open visible area for people to control the immediate environment for the emotion of safety ideas. This visibility is desired to be long-distance from the looking point, and within that, people create a control mechanism. As a result of the pattern, they became safer, stress levels decrease, feel more comfortable and confident, especially where it is unfamiliar to the user. The vistas of the fenestrations in buildings,

corridors, or activity areas should be considered to adapt the design with a prospect pattern (Figure 2.19.). The intended purpose of the area is vital to design the site. For instance, if a place is usually used with sitting activities, space's vista is designed according to that sitting height point. To increase the prospect effect, adding water elements to the fenestrations' sights creates a savannah-like effect, which is humans' inner tendency to reach.

Figure 2.19. Open vista and panoramic view provides prospect pattern (URL-12)

12. Refuge: It is a pattern that creates protection for people with their inner desire to cover the near places which are overhead and behind. The refuge conditions function as relaxing places, protection from climate and weather areas, and physical dangers. The earliest example of refuge is sitting under and lean on a tree, sitting on a bench in the park where the back is a closed area with trees is a wall, but it is an open vista at the front. Inside the buildings, the activity units on the three sides of the place are closed where height is lower than the whole area places are using the refuge pattern. It provides safety and focuses like reading or working units or meditating areas. For the need for various activities and densely populated places, there could design different types of refuge areas (Browning *et al.*, 2014). It is a better solution to think prospect and refuge patterns together that protected but as at least one way having a visual connection and vista as shown in Figure 2.20..

Figure 2.20. Surrounded spaces provide refuge pattern, such as a bird nest (URL-13)

13. Mystery: Through the ages, curiosity and a sense of wonder have made human progress and discoveries. Like this progress in life, the sense of mystery created by the places attracts people with curiosity that evokes. Mystery in space causes the user to investigate the area deeper and creates a feeling that everything is not apparent, and there is more to search for understanding the site. The location promises more information than it seems. It encourages people to move and analyze the place to access the information. The shadows and shade combinations create unseen vistas and awaken a sense of curiosity in mind; curving edges generate a desire to move and arousing curiosity to explore what is happening through the movement. Using the vegetation and topography to slowly reveal the buildings that a single view is not enough to explore the place is a strategy to use mystery as a design pattern. Moreover, the use of mystery in buildings provides exploration and research skills for the children. Figure 2.21 shows the mystery pattern with the structural curves that wonder the users what the path leads them.

Figure 2.21. The natural curves in the structure make user wonder what happens next (URL-14)

14. Risk/Peril: The pattern of Risk/peril permits the user's risk factor, but within that risk, it shows trustworthiness to protect the user from the risky conditions. Several designs are shown as examples of that pattern as glass floors in high areas that experience the user to feel like they can fall any moment; however, it also provides trust for the structure to carry them. The glass façades that sense the user's risk of falling and protecting from possible dangers create a risk pattern in design. The infinity edges in buildings create the risk effect in buildings. Figure 2.22. shows the floor made of glass material that provides the risk and peril pattern.

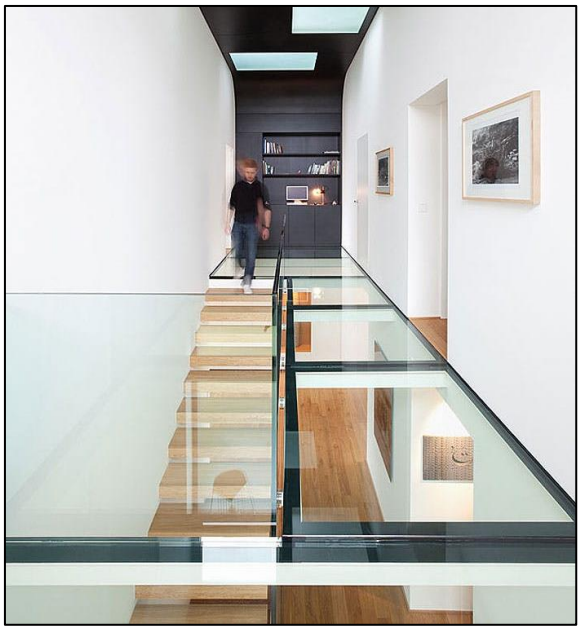


Figure 2.22. The floor made of glass material (URL-15)

3. MATERIAL AND METHODOLOGY

Biophilic design gains a more solid place in the literature day by day with studies in this field. Studies have indicated that one of the most significant shortcomings in this field is the deficiency in determining the boundaries of design principles of biophilic design. Since the concepts are very comprehensive, it will be helpful to specify more solution-oriented and specific requirements in terms of practice.

Green Building Rating Tools (GBRTs) are established to determine the requirements for sustainability and create a standard. British Research Establishment Environmental Assessment Method (BREEAM), as the first GBRT is established in 1990 and used as an international rating tool that originates in Britain (Cole & Jose Valdebenito, 2013). After the first rating tool, the other rating methods are developed as Leadership in Energy and Environmental Design (LEED), Building Environment Assessment Method (BEAM), WELL Building Standard (WBS), Living Building Challenge (LBC), and Green Mark (GM). While these certifications generally focused on building and energy performance, it seems that the focus has gradually been on health and well-being. LEED is the most common and dominant GBRT around the world (Wu, Shen, Yu, & Zhang, 2016)

In this section, the scoring, evaluation, and requirements of green building evaluation systems, biophilic design, and universal design principles related credits are determined. Among the green building evaluation systems, those that refer to biophilic design criteria in the primary criteria or pilot credits were selected to investigate. Three examples of green building evaluation systems named LEED, WELL, and LBC (Living Building Challenge) are examined in this context. The green building rating tools are retrieved from their website, and the most updated versions are considered. A guidebook with a reference table is created by bringing together the biophilic and universal design materials taken from green building rating systems.

3.1. LEED v4.1 Green Building Rating System

As a Green Building Rating system, LEED is existing for the last eighteen years in the operation, construction, and design of green buildings with more than 93000 certified and registered projects worldwide since 1996. It is established in America. With the technology improvements, developments on regulations, and new systems, more focus on accessibility, and user-friendly design, the LEED is upgraded to the LEED v4.1 version (Council, 2021b).

LEED v4.1 Green Building Certificate System has its rating systems with credits, and some of the credits have intersections with biophilic design and universal design principles. LEED credits are examined one by one to reveal the intersection; those related to biophilic design were identified and tabulated. Appendix 1. shows that the latest LEED version, V4.1, includes some biophilic design criteria covering 15 points of the 110 points table in the certification criteria. The fifteen points here are focused on specific criteria, including Visual Connection with Nature, Non-Visual Connection with nature, Non-Rhythmic Sensory Stimuli, Thermal and Airflow variability, Connection with Natural Systems, and Dynamic and Diffused Light. There are water-related substances in the LEED certification system, but none of them are for biophilic design to keep humans in the same environment with water as a restorative element in the Presence of Water pattern. The existence of biomorphic forms and patterns is not mentioned in the LEED system. Complexity and order, Prospect, Refuge, Mystery, Risk and Peril patterns and their reflections do not exist in the LEED v4.1.

As a pilot credit in LEED v4.1, six credits include biophilic design aspects. A specific credit named “Designing with Nature, Biophilic Design for the Indoor Environment” in the pilot studies and possible score points are estimated as one point, which shows not much attention is given on the biophilic design aspects. The requirement in this pilot credit is to include five different biophilic parameters. Here, those that meet the requirements of existing credits such as thermal comfort, daylight, quality views, protect or restore habitats will be seen as providing biophilic character in parallel. Since there is no clear definition, it is a study that is limited to verbal expressions.

The examination of the LEED v4.1 shows that in the credits, there is no place for the universal design parameters among the existing credits. However, the pilot study named Inclusive design shows that to talk about sustainability, the importance of accessibility will

be gradually understood. The deficiency here will be noticed that the title of inclusive design is among the pilot studies. Moreover, the value of Inclusive Design Credit is calculated as one point, which shows that enough attention is not given yet as a pilot credit. There are five parameters inside the credit: physical access, wayfinding, assistive technology, emotional health, and inclusive space. Out of the five parameters, projects include four parameters that meet the conditions of the credit. The fulfillment of one of the sub-conditions of each of these five credits is sufficient to be accepted. In this case, it is sufficient to have some accessibility conditions provided partially within the project. Therefore, meeting the inclusive design pilot credit conditions does not provide inclusive design parameters in-depth. Appendix 2. investigates the related credits of universal design based on seven universal design parameters. There is a requirement associated with each parameter; however, it is not enough and does not contain solutions specific to various places.

3.2. WELL V2 Building Standard

WELL Building Standard is a tool for companies and buildings to balance the human health conditions and sustainability that improve well-being, health, and the planet since the first version was launched in 2014. With scientific research and industry practices, the standard was created and evolved to realize the deficiencies and scientific developments. More than 150 WELL concept advisors work on the last version and create the inputs and their solutions. The standard is focused on four tenets as evidence-based, verifiable, implementable, and presented for outside input (I. W. B. Institute, 2020).

Appendix 3. shows the WELL V2 Credits related to the biophilic design principles and the credit requirements. There are credits related to visual connection with nature, non-visual connection with nature, dynamic and diffuse light, connection with natural systems, thermal and airflow variability. The connection with biophilic design is mainly established through thermal and airflow variability parameters that establish thermal comfort, air circulation, and humidity control requirements. The principles as biomorphic forms and patterns, prospect, refuge, risk and peril are not mentioned in the WELL V2 Standard. There are credits about the water feature; however, it is not connected with the biophilic design pattern, the presence of water. Having restorative spaces and mentioning circadian lighting design credit in the WELL V2 coincides with biophilic design principles. Also, the credits have drawn the guiding boundaries in visual connection with nature biophilic design pattern, with precise

requirements in determining the ideal window design and opening ratios for humans and their health.

Appendix 4. shows the WELL V2 Credits related to the Universal Design Principles and their requirements. There are specific credits for the universal design as Accessible and Universal design and Circulation Network. These credits are analyzed according to seven principles of universal design. In the light of the credits, it transformed into the table. Table 3.4.shows that five of the seven principles are included in the credits and mainly, credits focus on the perceptible information pattern of universal design. The low physical effort and detailed size and space for approach and use patterns are not sufficiently addressed in the credits.

3.3. The Living Building Challenge Standard

The Living Building Challenge attempts to define sustainability in today's conditions that try to impact communities with the construction and building opportunities that affect life and cultural fabric and make the world a better place, and it was launched in 2006. From the latest date of April 2019, in 29 countries, there are 563 registered projects in Living Building Challenge. The certificate is applicable for any building project as new construction, preservation, or renovation projects. There are seven categories of performance in the program called “petals,” Every petal is sub-categorized in imperatives: the number of twenty in total. The purpose of the petals is the same as any project. However, the requirements vary with the condition of the projects. (I. L. B. Institute, 2019). The latest version of the certificate is LBC 4.0, and its connection with the biophilic design is listed in Appendix 5.

As seen in Appendix 5., a specific credit named Beauty and Biophilia in the LBC 4.0 shows the given value to the biophilic design; however, the credit requirements are not specific, so general evaluation existed for the credit. In LBC, Natural shapes and forms pattern is mentioned the first time between the other certification system. Moreover, visual and non-visual connection with nature, connection with the natural system, thermal and airflow variety, dynamic and diffuse light, and biomorphic forms and patterns parameters take place in the credits of LBC. It is understood that when specifying the requirements, instead of describing them with specific numbers, they are directed to general rules and regulations and

evaluated on the results obtained from these. The related credits show that LBC 4.0 cares about the human-nature interaction; however, it does not mention the prospect, refuge, mystery, or risk and peril parameters. Nature in the space patterns exists in the credits, natural analogues patterns exist in a small amount, and the nature of the space patterns is not mentioned in the LBC 4.0.

Appendix 6. shows the LBC 4.0. credits related to the universal design parameters and their related requirements. The table shows a credit named Universal Design Access, and it has equitable use, tolerance for error, and size and space for approach and uses parameters in universal design. There are no specific requirements for flexibility in use, simple and intuitive use, perceptible information and low physical effort patterns. Although not specified in detail in the LBC credit, the credit mentions complying with the projects with the universal design standards and internationally equivalent guidelines for accessibility.

3.4. Evaluation of the Findings

The latest versions of the green building certificate systems as LEED v4.1, WELL V2, and LBC 4.0, are researched to find intersections between biophilic design patterns and universal design patterns. Table 3.1 shows the biophilic design patterns intersection of the green building certificates. It emerges from the table that LEED V4.1 credits have directly related seven patterns of biophilic designs which mainly consist of nature in the space patterns. It shows that the available version of the LEED credits does not mention the nature of the space patterns. WELL V2 credits have related five biophilic design patterns related to the nature in the space pattern. LBC 4.0 is having six related parameters of biophilic design out of fourteen parameters. Different than the other certificate systems exemplified, it has biomorphic form and pattern parameter-related credit. For the total ratio, the most mentioned biophilic patterns are visual connection with nature, non-visual connection with nature, access to thermal and airflow variety, dynamic and diffuse light, and material connection with nature. There are water-related credits in the certificate systems; however, they focus on sustainable water use with its structural system. The biophilic pattern “presence of water” is aimed at the restorative effect of the water used as a design element. Due to this difference, no certification system could get any points from the pattern. The table concludes that green building certificates connected with biophilic design patterns are used as a guidebook for the

nature in the space patterns and two natural analogues patterns as biomorphic form and pattern and material connection with nature.

The green building rating tools serve as energy-oriented tools. However, it is necessary to evaluate a human-oriented approach with a biophilic and universal design perspective. The focus on health and well-being rather than energy efficiency in the pilot credits of green building certification systems and the updated certificate credits shows that the gap in this area is recognized and will be gradually closed.

Table 3.1 shows that the green building rating tools are more focused on the engineering, energy efficiency, and performance of the buildings rather than a holistic approach to building, nature and humans together. The strategies are considered more building centric which is not detailly investigate the effect of the design on human health. However, some credits and requirements related to natural light, thermal and airflow, and material connection with nature show studies on the importance of connection with nature for human beings.

The effect of natural light on increasing the serotonin level is proved; thus, the common areas and residents' design to take natural light is crucial. Moreover, taking the morning light to build up their circadian rhythm is essential.

Table 3.1. Direct references of biophilic design principles in green building certificate systems ratio

PATTERNS OF BIOPHILIC DESIGN		LEED V4.1	WELL V2	LBC 4.0	TOTAL RATIO
NATURE IN THE SPACE	1.Visual Connection with Nature	+	+	+	3/3
	2.Non-Visual Connection with Nature	+	+	+	3/3
	3.Non-Rhytmic Sensory Stimuli	-	-	-	0
	4.Access to Thermal and Airflow Variability	+	+	+	3/3
	5.Presence of Water	-	+	-	1/3
	6.Dynamic and Diffuse Light	+	+	+	3/3
	7.Connection with Natural Systems	+	+	+	3/3
NATURAL ANALOGUES	8.Biomorphic Forms and Patterns	-	+	+	2/3
	9.Material Connection with Nature	+	+	+	3/3
	10.Complexity and Order	-	+	-	1/3
NATURE OF THE SPACE	11.Prospect	-	-	-	0
	12.Refuge	-	-	-	0
	13.Mystery	-	-	-	0
	14.Risk and Peril	-	-	-	0
TOTAL RATIO		6/14	9/14	7/14	

Table 3.2 shows the direct references of universal design principles in green building systems. The table illustrates that LEED V4.1 has seven universal design principles, which shows it is the most connected green building system with universal design. WELL V2 Certificate has four direct references out of seven. LBC 4.0 has two references connected,

and it shows the lowest connection with universal design. The equitable use and tolerance for error are the most mentioned parameters in the certificates. Table 3.2 concludes that the combination of existing substances can guide assisted living facilities for the elderly.

Table 3.2. Direct references of universal design principles in green building certificate systems ratio

UNIVERSAL DESIGN PARAMETERS	LEED V4.1	WELL V2	LBC 4.0	TOTAL RATIO
1. Equitable Use	+	+	+	3/3
2. Flexibility in Use	+	+	-	2/3
3. Simple and Intuitive Use	+	+	-	2/3
4.Perceptible Information	+	+	-	2/3
5.Tolerance for Error	+	+	+	3/3
6.Low Physical Effort	+	+	-	2/3
7.Size and Space for Approach and Use	+	+	+	3/3
TOTAL RATIO	7/7	7/7	3/7	

4. EXAMINING UNIVERSAL DESIGN AND BIOPHILIC DESIGN PATTERNS IN ASSISTED LIVING FACILITIES

With the technological developments, some diseases and illnesses have been found to cure. Also, socio-economic developments and raised living standards have led to people's prolonged lifespan in developed and even developing countries. The researches show that the mortality age is average over 65 years, and lifespan is increasing over 75 years (Crews & Zavotka, 2006). The long lifespan of people increases the elderly and disabled population (Afacan & Erbug, 2009). When people reach 65 years, they usually categorize into the elder group. Elders categorize into three groups according to their ages in international classification. The first one is named elderly between 65-75 years old, the second group is called the senior who is between 75-90 years, and the third group is called very old, who are more aged than 90 (Shabalin, 2017).

Changing lifestyles and standards have raised accommodation problems for the elders. Some of them have a living problem with their family that their children do not want to take responsibility, or on the other side, some seniors do not want to burden their children. Some seniors, not because they have to do but not live alone, sell their homes and settle in an assisted living facility to share a social environment with their peers. Older adults who want to be in a social environment with peers, not to deal with cooking or cleaning, and live in an environment where their health is under control have evaluated the assisted living facility option.

Before the 1970s, assisted living facilities worldwide are primarily evaluated as physical care facilities that do not focus on increasing their occupants' living standards; however, within time, they are turning from acute care places into holistic care facilities (Brawley, 2006). The senior living environments become a hybrid model of hospitality, residential and healthcare facilities (Rosenfeld & Chapman, 2008).

These assisted living facilities can solve the housing problem and the health and psycho-social problem for the elderly. The focus of designing the assisted living places must be taken into the wellbeing and comfort of people rather than just considering the institution's functionality. The place will provide social interaction different from socially isolated places

in older times. Without just providing health opportunities for illnesses, the place is focusing on providing a restorative environment. Edward Steinfeld and Jordana Maisel state that "Health and wellness services as the foundations to positive living. With good health comes the ability to engage in the community, to interact with family and friends, and to fulfill one's potential" (Steinfeld & Maisel, 2012).

Senior living architecture focuses on design that provides accessible, flexible, and sustainable materials and enables natural light and ventilation. The design regulations for elderly care homes have base standards, contain essential criteria; however, the impact of living spaces for elders in the long term has not been explored. The codes and regulations direct architects very superficially, and with that, designs that have not been considered for a long enough period and contain fundamental deficiencies for elders are emerging.

Spending time outdoors is psychologically and physically beneficial for seniors; on the other hand, it is getting harder to physically interact outdoors because of the moving challenges and physical difficulties resulting from pre-existing conditions or come with the years. Thompson and Sugiyama explain the condition as "Many activities associated with moving around and enjoying the outdoors require a certain level of strength, agility, and stamina, the qualities that many older people are in the process of losing as aging advances" (Sugiyama & Thompson, 2007).

The prerequisite for a place to be livable, feel safe, and well here is the design of the space by taking into account the movements and living conditions of the living person and freeing the space for movement and circulation as much as possible. These are possible with universal design. Moreover, because the aging process decreases movement, take nature into the indoor environment and immediate surroundings are necessary to promote the elders' wellbeing. The biophilic design focuses on environmental qualities such as color, shape, materials, light, vegetation, space, air, and human psychology and physiology. With these substances' applications, designers give direction to the places that enhance the human experience, psychological and physiological health (DeGroff & McCall, 2016).

Considering the biophilic design and universal design principles, the assisted living facilities promise a living environment that approaches the ideal psychological, psychological and sociologically positive environment for the elders.

4.1. Analysis of Selected Assisted Living Facilities

Although the assisted facility design impact on the health of the elderly is noticeable where these places are designed with biophilic design criteria, there are no examples in Turkey and the world a lot less. In this part of the thesis, three sample projects among award-winning assisted living facilities in different world regions that meet highly biophilic and universal design criteria are analyzed. These examples were examined one by one within the framework of 14 patterns of biophilic design. Then the mentioned spaces meet among the seven universal design patterns, and their benefits to the user are specified.

4.1.1. The Village at White River Junction

The Village at White River Junction, located in Vermont/America, is a memory care and assisted living center designed by the 4240 Architecture Office and interiorly designed by the DPF Design Office. The center opened in January 2019 and was awarded the top prize in Senior Housing News Architecture and Design Awards 2019 (URL-16).

Figure 4.1. (a) and (b) General view of exterior façade, (c) and (d) Entrance details from The Village at White River Junction (URL-17)

The facility locates in downtown, which is in the center between a theater and church. From a walking distance, there is a theater, library, art gallery, yoga studio. The facility's site is across the two rivers, the White River's junction and the Connecticut River, and two rail lines. The façade is designed, and materials are selected in light of the environmental data. The site's parcel is challenging, and the architect is designed two L-shaped buildings that create a courtyard. The architect considers the site conditions, designs vast windows on the ground floor to connect the interior and exterior, and uses the site's plinth to maintain the residents' privacy (URL-16).

Figure 4.2. (a) First-floor plan (b) and (c) Restaurant area (URL-17)

The facility consists of five floors, and between these floors, the architects aim to create a vertical street idea. Several social areas are designed as a vegetable garden, dog run area, rooftop garden: the art gallery, movie theater, gym, music room, saloon, studio, stage, and library to support the vertical street plan. Greenough Garden is located at the street level, and the place is designed for the residents to cultivate and plant to feel like they have their gardens. There is a vertical plant wall in the garden, and residents may sit and eat their diner in the area. Moreover, the Windsor Dining room is at the street level, and residents observe the street, people, and the immediate environment (URL-16).

Memory Care Unit has 30 studio rooms on the second floor. There are activity spaces, dining rooms, and a garden area that design securely for the residents. Physical activities and gardening options are provided at the memory garden. The Gates Garden shows that the architecture team is aware of unity with nature for the elders and continues the idea vertically. Wilder Dining Room and Olcott Dining Room serve meals cooked by the chefs. They are designed in a traditional way to feel the residents that they are at home (URL-16).

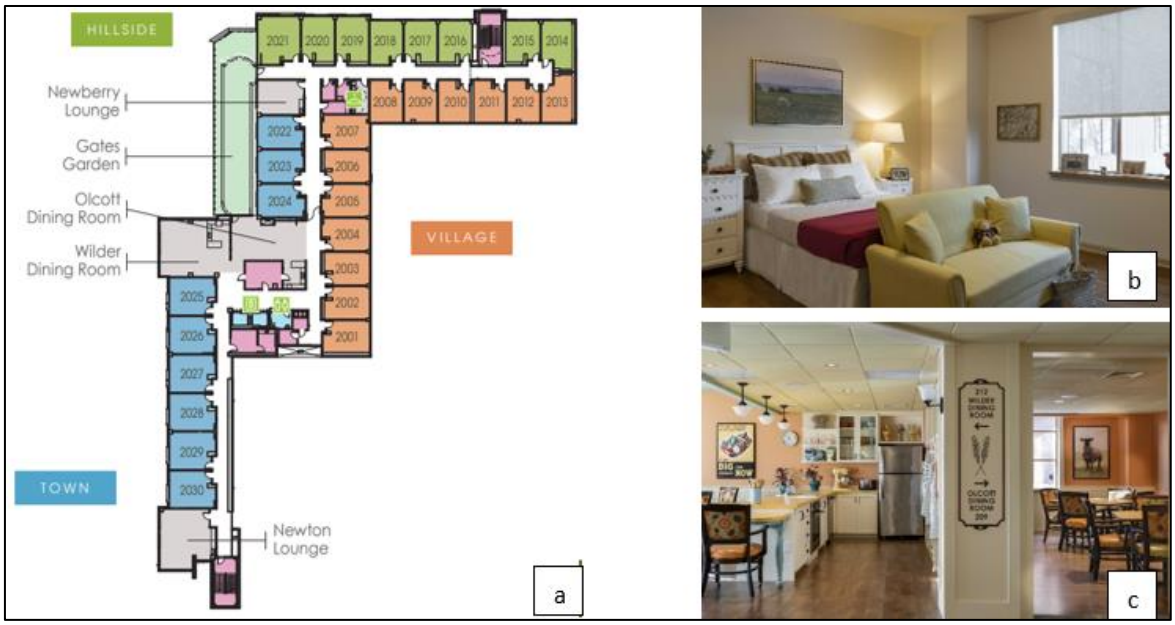


Figure 4.3. (a) Second-floor plan (b) Resident bedrooms (c) Kitchen area with guidance (URL-17)

On the third floor, Smith and Sons Kitchen is a traditionally styled kitchen that leads residents to do their meals, take cooking classes and take private dinners with their family and visitors. Gym class offers personal trainers and yoga, pilates, and Zumba classes. Vibrant green color and safe equipment and floor materials are chosen for the gym area. Larson studio is used for various art discipline events as craft workshops, musicians' and writers' presentations, and activity areas. The art gallery enables the local and regional artists to exhibit their designs and creates a place full of art that residents easily reach that art venue (URL-16).

Figure 4.4. (a) Third-floor plan (b) Kitchen area (c) Bedrooms with living areas (URL-17)

On the 4th floor, there is a dog park named Well's Perch; owners can walk with their dogs freely. The resident allows pets in the institution. Also, employees may take care of the dogs of the residents if they are not able to. The Miller's Stage room hosts concerts, performances from residents and guest performers, and theatrical performances (URL-16).

At the library, the residents have a panorama view through the hillside, and residents have activity alternatives as reading books, playing board games, do a puzzle, and watching films. Moreover, the art studio named Abbot has a view that shows the flow of local life. (URL-16)

Figure 4.5. (a) Fourth-floor plan, (b) Art studio, (c) Miller's stage room (URL-17)

Dining rooms are at several building levels; on the fifth floor, Cantore Terrace and Teddy's Pub give a panoramic landscape and town view. The movie theatre is classically decorated as old cinema environments. It has a modified sound system for the elders.

Figure 4.6. (a) Fifth-floor plan, (b) and (c) terraces that have a panoramic view, (d) movie theater (URL-17)

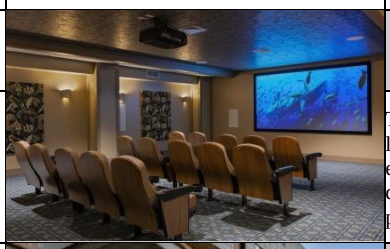
There are divergent types of rooms and apartments on the third, fourth, and fifth floors for assisted living to maintain the users' different needs and aspirations. Room options are one-bedroom (28-47 m²), deluxe one-bedroom (40-55 m²), two bedrooms (75-82 m²). Each of them has its bathroom and kitchenette. If they desire, there is an option for residents to bring their furniture. Each room has a different view; residents can choose the hillside, village, or town scenery (URL-16).

Table 4.1 shows that The Village at White River Junction provides thirteen of the fourteen biophilic design parameters; only the water feature is not provided in the environment. The project is generally compatible with universal design principles. The water feature parameter is not applicable in the place. It is essential to have some improvements in this regard. Each designed place has followed without separating people from their physical competence in design. According to the result of the table, the facility appeals to the user in psychological, physiological, and social terms.

Table 4.1. The Village at White River Junction's evaluation of fourteen patterns of biophilic design and seven universal design parameters

RESTORATIVE DESIGN MATRIX FOR ASSISTED LIVING FACILITIES								
THE VILLAGE AT WHITE RIVER JUNCTION		UNIVERSAL DESIGN PARAMETERS						
BIOPHILIC DESIGN PATTERNS	EXEMPLARY IMAGE OF THE FACILITY	1.Equitable Use	2.Flexibility in Use	3.Simple and Intuitive Use	4.Perceptible Information	5.Tolerance for Error	6.Low Physical Effort	7.Size and Space for Approach and
1.Visual connection with nature		-	+	+	+	-	-	-
Explanation		The architecture firm prioritizes the view of the residents that connect them to the environment. With color differentiation, it is easy to have perceptible information in the library. There is not an unnecessary complexity in the place. The library's upper shelves can stress users in terms of access. Also, the shelves are not designed up to the ceiling, which has been beneficial to prevent danger.						
2.Non-visual connection with nature		+	+	+	+	+	+	+
Explanation		The size of the pots that are planted and the distance between them are suitable and sufficient for use. On almost every floor, green areas allow residents to plant and have a tactile and olfactory bond with nature. The circulation areas and furniture are placed accordingly with the universal design parameters.						
3.Non-rhythmic sensory stimuli		+	+	+	+	+	+	+
Explanation		The fireplace areas create a non-rhythmic natural experience for the residents. The no-stepped entrance at the lobby area around the fireplace creates equal usage for wheelchair users and people who have trouble walking. Fireplace area designed safely with the control mechanism around the center. The automatic door and handle areas create a tolerable physical effort. The flooring material could be chosen to have tolerance for slipping and falling conditions.						
4.Thermal & Airflow Variability		+	+	+	NA	-	+	+
Explanation		The terraces and courtyards provide airflow and thermal variability. The terrace area is designed ideally for people who are seated and standing. The knee space is appropriate with sitting areas. The flooring material could be chosen more securely for the elders.						
5.Presence of water		Not available						
6.Dynamic and diffuse light		+	+	+	+	+	+	-
Explanation		The windows between the rooms enable light to be taken deeper into the facility. The kitchen cabinets are designed with glass cabinet doors, allowing users to see what is inside easily. Using a sprinkler system in the kitchen tolerates the errors in the place and prevents hazards. The entrance is designed with easily understandable signs that orient the user. Low hanger and refrigerator allow users to use them in different physical situations. It seems difficult for the user to reach the top shelves.						
7.Connection with natural systems		+	+	+	-	-	+	+
		The connection with natural systems provided through the garden and terraces shows seasonal and daily changes. Also, the large windows provide a connection between the indoor and outdoor environment. The courtyard is reached without steps that allow comfortable access for users.						

Table 4.1. (Continued) The Village at White River Junction's evaluation of fourteen patterns of biophilic design and seven universal design parameters

RESTORATIVE DESIGN MATRIX FOR ASSISTED LIVING FACILITIES								
THE VILLAGE AT WHITE RIVER JUNCTION		UNIVERSAL DESIGN PARAMETERS						
BIOPHILIC DESIGN PATTERNS	EXEMPLARY IMAGE OF THE FACILITY	1.Equitable Use	2.Flexibility in Use	3.Simple and Intuitive Use	4.Perceptible Information	5.Tolerance for Error	6.Low Physical Effort	7.Size and Space for Approach and Use
8.Biomorphic forms and patterns		+	+	+	+	+	+	+
Explanation		There used a tree trunk bark pattern at the ceiling, and on the walls, there used leaf formed paintings. The design is useful for all users with intentionally left empty seating areas for disabled users. Using soft edges inhibits possible damages for the users. Color differences on the floor and walls define the place. The used floor material is safe in case of any falling condition.						
9.Material connection with nature		+	NA	+	-	+	+	-
Explanation		At the façade and interior, there used timber as a natural material. The entrance has no steps, which makes it easy to access. The protrusion on the façade in the part where the entrance is, made an easy perception for people.						
10.Complexity and order		+	NA	+	+	+	+	+
Explanation		There used ordered elements at the exterior façade design, which have different ratios and materials that create the complexity. The ramp design solves the slope difference. The automatic door design prevents extra effort for the users.						
11.Prospect		-	+	+	+	-	-	+
Explanation		Large windows and terraces let the users have a wide field of vision of the surrounding. There defined flexible sitting areas to create alternative environments that serve the preference of the users.						
12.Refuge		-	+	+	+	+	+	+
Explanation		Inside the rooms, the sitting areas are secluded places of refuge. The place is designed for every user without differentiating their physical conditions.						
13.Mystery		+	+	+	+	+	+	+
Explanation		The circulation area creates a mystery of new places; the kitchen side is hidden from the pedestrians that came through the fireplace. The use of color has been used to define and separate spaces. The place is appropriate for all residents. Size and spacing is useful for everyone						
14.Risk and Peril		+	+	+	NA	+	-	+
Explanation		Wall-length windows create a risky feeling for the viewers; however, it is safe with the structure. Alternative seating options are designed to have a flexible solution for the users.						

4.1.2. Trousdale Senior Living

Trousdale is a Memory Care and Assisted Living Facility located in San Mateo County, California. The owner is Peninsula Health Care District, the facility's architect is Smith Group, and with its architecture, the project wins an award of merit from the American Institute of Architects (AIA) in 2019 awards (URL-18).

The facility has a six-story that has 24 memory care and 101 assisted living units. Health, social connection, and comfort are the project's priorities, and it cares about the relation between the building and the environment. Its wide openings in the façade, a small restaurant, a commonplace that attracts people on the ground floor, and the 8URL atrium designed with landscape features support the connection with the environment and society. Moreover, the architecture office tries to connect the interior with the periphery with the large windows, balconies, gardens, and terraces. To ensure the security of the memory care residents, they are situated on the upper floors (URL-18).

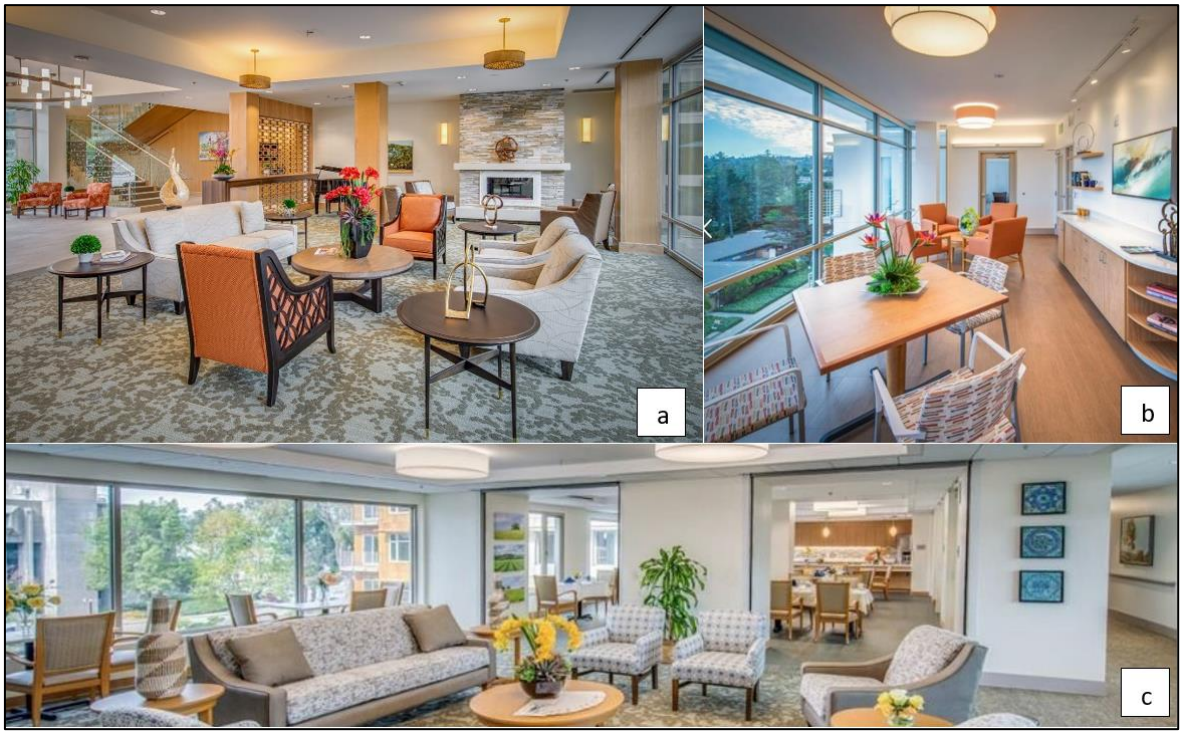


Figure 4.7. (a) Lobby area, (b) Activity area, (c) Floor gathering area, (URL-19)

Figure 4.7. shows the socialization areas of the Trousdale residents. Here, it is crucial to have a design that allows the relationship with the environment, colors, patterns and

communication. It is seen that the space looks spacious with colors, the facility provides a broad perspective to the user, and communication with nature is established through wide-span windows.

There are activity places on each floor that leads to socialization for the residents. The flexibility is a crucial concept of the project provides different configurations of the rooms that the total units change between 136 to 92 units considering the need of the users. The electrical and mechanical solutions are designed accordingly with the flexibility options that if a change is required, the only action that will be done is the furniture changes. (URL-19)

There are different room opportunities for residents to choose what suits their needs. Every room has its bathroom and kitchenette. A wellness center allows residents to have therapies with physicians; a life-learning program offers lectures and workshops in different fields. The facility is pet-friendly and creates an environment that residents feel at home and bring their loved ones. Moreover, the facility is involved in an intergenerational program that connects the elders with children. The residents share their experiences with children; it provides a sense of worthiness and purpose for the elders and develops learning and empathy skills for the children. The program socially benefits both age groups. (URL-19)

Figure 4.8. shows the room options of the residents with a representation as a three-dimensional diagram. It shows that every room has its bathroom and kitchenette. A separate dressing room and living room are available as options. There is also an alternative apartment with two bedrooms and common areas. Sizes of the spaces and design dimensions, and circulation areas comply with universal design principles.

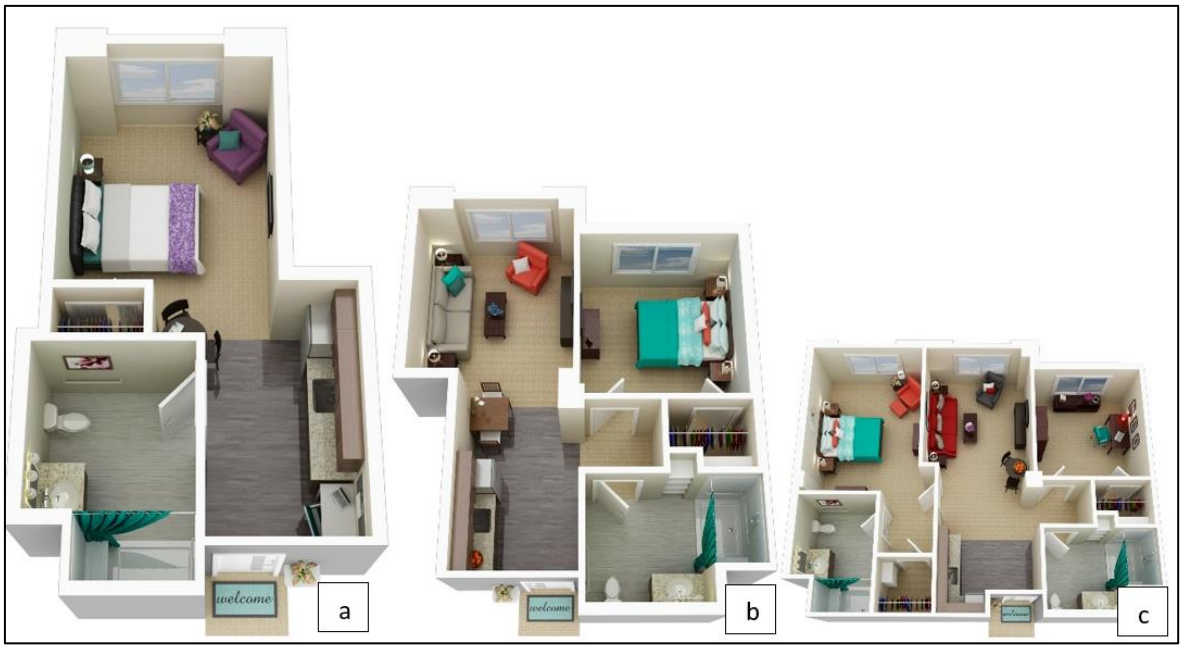


Figure 4.8. (a) The Maple Room with kitchenette, (b) The Oak Room with a living room, (c) The Redwood Room with two bedrooms, two bathrooms, and a shared living room and kitchenette (URL-20)

The site that located the facility is problematic at a point because of the regulations. The entrance of the building is at the corner of the two main streets. The advantage is it allows users to connect with society; however, setting back the entrance could be better for the ease and accessibility of the residents. (URL-20)

Table 4.2. shows the facility's connection with biophilic and universal design principles. The place maintains the fourteen principles of biophilic design, and universal design principles are applied in the design process. The place presents an environment that residents has socially, physically, and physiologically active and connected. The designed areas as terraces are not resolved detailly, and the dimensions are not sufficient for the users. Room sizes, lobby areas, and circulation areas have been found to comply with universal design criteria in general. The presence of the water element, the presence of a fireplace, the patterns inspired by nature used on the floor and walls, the natural materials and forms used are successful examples of biophilic design.

Table 4.2. The Trousdale Senior Living's evaluation in terms of fourteen patterns of biophilic design and seven universal design parameters

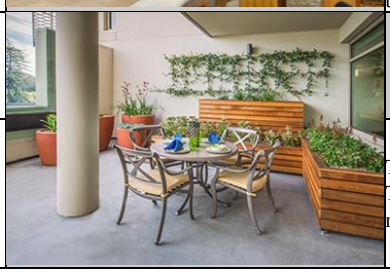
RESTORATIVE DESIGN MATRIX FOR ASSISTED LIVING FACILITIES								
THE TROUSDALE SENIOR LIVING		UNIVERSAL DESIGN PARAMETERS						
BIOPHILIC DESIGN PATTERNS	EXEMPLARY IMAGE OF THE FACILITY	1.Equitable Use	2.Flexibility in Use	3.Simple and Intuitive Use	4.Perceptible Information	5.Tolerance for Error	6.Low Physical Effort	7.Size and Space for Approach and
1.Visual connection with nature		+	+	+	+	-	+	-
Explanation		Having high wall-length windows increases the visual connection of the space with nature. The place serves options for the user to sit in the area. The fact that the furniture is movable and easy to move and the place is not filled with excess items provides a flexible use.						
2.Non-visual connection with nature		+	+	+	-	-	+	+
Explanation		The water feature in the courtyard creates a non-visual connection with nature with its sound and haptic experience. The courtyard provides appropriate spacing size and spacing for the users.						
3.Non-rhythmic sensory stimuli		+	+	-	+	+	-	-
Explanation		The fireplace areas create a non-rhythmic natural experience for the residents. The flooring material decreases the hazard probability; the material is not harmful to the users that may fall.						
4.Thermal & Airflow Variability		+	+	+	+	+	+	+
Explanation		The fact that the windows are easily opened and closed by the users provides airflow. The size and dimensions of the cinema room are suitable for users. There are spaces for wheelchair users in the seating area. The floor material is safe for any fall situation.						
5.Presence of water		+	+	+	-	-	+	+
Explanation		The pond in the courtyard provides a positive effect with the sound of water, perspective, and feeling. Stones under the pond create a natural effect. The courtyard provides appropriate spacing size and spacing for the users; however, it could be solved with more greenery and natural floor materials.						
6.Dynamic and diffuse light		+	+	+	-	+	+	+
Explanation		The use of glass as a divider between the lobby and the areas associated with the lobby provides natural and indirect lighting. The place has been designed where everyone can easily reach without a level difference on the ground. The reception desk of two different heights is used in the reception area in order to appeal to every user.						
7.Connection with natural systems		+	+	+	NA	-	-	-
Explanation		The terraces and courtyards provide airflow and thermal variability. Tolerance for error is not considered in place with the chair, and table material may lead to harm to the user, and the dimensions are not appropriate						

Table 4.2. (Continued) The Trousdale Senior Living in terms of fourteen patterns of biophilic design and seven universal design parameters

RESTORATIVE DESIGN MATRIX FOR ASSISTED LIVING FACILITIES								
THE TROUSDALE SENIOR LIVING		UNIVERSAL DESIGN PARAMETERS						
BIOPHILIC DESIGN PATTERNS	EXEMPLARY IMAGE OF THE FACILITY	1.Equitable Use	2.Flexibility in Use	3.Simple and Intuitive Use	4.Perceptible Information	5.Tolerance for Error	6.Low Physical Effort	7.Size and Space for Approach and Use
8.Biomorphic forms and patterns		+	+	+	NA	+	+	+
Explanation		Lighting on the ceiling, decorative accessories, curtain patterns, and patterns on the floor consist of forms inspired by nature. There is an elevator option in the place. The step height is appropriate for easy use; the landing is designed to convey the user comfortably. The carpet coating on the steps provided protection.						
9.Material connection with nature		+	+	+	-	+	+	+
Explanation		At the facility, there used natural materials at the interior and the façade. The place designed accordingly with the universal design parameters						
10.Complexity and order		+	+	+	+	+	+	+
Explanation		There used ordered elements in the exterior façade design, which have different ratios and materials that create the complexity. The building entrance is designed with the same ease of access for every user.						
11.Prospect		+	+	+	+	-	-	-
Explanation		The fact that the terrace area provides a comprehensive perspective for the users creates a sense of dominance in the environment in people. However, the terrace area has not been thought out and designed in detail. More detailed solutions can be produced in the following stages.						
12.Refuge		-	+	-	+	-	-	-
Explanation		Inside the rooms, the sitting areas are secluded places of refuge. Although the floor material was used as sound-absorbing and safe for space, it is considered problematic in terms of access to shelves and safety.						
13.Mystery		+	+	+	+	+	+	+
Explanation		There are different opportunities for accessibility that lead to the mystery pattern. The furniture locates appropriately with the universal design parameters.						
14.Risk and Peril		-	+	+	NA	+	-	-
Explanation		Wall-length windows create a risky feeling for the viewers; however, it is safe with the structure. The place serves options for the user to sit in the area. The users of the place are to understand usage if it is their first time in the area. The height of the tables and shelves based on the wall is not suitable for every user.						

4.1.3. Westminster Village

Westminster Village is a non-profit community; it was established in 1988 by friends who want to invest in their retirement life. The place needs a renovation and additional building to capture the time requirements and complete the missing needs because of its long lifespan. In January 2008, the architecture firm Perkins Eastman demolished a part of the single-story facility and built a two-story building that includes 23 assisted living rooms and common places that meet the time. The money earned for the facility spends on the residents and the building itself. It is also an award-winning facility, which is Best of 50 Housing awards from the National Association of Home Builders in 2009, from AIA Design for Aging Review Award of Merit in 2009, and American Society for Interior Designers in 2009 (URL-21).

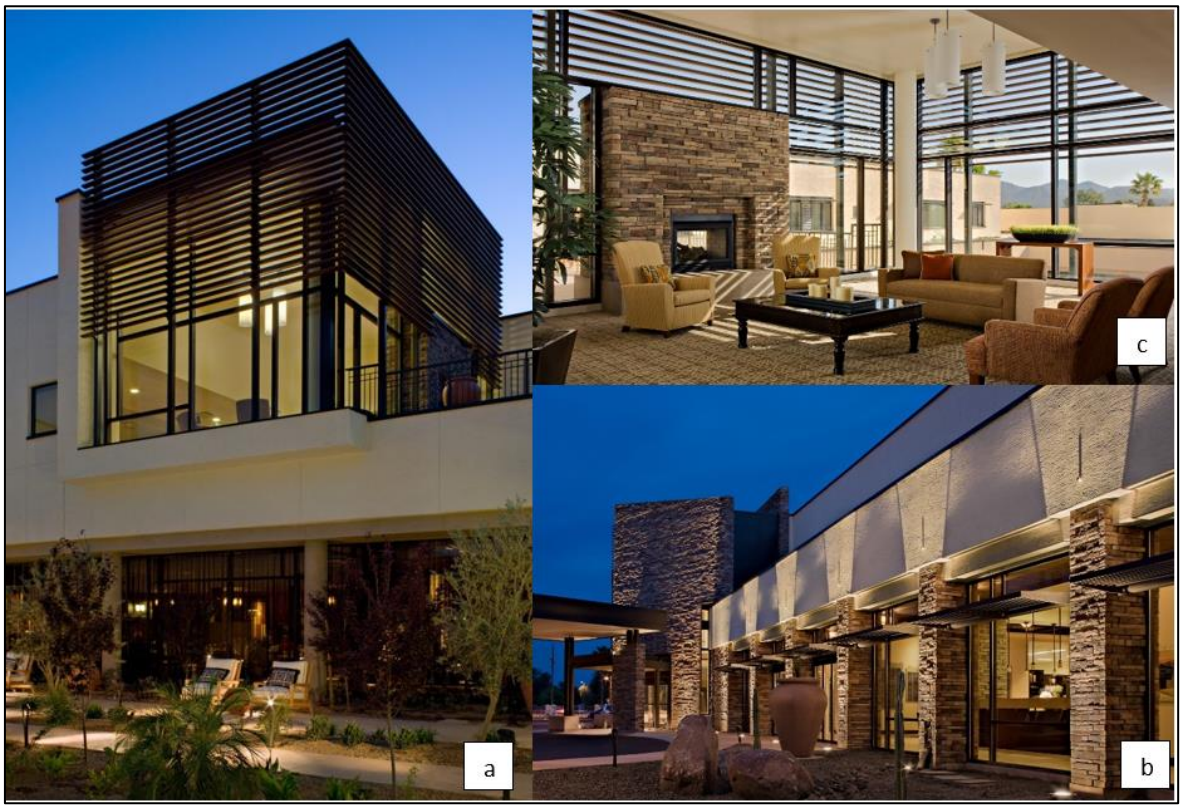


Figure 4.9. (a) The entrance tower of the Westminster Village, (b) The exterior façade design of the facility, (c) The connection of the space with natural materials and fireplace (URL-22)

There are 248 rooms for the residents with eight different combinations, which are preferred for different users that offer independent living, assisted living, dementia, and nursing care. At the assisted living renovated part, every area is considered to view greenery or water.

There are floor-to-ceiling windows on the ground floor that could be opened to feel the fresh air and blends the indoor and outdoor environment. (URL-21)

Figure 4.10. The variety of room options of the Westminster Village (URL-23)

There are six dining facility services for the residents; one of them is near the pool that they can have refreshing drinks, one is a casual place that they can socialize in the daytime, one is formal dining that they can spend quality of time, one is like take and go area like a marketplace, one is at the courtyard and another in the lounge area. The design of those areas is planned accordingly with the local dining places to appeal to the residents. The first floor has 23 assisted living rooms, activity areas, dining places, and living room areas (URL-24).

The first-floor views are designed accordingly to the environment to give the preferred views for residents. The chosen colors are selected accordingly with the local conditions; especially the desert environment affects the preferences. For instance, the orange comes from the rust and desert, greens from the cacti, brown from the wood and stone (URL-24)

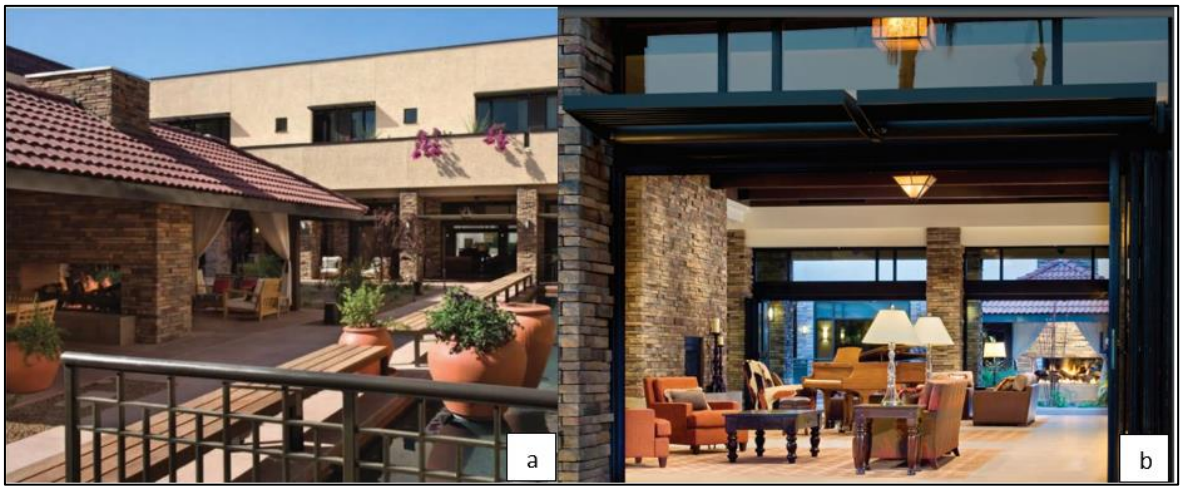


Figure 4.11. (a) The courtyard area with a pond and bridge, (b) Fully openable window design (URL-22)

Table 4.3 shows Westminster Village's evaluation in terms of the biophilic and universal design principles. According to the conclusion from the table, this space has a state that carries every sample of biophilic design parameters. Having an inner garden and using the water element in this area, people passing over the water through a bridge and thus being integrated with space are among the positive aspects of the space. In addition, this courtyard area provides air and heat circulation. Hence, the presence of water and thermal and airflow variability patterns are provided in the facility. The predominant use of wood and natural stone in the space, the fact that doors and windows can be fully opened removes the boundaries between interior and exterior and make people feel in a natural environment. Natural colors used in the space, patterns, and paintings evoking nature and indoor plants also strengthen this theme.

It has been observed from Table 4.3 that space has a suitable design in terms of accessibility. The place's entrance has different heights and materials compared to other regions, making it easily perceptible. In addition, the entrance is not defined by steps but is level, making it easier for every user to access. Leaving wide openings in places such as lobby areas, common areas, gardens, rooms and being suitable for flexible use are among the advantages of the space. The high shelf heights in the library area create difficulties in terms of user access. Also, the lack of signs directing the users has been identified. Apart from these, the place has been found to comply with universal design criteria.

Table 4.3. Westminster Village evaluation in terms of fourteen patterns of biophilic design and seven universal design parameters

RESTORATIVE DESIGN MATRIX FOR ASSISTED LIVING FACILITIES									
WESTMINSTER VILLAGE		UNIVERSAL DESIGN PARAMETERS							
BIOPHILIC DESIGN PATTERNS	EXEMPLARY IMAGE OF THE FACILITY	1.Equitable Use	2.Flexibility in Use	3.Simple and Intuitive Use	4.Perceptible Information	5.Tolerance for Error	6.Low Physical Effort	7.Size and Space for Approach and ...	
1.Visual connection with nature		+	+	+	+	+	+	+	
Explanation		At the interior, there are used plants, and also windows have vistas that include natural elements. Contrast colors at the facility provide convenience to the user in perception. The size and space are appropriate for the universal design parameters.							
2.Non-visual connection with nature		+	-	+	+	-	+	+	
Explanation		There are green areas in the courtyard that allow residents to plant and design to touch, and they can hear the bird sounds from their rooms. All the residents have an opportunity to use the area and take fresh air in the courtyard.							
3.Non-rhythmic sensory stimuli		+	+	+	+	+	+	+	
Explanation		The fireplace areas create a non-rhythmic natural experience for the residents. There are indoor and outdoor fireplace areas. The place is designed with wall-sized windows so that the surroundings can be observed easily, and it provides a connection with nature.							
4.Thermal & Airflow Variability		+	+	+	-	+	+	+	
Explanation		The courtyard provides airflow and thermal variability. The inside and outside connection is designed without using any step. The size and dimension are appropriate for every resident.							
5.Presence of water		+	+	+	-	+	+	+	
Explanation		The balconies are designed as floating patios. The entrance is user-friendly that has not level differences. The relationship of the space with water is provided in a safe way for the users.							
6.Dynamic and diffuse light		+	+	+	+	+	-	-	
Explanation		From the sky window, the interior area accesses the light. The design is simple and understandable for everybody. The facility uses only the lower shelves for a straightforward approach, but it was not considered during the design process. Low-E glass and sunshades exist at the south façade, allow users to take light without distracting them.							
7.Connection with natural systems		+	+	+	-	+	+	+	
Explanation		The fact that the building's façade is mainly made of glass material has facilitated the connection with nature from the inside. With these windows designed to be fully openable and closed, users will clearly notice changes in seasonal changes, air changes, and plants.							

Table 4.3. (Continued) Westminster Village evaluation in terms of fourteen patterns of biophilic design and seven universal design parameters

RESTORATIVE DESIGN MATRIX FOR ASSISTED LIVING FACILITIES								
WESTMINSTER VILLAGE		UNIVERSAL DESIGN PARAMETERS						
BIOPHILIC DESIGN PATTERNS	EXEMPLARY IMAGE OF THE FACILITY	1.Equitable Use	2.Flexibility in Use	3.Simple and Intuitive Use	4.Perceptible Information	5.Tolerance for Error	6.Low Physical Effort	7.Size and Space for Approach and Use
8.Biomorphic forms and patterns		+	+	+	-	+	+	+
Explanation		The fabrics of the seatings, carved woods on the console, carpet on the floor, and used paintings show the biomorphic forms and patterns. The inside and outside connection is sold without using any step.						
9.Material connection with nature		-	+	+	-	-	+	-
Explanation		The stone wall and timber bookshelves and chairs create a material connection with nature. The flooring material appropriate for tolerating the hazards in the space. The height of the bookshelves is not accessible to all users, and it is not safe to use.						
10.Complexity and order		+	-	+	+	+	+	+
Explanation		At the façade, the different materials and repetitive elements create a complexity that is in order. With the design difference with height and material contrast, it is easy for the users to realize where to enter the building.						
11.Prospect		+	+	+	+	+	+	+
Explanation		Observing the surroundings from the window and balcony section on the upper floor will create a sense of domination of the environment.						
12.Refuge		-	+	+	-	-	+	-
Explanation		Inside the rooms, the sitting areas are secluded places of refuge. The flooring material appropriate for tolerating the hazards in the space. The bookshelves are not appropriate for every user and not safe.						
13.Mystery		+	+	+	-	+	+	+
Explanation		With the contrasting colors and dark edges at the corners of the place, the mystery effect is created. The place designed with different sitting options; the flooring material is appropriate for protecting the user from falling conditions; circulation area created appropriately for the use						
14.Risk and Peril		+	NA	+	-	+	+	+
Explanation		At the overscaled entrance tower, the wall-length windows create a risky feeling for the viewers; however, it is safe with the structure. With the high window and sunscreen, the entrance can be noticed even a long distance, creating perceptible information. A small ramp through the interior is suitable for every user.						

4.2. Analysis of Assisted Living Facilities Selected According to Green Building Certificates

In this section, examples of assisted living facilities with green building certificates will be examined. The assisted living facilities have been selected from LEED, WELL, and LBC certificates, which are certification systems with examples suitable for the definition of biophilic design and universal design within the credit system mentioned in the previous section.

4.2.1. Murano Senior Living

Murano Senior Living is a LEED-Gold Certified 24 story building located in Seattle, Washington, and completed in 2019 and Ankrommoisan Architecture design the building, including interior design. The facility has 243 total units, including independent living, assisted living, and memory care units. The building is located at a central location, making it possible for seniors to reach urban life easily. It is near to a museum, hospital, theater, restaurants, and cafes. With its façade, it is easy to recognize the entrance of the facility. (URL-26)

The ground floor mainly consists of a glass façade that connects the city life and the facility's public space with a visual connection. From the first to the third floor, the façade consists of a brick base and colorfully framed windows and at the exterior, and at the exterior building, the environment is planned with lush plantings, which provide the townspeople and facility connection.

Murano Senior Living Facility is located in the city and has not got enough land to connect with nature. However, the situation leads the designers to find practical solutions for the problem, and the building has as green and sustainable features, as a green roof, living wall, communal garden and herb garden, which the products of the garden are used for the food in its restaurant. The chef uses the terrace garden for fruits and vegetables. There are interior gardens to connect the residents with nature at the facility. Moreover, there is a stormwater treatment system that purifies the rainwater. (URL-26).

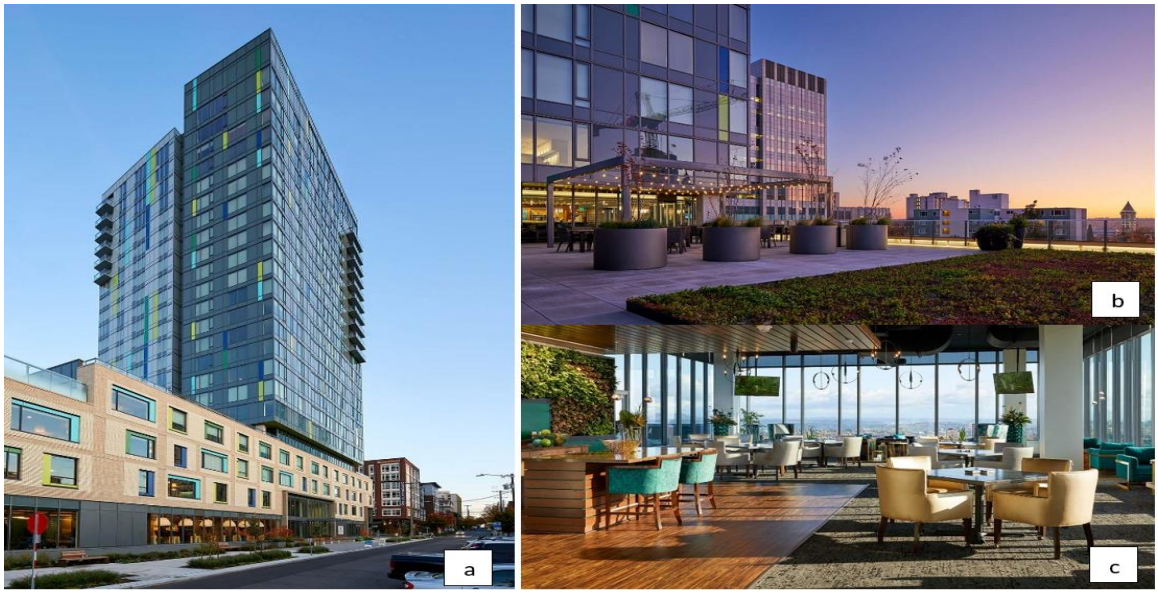


Figure 4.12. (a) The exterior view of the Murano Senior Living, (b) Murano Roof Deck area, (c) Murano Sky Lounge (URL-25)

Figure 4.12 shows the building's mass is retracted from the third floor to break the volume and height given by the multi-story. This retreat area is designed as a terrace garden, as shown in the upper right picture. On the top floor, common areas are designed for viewing the panoramic view. There is a cafe and restaurant here with city and sea views, and the interior design with natural materials and greenery leads to a biophilic environment.

The facility's public areas are designed with a framed experience idea that every place as corridor acts as a piece of art. Different materials provide the experiences with different fabrics, glass, paintings, and artworks with colorful experiences. Every floor created within the three-color scheme chosen from the dominant colors of the Pacific Northwest, the facility location to evoke a positive feeling and shared memories between the residents (URL-26).

The city’s digital mural is created to a wall by a local artist to connect the facility with a sense of place. One wall is left blank, which is shaped by the residents soon. Make an exhibition environment idea from the facility's neighborhood, including Frye's art museum (URL-26).

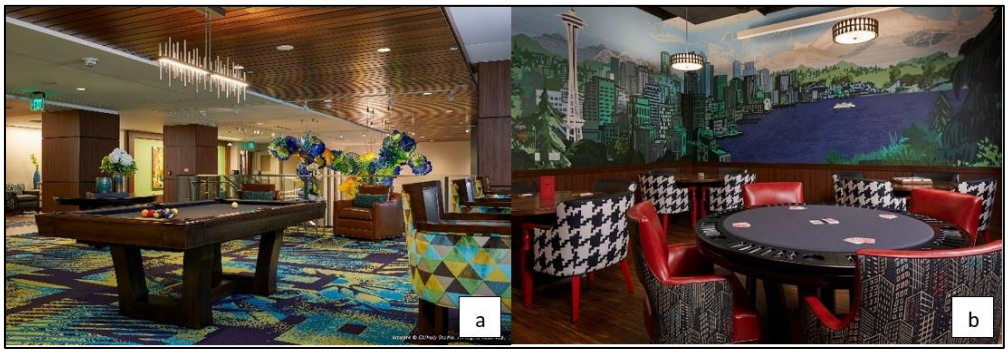


Figure 4.13. (a) Billiards area with three color schemes, (b) Card room with a digital mural of the city on the walls (URL-25)

The facility has 24 stories, and it is necessary to create a gathering area for the residents accessible for everyone. The architects design the public areas near the elevators for residents to reach and use the places easily. Getting daylight inside the facility is an essential aspect for the architects, and it is achieved with an expansive window that allows residents a panoramic view. Murano is a pet-friendly facility that allows cats and dogs, and on the terrace, there is a dog-run area. There are different room alternatives as suit room, one-bedroom, two-bedroom, penthouse, and memory care suites. Each room has designed with a bathroom and kitchen that feels like a home for the residents (URL-26).

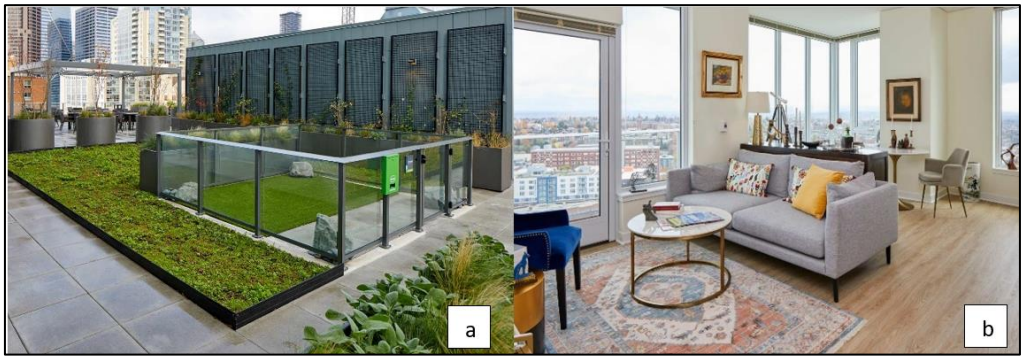


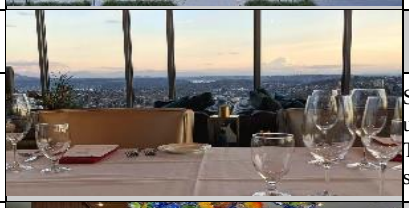
Figure 4.14. (a) Roof dog-run area, (b) The city and sea view of the rooms (URL-25)

Table 4.4 shows the biophilic and evaluation of Murano Senior Living in biophilic and universal design patterns. The table shows that the facility meets the majority of the patterns and parameters. The only shortcoming of biophilic parameters is that the power of the presence of water is not used in the place. Although it is a multi-story building, nature is reflected in the interior horizontally and vertically, and the design has been solved in parallel with the universal design parameters. The architecture team uses different colors and forms to reflect different user experiences in nature.

Table 4.4. Murano Senior Living evaluation in terms of fourteen patterns of biophilic design and seven universal design parameters

RESTORATIVE DESIGN MATRIX FOR ASSISTED LIVING FACILITIES									
MURANO SENIOR LIVING		UNIVERSAL DESIGN PARAMETERS							
BIOPHILIC DESIGN PATTERNS	EXEMPLARY IMAGE OF THE FACILITY	1.Equitable Use	2.Flexibility in Use	3.Simple and Intuitive Use	4.Perceptible Information	5.Tolerance for Error	6.Low Physical Effort	7.Size and Space for Approach and
1.Visual connection with nature		+	+	+	+	+	+	+
Explanation		The facility has a sea view, and since it has 24 floors, the rooms can see the sea from a broad perspective. The layout of the rooms is open to flexible use. The scale is suitable and sufficient for the user. There are many options for the rooms.						
2.Non-visual connection with nature		+	-	+	+	-	+	+
Explanation		The terrace area creates a sensory environment connected with nature. There is a sufficient area for circulation and usage. Although the place is multi-story, the greenery is spread over the floors, showing that the connection with nature can be provided in multi-story buildings.						
3.Non-rhythmic sensory stimuli		+	+	+	-	+	+	+
Explanation		Having a fireplace in the lobby area that can be watched from both sides provides non-rhythmic sensory stimuli for the residents. The dimensions and width of the space are sufficient for the users to move and use easily. The floor material creates safety for users. Seating areas defined in various areas provide a flexible use for the user.						
4.Thermal & Airflow Variability		+	+	+	+	+	+	+
Explanation		The use of openable windows in the rooms and common areas provides natural ventilation and heat exchange. The opening of the windows from above and inwards is intended for security. The use of natural materials and the size of the space are suitable for users.						
5.Presence of water		Not available						
6.Dynamic and diffuse light		+	+	+	-	+	+	+
Explanation		The connection of the upper floor with the reception area allows it to receive the diffuse light to the area. The colored glasses filter the light and transmit it to the areas behind. The fact that the reception desk is designed at two different heights shows that users with access disabilities are considered. Using direction signs will be beneficial for users.						
7.Connection with natural systems		+	+	+	+	+	+	+
Explanation		The design of the terrace area to allow the users to cultivate provides interaction with nature. This area allows the observation of the growth of plants and contact with nature.						

Table 4.4. (Continued) Murano Senior Living evaluation in terms of fourteen patterns of biophilic design and seven universal design parameters

RESTORATIVE DESIGN MATRIX FOR ASSISTED LIVING FACILITIES								
MURANO SENIOR LIVING		UNIVERSAL DESIGN PARAMETERS						
BIOPHILIC DESIGN PATTERNS	EXEMPLARY IMAGE OF THE FACILITY	1.Equitable Use	2.Flexibility in Use	3.Simple and Intuitive Use	4.Perceptible Information	5.Tolerance for Error	6.Low Physical Effort	7.Size and Space for Approach and Use
8.Biomorphic forms and patterns		+	+	+	+	+	+	+
Explanation		The lightings, paintings, fabric patterns, and patterns used on the floor at the facility are associated with the forms and colors found in nature. The presence of direction signs facilitates access to the desired reach place. The distance between furniture is sufficient in terms of access and ease of use. A flexible choice is provided to the user with different seating areas.						
9.Material connection with nature		+	+	+	+	+	+	+
Explanation		The floor, ceiling, tables, and chairs are made of wood in the cafeteria. In addition, the use of green walls in the place gives the user the feeling of being integrated with nature. Apart from that, natural materials were used in many places of the Murano Senior Living Facility.						
10.Complexity and order		+	NA	+	-	+	+	+
Explanation		The glass material used in the facade, window size changes, brick in two colors, and colors such as yellow, green, and blue provides design complexity. Maintaining the horizontal and vertical lines with the same and different materials creates order and provides a solution to the design's differences within the rule.						
11.Prospect		NA	+	+	NA	NA	+	+
Explanation		Since the building is multi-story, it offers a wide-angle perspective for the users. The abundant use of glass surfaces on the facade supports this view. The design of the façade with a completely transparent glass material supports the user experience of dominating the environment.						
12.Refuge		-	+	+	-	+	-	+
Explanation		The low ceiling height of the mezzanine and the design of some seats that cover the user like a cage create a shelter effect which leads to the refuge pattern.						
13.Mystery		+	+	-	+	-	+	-
Explanation		Instead of perceiving the entire space from a single point of view to the user, a design perceives spaces divided by design elements with circulation. Thus, it arouses curiosity and mystery. The openness of the shelves and reaching up to the ceiling can pose a danger to users.						
14.Risk and Peril		+	+	+	-	+	+	+
Explanation		Due to the glass cladding, users looking outside from inside may find themselves in danger, but they trust that the building's bearing leads to the risk and peril pattern.						

4.2.2. The Views of Marion Senior Living

The Views of Marion Senior Living is a WELL Certified facility served since 2004 in approximately 8270 m² campus areas with assisted living, long-term care, and dementia care units. The facility features twenty rehabs to home and twenty skilled nursing units, thirty independent/assisted living apartment homes, and exceptional memory care offering thirty-four studio apartment homes.

Figure 4.15. The exterior view of the facility (URL-27)

There is a health clinic, and licensed nursing staff are working 24/7. The facility has a one-touch system for emergencies and the staff informed the help is needed. There is a theater, cafeteria, fitness center, library, full-service salon, outdoor gardens, walking trails, and wildlife. (URL-28)

The facility has three different room options, one or two-bedroom apartments and a private studio suite. Figure 4.16 shows the different room plan types. Every room has its bathrooms designed parallel to universal design parameters. The bathrooms have a grab bar, and showers have zero entrance levels parallel to safety and universal design needs. One-bedroom and two-bedroom apartments have a kitchenette with refrigerator and microwave devices, and cabinet heights are arranged to prevent access. Also, in parallel with the WELL standards, a spacious floor plan, individually controlled air and heating, ergonomic door handles and cabinets, a high ceiling, and large windows are used at the facility (URL-28).

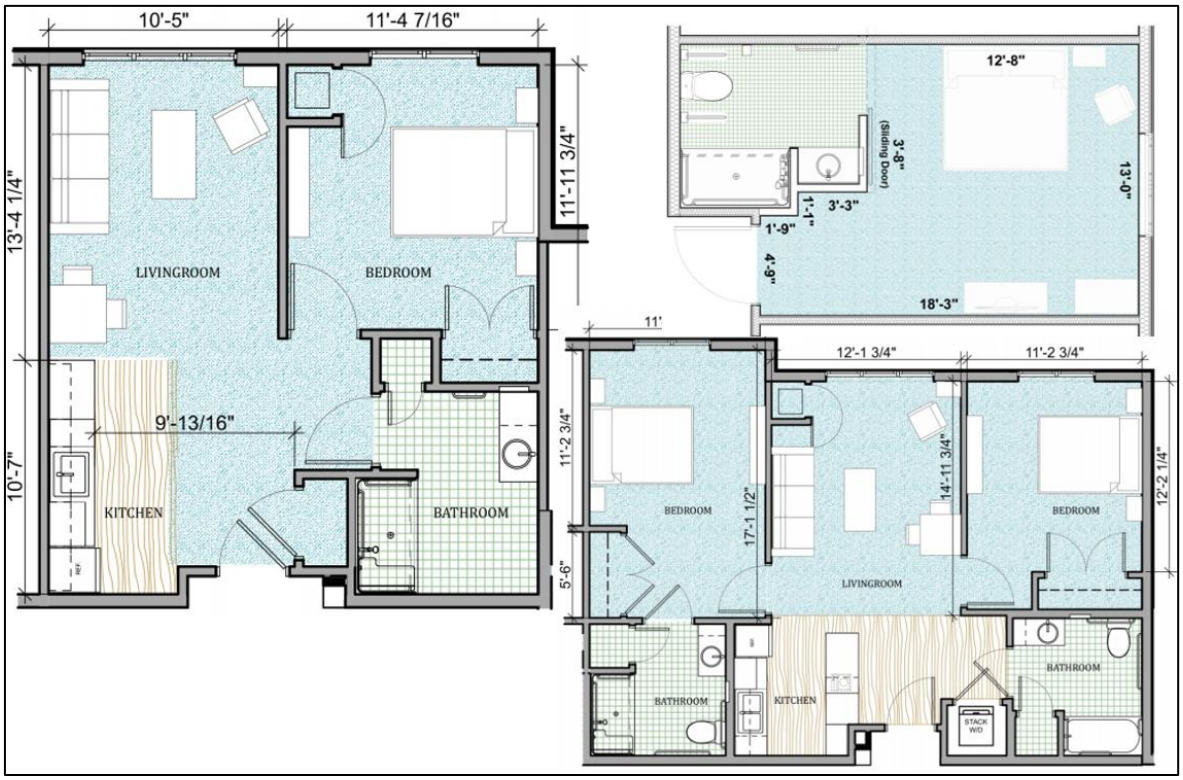


Figure 4.16. The room alternative plans of The Views Senior Living (URL-27)

Table 4.5 shows the evaluation of The Views Senior Living according to the biophilic patterns and universal design parameters. According to the conclusion of the table, the facility contains designs that carry twelve of the fourteen patterns of biophilic design. The prospect pattern could not be found due to the building's low-rise structure. Therefore, the lack of a broader view to dominate the environment is determined. In addition, a design associated with the water element is not observed.

Moreover, Table 4.5 indicates that natural lighting has been used effectively in the space. The windows are designed to be controlled by the users in terms of ventilation and temperature control. In addition, the facility meets the universal design parameters to a great extent. The positive aspects of the facility are the use of safe materials on the floor, distinctive colors that the users can easily perceive and the perception of place and direction, and the design of the dimensions and heights with all users in mind.

Table 4.5. The Views Senior Living evaluation in terms of fourteen patterns of biophilic design and seven universal design parameters

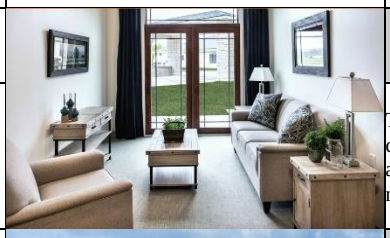
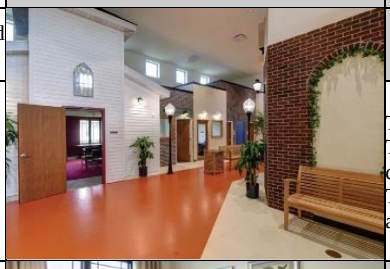
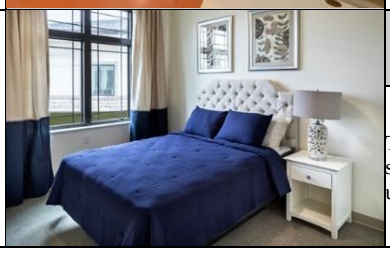
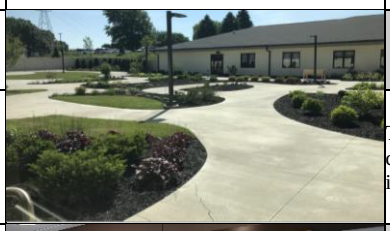
RESTORATIVE DESIGN MATRIX FOR CARE HOMES									
THE VIEWS SENIOR LIVING		UNIVERSAL DESIGN PARAMETERS							
BIOPHILIC DESIGN PATTERNS	EXEMPLARY IMAGE OF THE FACILITY	1.Equitable Use	2.Flexibility in Use	3.Simple and Intuitive Use	4.Perceptible Information	5.Tolerance for Error	6.Low Physical Effort	7.Size and Space for Approach and Use
1.Visual connection with nature		+	+	+	NA	-	+	-
Explanation		The glass doors create a visual connection with the garden. The coffee table can be positioned elsewhere as needed. Thus, the space is open to flexible use and the design is appropriate for universal design. Perceptible information is not available but does not seem necessary for the location.						
2.Non-visual connection with nature		+	+	+	+	+	+	+
Explanation		The touching of the natural elements, smelling and feeling the breeze creates a non-visual connection with nature. The entrance, which is perceived with its design and solved with a single elevation without creating a height difference, complies with universal design principles.						
3.Non-rhythmic sensory stimuli		+	+	+	-	+	+	+
Explanation		The fireplace creates non-rhythmic sensory stimuli for the residents. The floor material is appropriate to protect residents from possible injuries.						
4.Thermal & Airflow Variability		+	+	+	+	-	+	+
Explanation		The wall-length openable windows create a thermal and airflow variety at the facility. With the color differences in the other room, there created perceptible information for the users.						
5.Presence of water		Not available						
6.Dynamic and diffuse light		+	+	+	+	+	+	+
Explanation		The top and classic windows provide dynamic and diffused light at the facility. The flooring material is appropriate to protect users from possible dangers and different materials and shapes of the walls provide perceptible information. The wide doors and corridors comply with the size and space for approach and use.						
7.Connection with natural systems		+	+	+	NA	-	+	+
		The nature-viewed windows offer the opportunity for residents to observe seasonal changes in nature. The rooms are designed to appropriate with the universal design principles.						

Table 4.5. (Continued) The Views Senior Living evaluation in terms of fourteen patterns of biophilic design and seven universal design parameters

RESTORATIVE DESIGN MATRIX FOR CARE HOMES								
THE VIEWS SENIOR LIVING		UNIVERSAL DESIGN PARAMETERS						
BIOPHILIC DESIGN PATTERNS	EXEMPLARY IMAGE OF THE FACILITY	1.Equitable Use	2.Flexibility in Use	3.Simple and Intuitive Use	4.Perceptible Information	5.Tolerance for Error	6.Low Physical Effort	7.Size and Space for Approach and Use
8.Biomorphic forms and patterns		+	-	-	+	-	-	+
Explanation		The evocation of natural forms inspires the curved nature of the landscape and circulation boundaries. The dimensions are appropriate for every user and the information sign leading the users.						
9.Material connection with nature		+	+	+	+	+	+	+
Explanation		Wood and stone materials are used in the reception area. Also, considering the difference in height at the reception desk is suitable for wheelchair users and complies with universal design principles. Besides, carpet coating on the floor prevents dangerous situations. Direction signs are sufficient to realize the functions of the space.						
10.Complexity and order		+	+	+	+	+	+	+
Explanation		Various materials such as wood, stone and concrete used on the facade, fishbone pattern applied and the scale difference in the windows between floors create a complex structure. Horizontal and vertical lines and repetition in the windows create an order.						
11.Prospect		Not available						
12.Refuge		+	+	+	+	+	+	+
Explanation		Although there is normally a high ceiling in the space, creating lower and surrounded areas in specific places defines a shelter for the residents. The soft material used on the floor ensures safe use. The use of light and color guides the user and provides information about the spaces.						
13.Mystery		+	+	+	+	+	+	+
Explanation		The fact that the spaces move along a curved path allows the user to explore the place by progressing, which creates curiosity in the user. The place is appropriate to universal design principles.						
14.Risk and Peril		+	+	+	+	+	+	+
Explanation		Stairs, floors, tables, and chairs are made of natural materials. An alternative to the stairs is an elevator. The Stairstep height and landing area suitable for user comfort.						

4.2.3. The Summit at Rockwood

Rockwood Retirement is located in Spokane, Washington, and was established in the 1960s. After the need for restoration is required to understand the needs of the new residents and more ecologically sustainable. The design is created considering the biophilic principles. The NAC and Perkins Eastman architecture firm restore the place and design the eleven-story building in March 2016. The renovation includes 62 living units, an auditorium that allows concerts, a heated pool, a fitness center, a bistro, and a library. (URL-29)

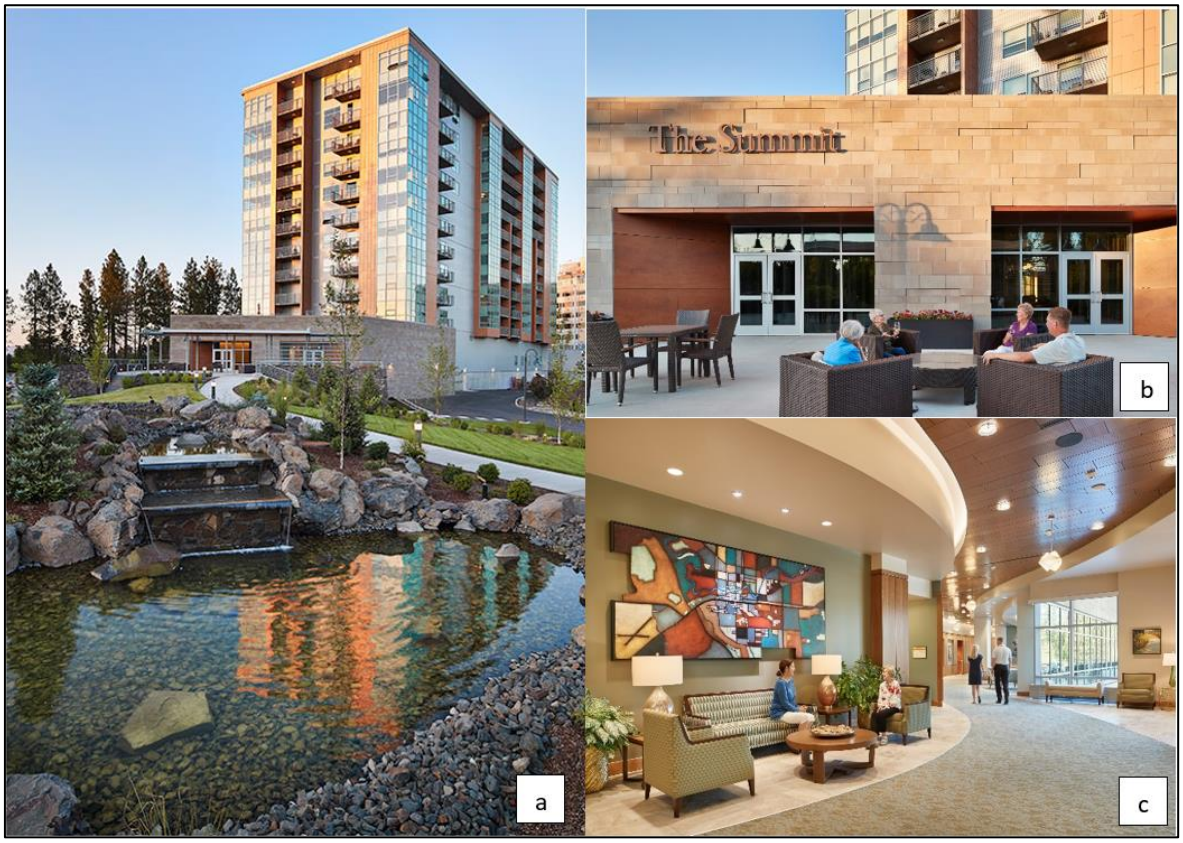


Figure 4.17. (a) The exterior view of the Summit at Rockwood, (b) The terrace area, (c) The lobby area with a curvilinear circulation (URL-29)

The community has a Livewell program that includes seven patterns: healthy mind and body, social connections, lifelong learning, financial well-being, mindfulness, fun and entertainment, and spirituality. There designed four different dining alternatives within these principles: an outdoor dining area, a ballroom, an indoor swimming pool, a business and arts center, a wellness center, and a library. Moreover, the residents have an opportunity at the garden to plant and gardening.

Figure 4.18. Layout plan of Rockwood South Hill Retirement (URL-30)

The building has a view of mountains, forests, and the Spokane River. The renovated design is also inspired by the river, which seems to connect the amenity areas at the curvilinear. The corridor is designed like a flowing river which shows the role environmental influences play in design. Moreover, the colors used in the facility are inspired by the Pacific Northwest forests that consist of tones of greens, browns, reds, and copper.

There designed several alternative room layouts for residents to choose from according to their needs. All alternatives have balconies, a private kitchenette, and bathrooms. The rooms for the aging residents with memory care designed with a visual line for the site and broad perspective points to understand where they locate, and sign and wayfinding systems are provided (Kurtz, 2021)

Figure 4.19 shows the several alternative room layouts that allow residents to choose according to their needs. All the residents' rooms have a balcony, which gives them an advantage of connecting with nature, take fresh air, feeling dominance over the place, which leads to the prospect pattern.

Figure 4.19. Floor plans of Rockwood Southill Retirement (URL-31)

Table 4.6 shows The Summit at Rockwood's evaluation in terms of biophilic and universal patterns. According to the conclusion from the table, the facility has a state that carries every sample of biophilic design parameters. Although it is a multi-story building, the balcony in each room strengthened the user's connection with nature and increased their command of the environment by view the environment from a wide-angle and take fresh air inside the rooms and balance the inside-outside temperature. It supports risk and peril, prospect, and thermal and airflow variability patterns. The facility has a large garden located close to the forest, observing nature's seasonal changes and interacting with other livings, supporting visual connection with nature. In addition, the facility allows pets, and it provides contact with non-visual connection with nature pattern. The curved forms of the spaces, the colors used, the paintings used on the walls are inspired by nature, supporting "biomorphic forms and patterns" and "mystery" parameters.

The pictures examined in Table 4.6 show that the universal design parameters are effectively provided in the facility. The deficiencies are observed in the universal design due to directional signs lacking some areas, safe floor material, and high shelf usage in the library in some places. Apart from these, the facility works following the universal and biophilic design principles.

Table 4.6. The Summit at Rockwood evaluation in terms of fourteen patterns of biophilic design and seven universal design parameters

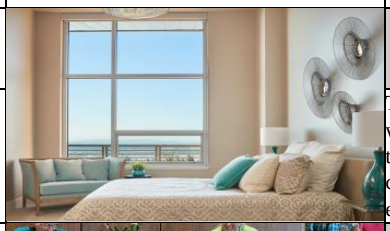
RESTORATIVE DESIGN MATRIX FOR ASSISTED LIVING FACILITIES								
THE SUMMIT AT ROCKWOOD		UNIVERSAL DESIGN PARAMETERS						
BIOPHILIC DESIGN PATTERNS	EXEMPLARY IMAGE OF THE FACILITY	1.Equitable Use	2.Flexibility in Use	3.Simple and Intuitive Use	4.Perceptible Information	5.Tolerance for Error	6.Low Physical Effort	7.Size and Space for Approach and Use
1.Visual connection with nature		+	+	+	+	+	+	+
Explanation		The rooms and also most of the windows at the place have a visual connection with nature. The rooms have characteristics that every occupant finds it easy to access and use with less physical effort. The rooms have a simple characteristic that every occupant finds easy to access and use less physical effort.						
2.Non-visual connection with nature		NA	NA	+	NA	+	+	+
Explanation		A pet-friendly environment leads to a haptic experience for the residents. All the residents have an opportunity to use the area and take fresh air in the courtyard.						
3.Non-rhythmic sensory stimuli		+	+	+	+	+	+	+
Explanation		The fireplace areas create a non-rhythmic natural experience for the residents—the place design for everyone without discriminating against anyone. The size and spacing are appropriate for everyone.						
4.Thermal & Airflow Variability		+	+	+	+	+	+	+
Explanation		The use of glass on a large part of the facility's exterior walls and designing them to be opened with windows and doors allows fresh air to be taken in and provides temperature control.						
5.Presence of water		+	NA	NA	NA	-	NA	NA
Explanation		There is an artificial lake in the garden where residents can listen to the sound of the water and find peace around it, as it is constantly flowing.						
6.Dynamic and diffuse light		+	+	+	+	+	+	+
Explanation		Since the lobby area is designed in a wide opening and the hanging floor is connected to this area, the mezzanine receives indirect light. The building is designed as a rectangle extending in the east and west direction, and the common areas and rooms receive natural light during the day.						
7.Connection with natural systems		NA	NA	NA	NA	NA	NA	NA
		Having a large garden and connecting this area with the forest allows observing various kinds of animals and plants. The natural system connection is provided through this garden; seasonal and daily changes are observed.						

Table 4.6 (Continued) The Summit at Rockwood evaluation in terms of fourteen patterns of biophilic design and seven universal design parameters

RESTORATIVE DESIGN MATRIX FOR ASSISTED LIVING FACILITIES								
THE SUMMIT AT ROCKWOOD		UNIVERSAL DESIGN PARAMETERS						
BIOPHILIC DESIGN PATTERNS	EXEMPLARY IMAGE OF THE FACILITY	1.Equitable Use	2.Flexibility in Use	3.Simple and Intuitive Use	4.Perceptible Information	5.Tolerance for Error	6.Low Physical Effort	7.Size and Space for Approach and Use
8.Biomorphic forms and patterns		+	+	+	+	+	+	+
Explanation		The texture of the sofa inspired by the biomorphic patterns. The inside and outside connection is sold without using any step						
9.Material connection with nature		+	+	+	+	+	+	+
Explanation		The stone fireplace area and timber chairs and desk create the material connection with nature. The flooring material appropriate for tolerating the hazards in the space. The bookshelves are not appropriate for every user and not safe.						
10.Complexity and order		+	+	+	+	+	+	+
Explanation		At the lobby and corridor, the different materials and repetitive elements create a complexity that is in order. With the design difference with height and material difference, it is easy for the users to realize where to enter the building						
11.Prospect		+	+	+	+	+	+	+
Explanation		Large windows and terraces let the users have a wide field of vision through the surrounding. The place serves comfort for the users and the design is appropriate for the principles of universal design						
12.Refuge		+	+	+	+	+	+	+
Explanation		The sitting areas with height differences and the enclosure provide being secluded places of refuge. The flooring material appropriate for tolerating the hazards in the space. The bookshelves are not appropriate for every user and not safe						
13.Mystery		+	+	+	+	+	+	+
Explanation		With the contrasting colors and dark edges at the corners of the place, the mystery effect is created. The place is designed with different sitting options; the flooring material is appropriate for protecting the user from falling conditions. Circulation area designed appropriately for the use						
14.Risk and Peril		-	+	+	-	+	+	-
Explanation		Wall-length windows create a risky feeling for the viewers; however, it is safe with the structure. With the high window and sunblind, the entrance can be noticed even a long distance. A small ramp through the interior is designed for every user.						

4.3. Evaluation of Findings

According to the results obtained from the tables, it is seen that the six sample projects examined carried twelve out of fourteen biophilic parameters. The Trousdale Senior Living, Westminster Village, and The Summit at Rockwood have examples for every biophilic design pattern. The Village at White River Junction and The Views Senior Living has thirteen out of fourteen patterns. The only missing pattern for both facilities is the presence of water. The Views Senior Living meets the twelve biophilic design patterns and the two patterns that are detected to missing are the presence of water and prospect pattern.

Table 4.7 that the presence of water pattern in three of the six assisted living case studies has the most significant deficiency in practice. On the other hand, the fact that the facilities carry thirteen of the fourteen parameters on average shows that the practices in the selected assisted living facilities set an example for biophilic design application from theory to practice.

Table 4.7. General biophilic design evaluation table of the examined senior living facilities

RESTORATIVE DESIGN MATRIX PARAMETERS	SENIOR LIVING FACILITIES			SENIOR LIVING FACILITIES WITH GREEN BUILDING CERTIFICATE			RATIO
BIOPHILIC DESIGN PATTERNS	THE VILLAGE AT WHITE RIVER JUNCTION	THE TROUSDALE SENIOR LIVING	WESTMINSTER VILLAGE	MURANO SENIOR LIVING	THE VIEWS SENIOR LIVING	THE SUMMIT AT ROCKWOOD	
Visual Connection with Nature	+	+	+	+	+	+	6/6
Non-visual Connection with Nature	+	+	+	+	+	+	6/6
Non-Rhythmic Sensory Stimuli	+	+	+	+	+	+	6/6
Thermal and Airflow Variability	+	+	+	+	+	+	6/6
Presence of Water	-	+	+	-	-	+	3/6
Dynamic and Diffuse Light	+	+	+	+	+	+	6/6
Connection with Natural Systems	+	+	+	+	+	+	6/6
Biomorphic Forms and Patterns	+	+	+	+	+	+	6/6
Material Connection with Nature	+	+	+	+	+	+	6/6
Complexity and Order	+	+	+	+	+	+	6/6
Prospect	+	+	+	+	-	+	5/6
Refuge	+	+	+	+	+	+	6/6
Mystery	+	+	+	+	+	+	6/6
Risk and Peril	+	+	+	+	+	+	6/6
TOTAL RATIO	13/14	14/14	14/14	13/14	12/14	14/14	

While the six determined assisted living facilities are examined, 14 photographs for each facility are evaluated according to biophilic parameters. Also, each of these photos is analyzed according to seven universal design parameters. Under these conditions, universal design criteria will be examined 14 times in an assisted living facility carrying 14 biophilic design parameters. The highest value for review options for universal design criteria would be fourteen times seven as ninety-eight in that method. For instance, if the facility contains thirteen of the fourteen biophilic parameters, then the universal design criteria will be examined thirteen times seven, a total of ninety-one times. Besides, it does not become possible to observe universal design criteria in some photographs. These situations are excluded from the criteria and are not included in the total universal design value. Therefore, there are differences in the total value in the ratio section in the table. In order to make these values more understandable, the values are given in percentages in the rightmost column and the bottom raw at Table 4.8.

Table 4.8. General universal design evaluation table of the examined senior living facilities

RESTORATIVE DESIGN MATRIX PARAMETERS	SENIOR LIVING FACILITIES			SENIOR LIVING FACILITIES WITH GREEN BUILDING CERTIFICATE			TOTAL RATIO	RATIO (%)
UNIVERSAL DESIGN PARAMETERS	THE VILLAGE AT WHITE RIVER JUNCTION	THE TROUSDALE SENIOR LIVING	THE WESTMINSTER VILLAGE	MURANO SENIOR LIVING	THE VIEWS SENIOR LIVING	THE SUMMIT AT ROCKWOOD		
Equitable Use	10/13	12/14	12/14	11/12	12/12	11/12	68/77	88,3
Flexibility in Use	11/11	14/14	11/13	11/12	11/12	11/11	69/73	94,5
Simple and Intuitive Use	13/13	12/14	14/14	12/13	11/12	12/12	74/78	94,5
Perceptible Information	7/9	7/11	6/14	7/12	9/10	10/11	46/67	68,6
Tolerance for Error	9/13	8/14	11/14	10/12	8/12	12/13	58/78	74,4
Low Physical Effort	10/13	9/14	13/14	12/13	11/12	12/12	67/78	85,9
Size and Space for Approach and Use	10/13	8/14	11/14	12/13	11/12	11/12	63/78	80,8
TOTAL RATIO	70/85	70/95	78/97	75/87	73/82	79/83		
TOTAL RATIO (%)	82,35	73,68	80,41	86,21	89,02	95,18		

5. DISCUSSION OF FINDINGS

The findings obtained reveal that the selected assisted living facilities holistically meet the biophilic design parameters as indicated in Table 4.7. Among the six assisted living facilities, three samples contain fourteen, two samples with thirteen, and one with twelve of fourteen biophilic design parameters. Consequently, the chosen facilities are practical guides to examine the application examples of biophilic design. Since each sample has a high biophilic value, there was no significant difference between green building certified and non-certified examples. The findings obtained as a result of the examination of six assisted living case studies are as follows.

5.1. Evaluation of Findings According to Biophilic Design Parameters

Although it is not directly known to be related to biophilic design, certificate credits related to parameters determined when their contents are examined show the relationship between the green building certificates and biophilic design principles.

The Visual Connection with Nature

The selected facilities have realized the importance of visual connection with nature, and this visual connection has been tried to be provided by having wide window openings, especially in common areas such as restaurants and lobby.

The visual connection with nature pattern investigation on selected GBRTs shows that supplying the facility's occupants to view the outdoor environment for 75% of progressively used floor areas is an ideal design method. The rooms with acoustic or visual requirements as conference rooms may not be included in 75%. The atrium design at the lobby, café, or restaurant area can be evaluated to meet the %30 of the indicated 75 percent view ratio. The glass of windows and their visible light transmittance must be more than %40, and if desired, natural tones of glass can be applied in some areas (Council, 2021a).

Nature view or nature-connected object minimum 7.5 meters away from the window is appropriate for the visual connection with nature pattern. The outside view should be observed inside the window's height at three times, without any obstacles like furniture. A

resting place with a nature view, indoors or in the outdoor area, can be designed in 5% of the net usable area inside the building. With the same features, up to 2% of the building can be designed as a rest area for staff. These areas should be designed as easily accessible spaces with a maximum distance of 60 meters from the building entrance. There should be a shading area that can be used when necessary, and at least one of the five seating areas should be a wheelchair area. These places should be located at least 7.5 meters away from the smoking areas (Council, 2021a).

Visual connection with nature, potted plants, artificial waterfall, vertical plant walls, nature-inspired paintings or ornaments, nature-related sounds, shapes, and patterns can be used in common areas (I. W. B. Institute, 2020). In the facilities, surveys and research should be conducted to measure the users' satisfaction every six months, design usage and needs analysis should be done (I. L. B. Institute, 2019). Table 5.1. shows the adaptable requirements of green building certificates to assisted living facilities for the visual connection with nature pattern.

Table 5.1. The adaptable requirements of green building certificates to assisted living facilities for the visual connection with nature pattern

	GREEN BUILDING CERTIFICATE CREDITS	THE ADAPTABLE REQUIREMENTS OF GREEN BUILDING CERTIFICATES TO ASSISTED LIVING FACILITIES
VISUAL CONNECTION WITH NATURE	LEED, Quality Views Credit	Provide occupants in the building to view the outdoor natural or urban environment for 75% of all regularly occupied floor areas. Auditoriums, conference rooms and gymnasiums may be excluded. Views into interior atria may be used to meet up to 30% of the required area.
		Views must be through glass with a visible light transmittance (VLT) above 40%. If the glazing has frits, patterns, or tints, the view must be preserved. Neutral gray, bronze and blue-green tints are acceptable.
		Views must include at least one of the following: -Nature, urban landmarks, or art; or objects at least 7.5 meters from the glazing exterior. -Occupants must have direct access to the view and be within three times the head height of the glazing with no permanent interior obstructions between the occupant and the window or moveable furniture and partitions blocking the view. Exceptions: Vertical columns smaller than 0.3 meters wide and horizontal features smaller than 0.3 meters high are excluded.
	LEED, Places of Respite Credit	- Provide places of respite that are accessible to patients and visitors, equal to 5% of the net usable program area of the building. - Provide additional dedicated places of respite for staff, equal to 2% of the net usable program area of the building. - Places of respite must be outdoors, or located in interior atria, greenhouses, solaria, or conditioned spaces
		- The area is accessible from within the building or located within 60 meters of a building entrance or access point. - Options for shade or indirect sun are provided, with at least one seating space per 18.5 square meters of each respite area, with one wheelchair space per five seating spaces. Universal-access natural trails that are available to visitors, staff, or patients may account for no more than 30% of the required area, provided the trailhead is within 60 meters of a building entrance.
		Outdoor areas must meet the following requirements: A minimum of 25% of the total outdoor area must be planted with two or more adapted or native vegetation types, or have overhead vegetated canopy. The area is open to fresh air, the sky, and the natural elements. Places of respite may not be within 7.6 meters of a smoking area.
	WELL V2, Nature and Place	The project integrates the following throughout the space, including common circulation routes, shared seating areas and rooms: o Natural materials, patterns, shapes, colors, images or sounds. o At least one of the following: Plants (e.g., potted plants, plant walls), Water (e.g., fountain), Nature views
	WELL V2, Restorative Spaces	At least one restorative space is available to all regular occupants. Space may be indoor or outdoor that meet the requirements: • Totals at least 7 m² plus 0.1 m² per regular occupant, up to a maximum of 186 m². • Provides a restorative environment that considers at least five of the following: • Lighting (e.g., dimmable light levels for indoor spaces). • Sound (e.g., water feature, natural sounds, sound masking) • Thermal comfort (e.g., sun-exposed and shaded areas for outdoor spaces). • Nature incorporation • Calming colors, textures and forms and visual privacy
	WELL V2, Access to Nature	The project provides a combination of indoor plants (e.g., potted plants, plant beds, plant walls), water feature or view comprising of natural areas, such as green spaces (e.g., park, forest) or blue spaces (e.g., ocean, lake).
	LBC 4.0, Access to Nature	All projects must connect people and nature by providing sufficient and frequent human-nature interactions in both the interior and exterior of the project to connect the majority of occupants with nature directly. All projects must complete a post-occupancy evaluation that addresses the project's health benefits, including the benefits of daylight, fresh air, and access to nature at least once within six to twelve months of occupancy.

Non-Visual Connection with Nature

Some facilities have a tolerant approach to keeping pets with residents, providing the non-visual connection with nature with the tactile and sensory connection. Moreover, the hobby gardens, indoor planting areas for residents, green courtyards, and outdoor areas of the facility provides; visual, olfactory, auditory, and tactile connection with nature
The non-visual connection with nature pattern in selected GBRTs suggests that field research should be carried out for the primary plant species, vegetation in the local place, treemaps, and endangered species in the area where the building is located (Council, 2021a).

The tactile, olfactory, and auditory connection to nature is most intensely provided by access to the outdoor area. For this reason, the facility should be designed with a planning scheme that users can easily access, especially inpatients outdoor. These spaces, where people get fresh air and connect with nature, are preferred to be designed 7.5 meters away from exhaust pipes with exhaust outlets or roads with idling cars (Council, 2021a).

The designed outdoor space should be at least 30% of the total site area. At least 25% of this outdoor area should consist of at least two kinds of vegetation or tree species. There should be at least two examples of a socialization area, habitat area, garden, and recreation area in the designed outdoor space (I. W. B. Institute, 2020).

In the project, especially in common areas, the possibility of finding plants, a hobby garden, a water pond or fountain, and their sound is heard or touched by the users provide opportunities for non-visual contact with nature. Moreover, a restorative space that may be interior or outdoor has access to natural sounds as birds or water, and nature incorporation provides a non-visual connection with nature (I. L. B. Institute, 2019). Table 5.2. shows the adaptable requirements of green building certificates to assisted living facilities for non-visual connection with nature pattern.

Table 5.2. The adaptable requirements of green building certificates to assisted living facilities for non-visual connection with nature pattern

	GREEN BUILDING CERTIFICATE CREDIT	THE ADAPTABLE REQUIREMENTS OF GREEN BUILDING CERTIFICATES TO ASSISTED LIVING FACILITIES
NON-VISUAL CONNECTION WITH NATURE	LEED V4.1, Site Assessment	Complete and document a site survey or assessment that includes the following information: Primary vegetation types, greenfield area, significant tree mapping , endangered species lists, invasive plant species listed by regional, state, or federal entities.
	LEED V4.1, Direct Exterior Access	- Provide direct access to an exterior courtyard, terrace, garden, or balcony. The space must be at least 0.5 square meters per patient for 75% of all inpatients and 75% of qualifying outpatients whose clinical length of stay exceeds four hours.
		- Patients whose length of stay exceeds four hours, and whose treatment makes them unable to move, such as emergency, stage 1 surgical recovery, and critical care patients, may be excluded.
		- Places of respite outside the building envelope that meet the requirements are immediately adjacent to clinical areas or with direct access from inpatient units may be included.
		- Qualifying spaces must be designated as nonsmoking. The spaces must also meet the requirements for outdoor air contaminant concentrations and be located more than 30 meters from building exhaust air locations, loading docks, and roadways with idling vehicles.
	LEED V4.1, Open Space	- Provide outdoor space greater than or equal to 30% of the total site area (including building footprint).
		- At least 25% of the calculated outdoor open space must be vegetated with two or more vegetation types or have an overhead vegetated canopy.
		The outdoor space must be physically accessible and be one or more of the following: social area, recreational area, diverse green space, garden, habitat area.
	WELL V2, Nature and Place	The project integrates the following throughout the space, including common circulation routes, shared seating areas and rooms o Natural materials, patterns, shapes, colors, images or sounds. o At least one of the following: Plants (e.g., potted plants, plant walls), water (e.g., fountain), nature views
	WELL V2, Enhanced Access to Nature	One of the following requirements is met: • Outdoor space of at least 5% of the interior project area must be accessible to all regular occupants. •At least 70% of the accessible outdoor space as viewed from above must include plants or natural elements, including tree canopies. • At least one green space or blue space is within a 200 m walk distance from the project boundary and available to all regular occupants. • Green spaces must be a minimum of 0.5 hectares. • Occupants are encouraged to access outdoor nature (e.g., presence of signage or maps to outdoor nature, availability of breaks during the workday to visit outdoor nature).
	LBC 4.0, Urban Agriculture	All projects must dedicate a portion of their total project area to growing food or a smaller portion of their total project area to growing food and directly providing weekly community access to healthy local food that addresses community needs through farmers markets.

Thermal and Airflow Variability

The importance of natural ventilation in the rooms and common areas has been understood, and window opening systems that the users can control according to their needs have been

used. The terraces, interior courtyards, balconies, outdoor areas, and natural ventilation systems for the interior provides the pattern.

The thermal and airflow variability patterns connection provided in the GBRTs suggests giving the ability to their environment thermal comfort control to the residents at minimum 50% of the places at the facilities. Maintaining the group thermal controls is necessary for the common areas, letting the residents control the humidity, airspeed, and temperature (Council, 2021a).

It is necessary to assess the site to access the site's solar exposure, sun and shadow angles, shading opportunities, annual temperature and precipitation, and prevailing wind direction (Council, 2021a). For the mechanical ventilation systems, supplying the outdoor air monitors the places where the air intake is more than 1000 cfm, and an alarm mechanism must be set to detect the value of the airflow setpoint varies more than 15% of the upper limit of the specified range. It is necessary to supply direct exhaust to bathrooms and kitchens (I. L. B. Institute, 2019).

To meet the requirements, the openings for natural ventilation may design with a device for automatic indication. If the ventilation openings are closed at busy and active times, the designed alarm must start to give a sign (Council, 2021a).

The operable windows must be a minimum of %75 of the actively used areas and supply natural air ventilation. These window areas are %4 of the used floor areas at the minimum and %75 of the used places progressively during the day. There could be used indicator light located at windows that sign if the exterior air is appropriate to open the window (I. W. B. Institute, 2020).

Moreover, For the minimum 90% of regularly used areas, the dry-bulb temperature is ideally between 21 to 25 degrees, and the velocity of air above 1.7 meters is a maximum of 0,2 m/s. The thermal and airflow controls must be done equal to or more than twice a year (I. W. B. Institute, 2020).

In order to determine the area and height of the window opening, the middle distance of the window opening should be at most 1.8 meters above the floor of the space and the minimum

dimension of the opening is 0,3 meters, it is searched at least 70% of the operable windows and minimum one operable window in a room must be designed as specified dimensions. Whether the facility is in a cold climate or used a heating system, it is preferred that at least 30% of the windows can be opened at least 1.8 meters from the floor. The control mechanism of the windows is positioned a maximum of 1,7 meters high from the floor. There used low opening windows in the hot climate zones or warm weather (I. W. B. Institute, 2020).

A thermostat could provide the temperature control of a place or a technological interface that the users of the area reach from a phone or computer. These sensors in the area have located a minimum of one meter away from any other heated or cooler devices, doors, windows, and exterior walls (I. W. B. Institute, 2020).

The humidity of the commonly used spaces is between 30%-%60 apart from the high humidity areas. Moreover, the residents' rooms must have one hundred percent operable windows (I. W. B. Institute, 2020). Table 5.3. shows the adaptable requirements of green building certificates to assisted living facilities for thermal and airflow variability pattern.

Table 5.3. The adaptable requirements of green building certificates to assisted living facilities for thermal and airflow variability pattern

	THE GREEN BUILDING CREDIT	THE ADAPTABLE REQUIREMENTS OF GREEN BUILDING CERTIFICATES TO ASSISTED LIVING FACILITIES
THERMAL AND AIRFLOW VARIABILITY	LEED V4.1 Thermal Comfort	Provide individual thermal comfort controls for at least 50% of individual occupant spaces. Provide group thermal comfort controls for all shared multi-occupant spaces. Thermal comfort controls allow occupants, whether in individual spaces or shared multi-occupant spaces, to adjust at least one of the following in their local environment: air temperature, radiant temperature, airspeed, and humidity.
	LEED V4.1 Site Assessment	Complete and document a site survey or assessment that includes the following information: Solar exposure and shading opportunities, heat island effect potential, seasonal sun angles, prevailing winds, average monthly precipitation and temperature ranges
	LEED V4.1 Minimum Indoor Air Quality Performance	Provide outdoor air monitors for all mechanical ventilation systems with outdoor air intake flow greater than 1000 cfm (472 L/s). The monitoring device must be capable of measuring the minimum outdoor air intake flow and be capable of measuring the design minimum outdoor air intake flow with an accuracy of +/–10%. An alarm must indicate when the outdoor airflow value varies by 15% or more from the set point. The same requirements are applied to the direct exhaust airflow measurement device.
		Provide automatic indication devices on all the natural ventilation openings intended to meet the minimum opening requirements. An alarm must indicate when any one of the openings is closed during occupied hours.
	WELL V2, Operable Windows	At least 75% of the regularly occupied spaces have operable windows that provide access to outdoor air. For each floor, the openable window area, is at least 4% of the net occupiable floor area.
		Window operation: Indicator lights at windows (at least one per room with windows) cue occupants when the conditions outside are suitable for opening windows: PM2.5: 15 µg/m³ or lower, dry-bulb temperature: within 8 °C of indoor air temperature set point, relative humidity: 65% or lower.
	WELL V2, Thermal Performance	Dry bulb temperature is between 21-25 °C for at least 90% of standard occupied hours. The designed air velocity is not more 0.2 m/s at 1.7 m above the floor.
		The dry-bulb temperature, relative humidity, air speed and mean radiant temperature are monitored in regularly occupied spaces at intervals no less than twice a year (including once in June, July or August and once in December, January or February).
	LBC 4.0, Healthy Interior Environment	All projects must: Prohibit smoking within any buildings or enclosed spaces, and within 7,5 meters of any building opening, including air supply vents. Provide direct exhaust for kitchens, bathrooms, and janitorial areas.
	WELL V2, Enhanced Operable Windows	- At least 70% of operable windows may be opened such that at least half of the opening is not more than 1.8 m above the finished floor and the opening is at least 0.3 m in the smallest dimension. At least one such window is present in each room with operable windows. If the project is equipped with heating, at least 30% of operable windows may be opened such that the entirety of opening is at least 1.8 m above the finished floor). - At least one such window is present in each room with operable windows. - Controls for window operation are positioned not more than 1.7 m above the finished floor. Windows with low openings are to be used during mild and/or warm weather. - Windows are not to be opened when mechanical cooling is in operation (not required if no mechanical cooling is present or if the mechanical cooling system is configured to disengage automatically when windows are open). - Windows with high openings (if present) are to be used in cold weather.
	WELL V2, Thermal Zoning	Control over the temperature in the space is available through either thermostat presents within the thermal zone or a digital interface accessible to occupants on a computer or phone. The maximum size of each thermal zone is 60 m² or 10 occupants, whichever is larger. Temperature sensors are positioned at least 1 m away from exterior walls, windows and doors, direct sunlight, air supply diffusers, mechanical fans, heaters, or any other significant heat or cold sources.
	WELL V2, Humidity Control	Humidity data for all regularly occupied areas, except high-humidity spaces covering at least the previous six months, are between 30% and 60% for at least 98% of all business hours of the year.

Connection with Natural Systems

The Connection with natural systems parameter is provided by observing the time-dependent changes in the place and the environment. It is achieved by the fall of the leaves or the seasonal color change of trees, age-related changes of the animals they feed or observe in nature, seasonal events such as snow, rain, or the movement of the stars and the moon outdoors. On the other hand, the natural materials used in the interior and their change over time, the change that indoor plants experience over time provide users with a connected environment with natural systems.

On the site, maintain the original state of 40% of the greenfield area of the site and, if possible, restore the already disturbed parts while taking into account the soil and vegetation conditions. The green roof area could cover the needed ratio whether the used plants supply a habitat there. A part of the site could be designed with vegetable or fruit plants that are locally proper for the site conditions. This area is designed as 5% of the total vegetated area at a minimum, yet it is more than 23 square meters. If a facility in a city does not have enough site area, it can design 15% of the roof area as a green roof. This area should not be smaller than 18 square meters (Council, 2021a).

There should be a green area for walking or cycling at most 400 meters from the site area or within site, and a blue area with a water element to swim or walk around. The building's construction site must refrain from building on a floodplain, pristine greenfield, or prime farmland and protecting the local habitats. Before the construction period, research must contain the examination of the local habitats. It is not wanted to use pesticides or petrochemical fertilizers in the area (I. L. B. Institute, 2019). Table 5.4. shows the adaptable requirements of green building certificates to assisted living facilities for connection with natural systems pattern.

Table 5.4. The adaptable requirements of green building certificates to assisted living facilities for connection with natural elements pattern

	GREEN BUILDING CERTIFICATE CREDIT	THE ADAPTABLE REQUIREMENTS OF GREEN BUILDING CERTIFICATES TO ASSISTED LIVING FACILITIES
CONNECTION WITH NATURAL SYSTEMS	LEED V4.1 Protect and Preserve Area	Preserve and protect from all development and construction activity 40% of the greenfield area on the site. And Restore a portion of the site (including the building footprint) identified as previously disturbed and follow vegetation and soil requirements. Vegetated roof surfaces may be included in the habitat area calculations if the plants are native or adapted and provide habitat.
	LEED V4.1 Local Food Production (Pilot Credit)	Provide a dedicated portion of the site for onsite food production: gardens or planters with vegetables and/or edible nut- and fruit-bearing plants appropriate to the site. The area calculated shall be the actual growing area used to produce food-bearing plants. Size the area using one of the following metrics: o At least 5% of the site's vegetated area (excluding preserved or restored habitat area) but no less than 23 m² (250 square feet). Urban projects with a minimum density of 1.5 FAR, at least 15% of useable rooftop surface area (excluding mechanical equipment, skylights, roof drains, window washing staging, emergency egress routes, etc. and private balconies or decks) but no less than 18.5 m² (200 square feet).
	WELL V2, Physical Activity Spaces and Equipment	At least one of the following outdoor physical activity spaces is within 400 meters walk distance of the project boundary and available at no cost to regular occupants: o Green space (e.g., park, walking/biking trail). o Blue space (e.g., swimming area). o Recreational field or court. o Fitness zone that includes all-weather fitness equipment. For projects with child occupants, play space geared toward children (e.g., playground).
	LBC 4.0, Ecology of Place	All projects must avoid building on pristine greenfield, wilderness, prime farmland, or in a floodplain unless they meet an exception. Projects must preserve thriving, vibrant ecological environments and habitats.
		All project teams must document site and community conditions before starting work, including identifying the project's "reference habitat(s)."
		All projects must demonstrate that they contribute positively to the ecology of their place and restore or enhance the ecological performance of the site towards a healthy ecological baseline. The on-site landscape must be designed to mature and evolve and emulate the functionality of the reference habitat, as appropriate to the project's Transect.
		All project teams must assess cultural and social equity factors and needs in the community and consider those identified needs to inform design and process decisions.
		No petrochemical fertilizers or pesticides can be used to maintain the on-site landscape, including urban agriculture.

Dynamic and Diffused Light

The importance of natural lighting has been emphasized in selected facilities. Space is provided with directional and diffuse light with the designed buildings with skylights, inner courtyards, suspended floors, and high ceilings. The connection of natural light received in bedrooms with the circadian system in the human body has been considered significant.

The survey of shading and solar exposure sun angle change in the year could be documented first to act according to the data obtained. The relationship between the height, width, and

location of the designed building and the surrounding park, green area, or green area designed in the land should be calculated in advance with a computer program, and the design should be made in a way that will not prevent these spaces from getting sunlight (Council, 2021a).

For one or two-floored areas, minimum 100 lux at the not regularly used areas 25%, 20% for three or four floors, and 15% for five and more floor facilities. Moreover, with a daylight simulation, 30% of the common space areas are designed with a maximum six meters distance from the window or any glazing, and 70% of the seating arrangement designed a maximum of five meters away from the glazing that takes the natural light inside (Council, 2021a).

More than 7% of a room or a floor area, the envelope glazing area is designed. More than 25% of the floor area preferred to design with glazing in the rooms, and more than 40% visible light transmittance is preferred at the windows (I. W. B. Institute, 2020).

The staircase area is designed with a minimum of 215 lux. The skylight and windows used to take natural light are preferable. At the lighting design, the users' age group must be considered, and the design should be according to the ages and eyesight. The workshop areas and offices have a minimum of 320 lux, lobby, resting areas, cafeterias, and restaurants at least 110 lux at the task surfaces. It is preferred to have a dimmable light level at the facility that dimmed by itself after a specified hour (I. W. B. Institute, 2020).

If the light level of a room is to be determined, it can be measured at 140 cm height from the ground in the center of the common areas. In reading rooms or working areas, measurements can be taken from 45 cm above the table (I. W. B. Institute, 2020). Table 5.5. shows the adaptable requirements of green building certificates to assisted living facilities for the dynamic and diffused light pattern.

Table 5.5. The adaptable requirements of green building certificates to assisted living facilities for the dynamic and diffused light pattern

	GREEN BUILDING CERTIFICATE CREDIT	THE ADAPTABLE REQUIREMENTS OF GREEN BUILDING CERTIFICATES TO ASSISTED LIVING FACILITIES
DYNAMIC AND DIFFUSED LIGHT	LEED V4.1 Site Assessment	Complete and document a site survey or assessment that includes solar exposure and shading opportunities, seasonal sun angles.
	LEED V4.1 Daylight in Non-Regularly Occupied Spaces	Achieve at least 100 lux for 25% of the non-regularly occupied floor area for 1-2 floor buildings, 20% for 3-4 floor buildings, and 15% for buildings 5 floors and above.
	WELL V2, Light Exposure	Daylight simulation: Common spaces that have unassigned seating for at least 15% of regular occupants at any given time achieve one of the following targets: o At least 30% of the regularly occupied area is within a 6 m horizontal distance of envelope glazing on each floor and/or in each individual unit. o At least 70% of all seating in the spaces is within a 5 m horizontal distance of envelope glazing.
		o The envelope glazing area is no less than 7% of the floor area for each floor level or individual unit. o The floor plate is no more than 20 m between opposite walls that each have transparent envelope glazing, and there are no opaque obstructions higher than 1 m within a 6 m horizontal distance of the transparent envelope glazing.
	WELL V2, Daylight Design Strategies	At the façade design, envelope glazing is no less than 25% of the regularly occupied floor area or individual unit. Visible Light Transmittance (VLT) of windows is greater than 40%.
	WELL V2, Circulation Network	At least one staircase is open to regular occupants, services all floors of the project and is aesthetically designed through the inclusion of light levels of at least 215 lux when in use, windows or skylights that provide access to daylight.
	WELL V2, Visual Lighting Design	Visual lighting design for All Spaces except Dwelling Units • The illuminance thresholds take into consideration the tasks and the age groups of the occupants. • At least 90% of the project area is comprised of the following space types and meets the associated illuminance thresholds: • Offices and classrooms: minimum 320 lux at task surface • Lobby, atrium and transition (including corridor and outdoor pathways): minimum 110 lux at floor level • Storage spaces: minimum 110 lux at floor level • Dining, Lounge and Restrooms: minimum 110 lux at task surface.
	WELL V2, Circadian Lighting Design	• Electric lighting is used to achieve the following light levels: • The light levels are dimmable. If automated lighting is used, it is automatically dimmed after 8:00 pm. • The light levels are achieved in living rooms and kitchens at the height of 140 cm in the center of the room. If workstations are present, light levels are achieved at the height of 45 cm above the work-plane.
	LBC 4.0, Beauty and Biophilia	Projects must be designed to include elements that nurture the innate human/nature connection. Each project team must engage in a minimum of one all-day exploration of the biophilic design potential for the project. The exploration must result in a biophilic framework and plan for the project that outlines strategy and implementation ideas for the following: • How the project will be transformed by deliberately incorporating nature through Environmental Features, Light and Space, and Natural Shapes and Forms. • How the project will be transformed by deliberately incorporating nature's patterns through Natural Patterns and Processes and Evolved Human-Nature Relationships.

Material Connection with Nature

Material connection with nature has been on the interior and exterior facades of the spaces, on furniture such as tables, chairs, sofas, bookshelves, cabinets, beds, nightstands, and stone and wooden bridges used on the edges of the water element. The use of materials such as wood types and various natural stones creates a natural effect.

The use of wood materials in various colors and textures will create a visual and tactile complexity when diversified with stone and metal materials, and this has a stress-relieving effect on users.

The colors used in the assisted living facility are chosen from among the colors found in the ecosystem in the natural environment of the space will create an association of nature to the users. Green and shades of green can be distinguished more easily by people and have a relaxing and soothing effect on people.

It is achieved from the selected GBRTs that using natural materials in a facility assists the users in reducing their stress level and define a sense of place. Using local materials helps to define an identity for the project and user connection. For the used natural materials at the facility, a minimum of 30% of the used products is sourced. The products could be biobased, wood products, or reused natural products, which are highly preferable. Moreover, certified wood products should be encouraged (Council, 2021a).

It is preferable to use controlled extraction for the used natural materials like stone, timber, metals, and minerals. The used timber at the facility is harvested in conscious and sustainable methods that let the ecological function continues at the procured area (I. L. B. Institute, 2019).

The textile materials avoid or have lower than 100 ppm the mercury, lead, cadmium, halogenated flame retardants (HFR) compounds. Also, flooring materials, acoustic and thermal insulation products contain equal to or less than 100 ppm (I. W. B. Institute, 2020). Table 5.6. shows the adaptable requirements of green building certificates to assisted living facilities for material connection with nature pattern.

Table 5.6. The adaptable requirements of green building certificates to assisted living facilities for material connection with nature pattern

	GREEN BUILDING CERTIFICATE CREDIT	THE ADAPTABLE REQUIREMENTS OF GREEN BUILDING CERTIFICATES TO ASSISTED LIVING FACILITIES
MATERIAL CONNECTION WITH NATURE	LEED V4.1 Sourcing of Raw Materials	Use products sourced from at least three different manufacturers that meet at least one of the responsible sourcing and extraction criteria below for at least 15%, by cost, of the total value of permanently installed building products in the project.
		Use products sourced from at least five different manufacturers that meet at least one of the responsible sourcing and extraction criteria below for at least 30%, by cost, of the total value of permanently installed building products in the project. o *Wood products.* Wood products must be certified by the Forest Stewardship Council or USGBC-approved equivalent. Products meeting wood products criteria are valued at 100% of their cost for the purposes of credit achievement calculation. *Materials reuse*. Reuse includes salvaged, refurbished, or reused products.
	WELL V2, Enhanced Material Restrictions	At least 50% by cost of newly installed furniture, millwork and fixtures one of the following requirements: Textiles (i.e., fabrics including upholstery) and plastics in products contain 100 ppm (0.01%) by weight or less of the below compounds and chemical classes, unless higher amounts are mandated by local codes. For assessing compliance of a product, all pieces of each of the two material categories (textiles, plastics) are grouped together and each material category is assessed independently against the 100 ppm threshold: Halogenated flame retardants (HFR), per- and polyfluoroalkyl substances (PFAS), lead, cadmium, mercury.
		- Insulation products, including thermal and acoustic insulation in walls, ceilings, ducts, tubes and pipes, contain 100 ppm (0.01%) by weight or less of halogenated flame retardants (HFR). - Flooring products, ceiling and wall panels contain 100 ppm (0.01%) by weight or less of the halogenated flame retardants (HFR) and orthophthalates.
	WELL V2, Nature and Place	Incorporating natural elements into buildings can support occupant relief from stress and mental fatigue, as well as help establish a sense of place.
		The benefits of nature access can be achieved through numerous pathways such as direct (e.g., plants in the office), indirect (e.g., window views) or representational (e.g., photographs). Additionally, incorporating other key aesthetic elements, such as local culture, materials and art can help celebrate the project's unique identity and further enrich the space for occupants and visitors.
	LBC 4.0, Responsible Sourcing	All projects must advocate for: • The creation and adoption of third-party certified standards for sustainable resource extraction and fair labor practices for extraction of rock, metal, minerals, and timber. • Certification under the Natural Stone Council (NSC) 373 Standard by quarries and/or manufacturers of all dimension stone products used within the project
		All projects must either source 80% or more of all wood, by cost or volume from the intentional harvest of on-site timber for the purpose of clearing the area for construction or restoring/maintaining the continued ecological function of the on-site bionetwork, and the remaining 20% of wood must be from low-risk sources.

Biomorphic Forms and Patterns

The biomorphic forms and patterns parameter is generally observed in the interior with the natural forms and patterns in the paintings, sculptures, sofa fabrics, bedspreads, carpet patterns, wallpaper, wood carving details of the furniture, wall ornaments, and lighting elements. In the outdoor area, it is observed through the landscape layout and sculptures.
From the selected GBRTs, for the biomorphic forms and patterns, it is an inference that at the street level or first floor, it is more preferred to use the transparency, naturally formed murals and some installations, natural materials and patterns, and plants (I. W. B. Institute, 2020).

Complexity and Order

The complexity and order parameter is generally provided by the facade design of the buildings. Here, alternating windows with a regular appearance, changing the size of different floors or transforming them into an entire glass surface, using different colors on window borders, creating the wall surface with different materials on floors or in private spaces; while creating a specific order, on the one hand, it creates a complexity together with the variables.

From the selected GBRTs, the complexity and order pattern connection is established from the building façade design. It is suggested that using overhangs as shadings, canopies, having murals and installations, using different natural materials, and mixed colors and textures is the preferred design method (I. W. B. Institute, 2020).

Presence of Water

The water feature is designed that create an external connection with nature and place connection, and it is optional to use a fountain, plant walls, and nature views at the common areas and circulation spaces (I. W. B. Institute, 2020).
At the façade and the area near the exterior of the façade, it is preferred to use biophilic designed elements as water features, plants, and natural patterns seen from the street level are preferred (I. W. B. Institute, 2020). Table 5.7. shows the adaptable requirements of green

building certificates to assisted living facilities for biomorphic forms and patterns, presence of water, complexity and order patterns.

Table 5.7. The adaptable requirements of green building certificates to assisted living facilities for biomorphic forms and patterns, presence of water, complexity & order patterns

	GREEN BUILDING CERTIFICATE CREDIT	THE ADAPTABLE REQUIREMENTS OF GREEN BUILDING CERTIFICATES TO ASSISTED LIVING FACILITIES
BIOMORPHIC FORMS AND PATTERNS-PRESENCE OF WATER-COMPLEXITY & ORDER	WELL V2, Site Planning and Selection	All exterior building walls incorporate some combination of the following design elements on the street level façade (i.e., first floor or first 5.5 vertical m, whichever is less): o Windows or glazing that provide transparency into the space. o Overhangs such as canopies, awnings, eaves or shades. o Murals or other artistic installations. o Biophilic design elements (e.g., plants, water features, nature patterns, natural building materials). Mixed building textures, colors and/or other design elements
	WELL V2, Nature and Place	Nature access can be achieved through direct (e.g., plants), indirect (e.g., window views) or representational (e.g., photographs). Incorporating other key aesthetic elements, such as local culture, materials and art can help celebrate the projects' unique identity and further enrich the space for occupants and visitors.
		The project integrates the following throughout the space, including common circulation routes, shared seating areas and rooms (e.g., conference rooms, common spaces) and workstations (as applicable): Natural materials, patterns, shapes, colors, images or sounds. At least one of the following: Plants (e.g., potted plants, plant walls), water (e.g., fountain), nature views.
	LBC 4.0, Beauty and Biophilia	Projects must be designed to include elements that nurture the innate human/nature connection. Each project team must engage in a minimum of one all-day exploration of the biophilic design potential for the project. The exploration must result in a biophilic framework and plan for the project that outlines strategy and implementation ideas for the following: • How the project will be transformed by deliberately incorporating nature through Environmental Features, Light and Space, and Natural Shapes and Forms. • How the project will be transformed by deliberately incorporating nature's patterns through Natural Patterns and Processes and Evolved Human-Nature Relationships. • How the project will be uniquely connected to the place, climate, and culture through Place-Based Relationships. The project must meaningfully integrate public art and contain design features intended solely for human delight and the celebration of culture, spirit, and place appropriate to the project's function.

Risk and Peril

It occurs when places are perceived as dangerous without protection and become safe with structural systems when people feel at risk and safe together. The pattern is provided by the

users' fear of looking out from a high floor and their confidence in the building's structure, on glass facades from floor to ceiling in assisted living facilities. Thus, the pattern is available in mezzanines, glass floor surfaces, or places designed with floor-to-ceiling glass.

Non-Rhythmic Sensory Stimuli

The non-rhythmic sensory stimuli parameter is provided by the fireplaces designed in the building's lobby areas, the inner garden, and the fire pits in the outdoor area. The fire's unpredictable movements and rhythm and the airflow support this parameter and provide an unpredictable resident experience.

Prospect

The places the floor height varies, spaces with low ceilings and mezzanine floors create a sense of shelter for the user that provides the refuge pattern. The designs that allow the users to observe the lobby area from the mezzanines, which are solved by looking at the common areas such as the lobby, will make the users feel safe.

Refuge

Observing spaces such as the lobby area from the mezzanine floors creates a sense of domination of the environment in the user, supports the prospect pattern. High and wide spaces where users can observe their surroundings also support this parameter. These are usually provided in these spaces with large windows and balconies.

Mystery

The "Mystery" pattern is usually provided by the users' desire to learn the next space in the corridors, interconnected spaces, and gardens, thanks to the designed plan of the area. In these areas where people walk, the fact that the curved and the right or left directed ways cannot be perceived with a fixed gaze and that people will be learned by moving triggers the sense of mystery. Changes in floor height in the interior, transitions from narrow spaces to large spaces create different perceptions of space, and this change causes changes in the dopamine levels of the guests.

5.2. Evaluation of Findings According to Universal Design Parameters

The study has determined that universal design parameters are included in some criteria of green building certificates. Some universal design-related credits are included as pilot credits.

Equitable Use

At the assisted living facilities, equitable use parameter is observed at the entrances without steps, doors designed without applying force to open and close, motion-sensitive technologies in lighting, windows, and automatic curtain systems examined in case studies.

The entrance design should be enabling inclusive access to every user and designed flexibly to a possible change if needed (I. W. B. Institute, 2020), and the service counters and desks as information desks designed at an accessible height for everyone (I. W. B. Institute, 2020). The interior project, the outdoor area, and public areas must have safeguard access to people with physical disabilities with the universal design principles (I. L. B. Institute, 2019). Table 5.8. shows the adaptable requirements of green building certificates to assisted living facilities for equitable use pattern.

Table 5.8. The adaptable requirements of green building certificates to assisted living facilities for equitable use pattern

	GREEN BUILDING CERTIFICATE CREDIT	THE ADAPTABLE REQUIREMENTS OF GREEN BUILDING CERTIFICATES TO ASSISTED LIVING FACILITIES
EQUITABLE USE	WELL V2, Accessibility and Universal Design	Physical access: entry, exit and key interaction points that enable inclusive entrance to the project and strategies that enable flexible usability of the space to accommodate change as needed
	LEED V4.1, Inclusive Design	The sales and service counters have to be designed with an accessible height.
	LBC 4.0, Universal Access	Projects must provide for and enhance the public realm through design measures and features accessible to all members of society, such as street furniture and public art gardens, and benches
		All projects must make all primary transportation, roads and non-building infrastructure that are considered externally focused (e.g., plazas, seating, or park space) equally accessible to all members of the public regardless of background, age and socioeconomic class with reasonable steps taken to ensure that all people can benefit from the project's creation.
		All projects must safeguard access for those with physical disabilities through designs meeting either the Principles of Universal Design (the United States Access Board), the Americans with Disabilities Act (ADA), and the Architectural Barriers Act (ABA) Accessibility Guidelines, or international equivalent.

Flexibility in Use

As observed in the sample projects, various table heights, chairs and armchairs, and height-adjustable tables and chairs are preferred in the workshop areas. Providing a variety of usage in the area where users will socialize and allowing the user to choose supports this parameter.

At the facility, for the flexibility of the building and future adaptive uses, designing a soft space that is a minimum of 5% of the department area is designed for possible future growth. It is suitable to use height adjustable desks or counters to adjust accordingly to users' body conditions. Moreover, the seatings could be designed at resting areas, lobbies with different heights, and designs without backrest or armrest features. The demountable, movable, or modular partitions and furniture are provided flexibility in the area (Council, 2021a).

The lighting system allows the users to control and change the color temperature, light distribution, and color with different possible options for the users with manual or digital

interfaces (I. W. B. Institute, 2020). Table 5.9. shows the adaptable requirements of green building certificates to assisted living facilities for flexibility in use pattern.

Table 5.9. The adaptable requirements of green building certificates to assisted living facilities for flexibility in use pattern

	GREEN BUILDING CERTIFICATE CREDIT	THE ADAPTABLE REQUIREMENTS OF GREEN BUILDING CERTIFICATES TO ASSISTED LIVING FACILITIES
FLEXIBILITY IN USE	LEED V4.1, Design for Flexibility	Height adjustable desks, adjustable height counters (with fixtures, where applicable).
		Include resting areas with seating at various heights, including seating with backrests and without armrests.
		Increase building flexibility and ease of adaptive use over the life of the structure by employing at least three of the following strategies. o Use interstitial space. Design distribution zone utility systems and equipment including HVAC, plumbing, electrical, information technology, medical gases, and life safety systems to serve the occupied zones and have the capacity to control multiple zones in clinical spaces. o Provide programmed soft space, such as administration or storage, equal to at least 5% of departmental gross area (DGA). Locate soft space adjacent to clinical departments that anticipate growth. Determine a strategy for future accommodation of displaced soft space. o Provide shell space equal to at least 5% of DGA. Locate it such that it can be occupied without displacing occupied space. o Identify horizontal expansion capacity for diagnostic and treatment or other clinical space equal to at least 30% of existing floor area (excluding inpatient units) without demolition of occupied space (other than at the connection point). Reconfiguration of additional existing occupied space that has been constructed with demountable partition systems is permitted. o Design for future vertical expansion on at least 75% of the roof, ensuring that existing operations and service systems can continue at or near capacity during the expansion. o Designate space for future above-grade parking structures equal to 50% of existing on-grade parking capacity, with direct access to the main hospital lobby or circulation. Vertical transportation pathways that lead directly to the main hospital lobby or circulation are acceptable. o Use demountable partitions for 50% of applicable areas. o Use movable or modular casework for at least 50% of casework and custom millwork. Base the calculation on the combined value of casework and millwork, as determined by the cost estimator or contractor
	WELL V2, Occupant Lighting Control	Lighting systems have at least three lighting levels or scenes that allow for changes in light levels and have an ability to change at least one of the following: o Color o Color temperature. o Distribution of light by controlling different groups of lights or through preset scenes.
		All regular occupants have control over their immediate lighting environment through at least one of the following: o Manual controls (e.g. switches or control panels) located in the same space as each lighting zone. o Digital interface available on a computer or phone.
		Lighting for presentation or projection walls are separately controlled.

Simple and Intuitive Use

As observed in the case studies, the facility plan can be easily perceived by the user, and that the furniture and equipment used can be used with simple instructions to support this parameter. The purpose of the design is that a person who will experience the place for the first time can continue his or her activities in the space intuitively without support from someone else. In assisted living facilities, this parameter can be observed in the devices in the kitchen, in the lobby area, in the furniture in the common areas, and in the facility plan, which has a simple wayfinding strategy.

The drawer and door equipment are designed without the wrist's twist or grasp need (Council, 2021a). The staircase and elevators are designed close to the building entrance or the reception area (I. W. B. Institute, 2020). Table 5.10. shows the adaptable requirements of green building certificates to assisted living facilities for simple and intuitive use pattern.

Table 5.10. The adaptable requirements of green building certificates to assisted living facilities for simple and intuitive use pattern

	GREEN BUILDING CERTIFICATE CREDIT	THE ADAPTABLE REQUIREMENTS OF GREEN BUILDING CERTIFICATES TO ASSISTED LIVING FACILITIES
SIMPLE AND INTUITIVE USE	LEED V4.1, Inclusive Design	Door and drawer hardware that requires no grasping, pinching, or twisting of the wrist.
	WELL V2, Circulation Network	At least one staircase is open to regular occupants, services all floors of the project and is supported by the following: • Point-of-decision signage is present at the following locations: • Near the main building entrance or the reception desk. At elevator or escalator banks on each floor. • At the base of stairs and stairwell re-entry points on each floor • If stairs are not visible from signage locations, wayfinding signage is used to guide occupants to the stairs.

Perceptible Information

As observed in the sample projects, the design of the entrance space in the nursing home facade design differs according to the material or form and its surroundings, which defines a perceptible space for the users. In addition, the presence of explanatory signs in the floor

corridors, the presence of signboards and clear plans to guide the users in the entrance and lobby area, and the use of color to highlight spatial differences.
The designed haptic, tactile or visual technologies as audios or visuals precisely control the space present to the residents and create tactics for contrasting colors, textures, or sounds to create perceptible information (I. W. B. Institute, 2020). The tactile maps, signages, or technological information systems installed in the facility to direct the user or help for wayfinding systems are preferred (I. W. B. Institute, 2020). Moreover, the control systems with touch screens and voice could be used at windows and lighting systems or heating and cooling devices. The monitors of the devices are used without a glaring surface without any cost to the users (I. L. B. Institute, 2019).

In the outdoor area, it is necessary to design warnings at the interference of cars and pedestrian paths. Also, directional warnings will design without texts and with the image or visual signs, or use haptic maps. The other option for the users is aromatic signs that guide the users with more minor visual abilities. (Council, 2021a)

The common areas and entrances are designed with an open view that users can quickly notice and reach. For the critical access points as entrances, it is possible to use patterns, elements, and color preferences to pay attention to the areas (Council, 2021b). Table 5.11. shows the adaptable requirements of green building certificates to assisted living facilities for perceptible information pattern.

Table 5.11. The adaptable requirements of green building certificates to assisted living facilities for perceptible information pattern

	GREEN BUILDING CERTIFICATE CREDIT	THE ADAPTABLE REQUIREMENTS OF GREEN BUILDING CERTIFICATES TO ASSISTED LIVING FACILITIES
PERCEPTIBLE INFORMATION	WELL V2, Accessibility and Universal Design	Wayfinding strategies that use color, texture, images and other multi-sensory visually perceptible information (e.g., to accommodate sensory requirements of neurodiverse individuals)
		Strategies that help individuals intuitively navigate through the project (e.g., signage, tactile maps, symbols, auditory cues, information systems)
		At least one staircase is open to regular occupants, services all floors of the project and located physically and/or visibly before elevators/escalators as measured from the main entry point to the building.
	LEED V4.1, Inclusive Design	• Voice or touch screen operated controls for devices and systems affecting occupancy of space and user comfort, including but not limited to lighting, window shades, and thermostats. • Include detectable warnings where pedestrian paths intersect with vehicular paths • Directional signage with non-text diagrams/symbols and Braille or active visual or audio signaling on dynamic signs. • Design the site with open sightlines to and from entries and public access points. • Haptic maps • Aromatic elements to guide users with limited sight • Patterns and color blocking to identify key public access spaces (e.g., entries, exits, restrooms) • Install monitors and lit screens with non-glare surfaces • Continuous linear path indicators
	LEED V4.1, Interior Lighting	Glare Control: For all regularly occupied spaces, meet one of the following requirements: • Use light fixtures with a luminance of less than 7,000 candela per square meter (cd/m)2 between 45 and 90 degrees from nadir. • Achieve a Unified Glare Rating (UGR) rating of <19 using software modelling calculations of the designed lighting
		Lighting Control: Provide dimmable or multilevel lighting for 90% of occupant spaces. Surface Reflectivity: use interior finishes with a surface reflectance greater or equal to 80% for ceilings and 55% for walls. Use furniture finishes with a surface reflectance greater or equal to 45% for work surfaces and 50% for movable partitions.
	WELL V2, Accessibility and Universal Design	Strategies that use color, texture, images and other multi-sensory visually perceptible information (e.g., to accommodate sensory requirements of neuro-diverse individuals
		Technology (e.g., audio and visual equipment, web access) that helps individuals fully utilize a space (e.g., to assist blind or deaf individuals, or those who do not speak the native language), made available to all occupants at no cost

Tolerance for Error

As observed in the case studies, priority has been given to choosing the floor material from a soft material to prevent a dangerous situation. It is aimed that the users overcome this situation with a minor injury in case of a fall. It is crucial to design a grab bar for the users and a button to ask for help in case of an emergency in toilets and bathrooms. The kitchen area aims to design the cabinets and counters at a height that users can easily access and take

precautions to prevent any object from falling on them. A carbon dioxide sensitive sensor and alarm system have been used to take early action in any fire in the space.For the elevator, it is preferred to delay the door closing opportunity to tolerate any problems. It must be easy to reach emergency alarm systems, and sending the signal could be done with sound systems and using carbon dioxide monitors that detect the high concentration of the gas in the environment and warning is with visual and audible methods (Council, 2021a).

The wayfinding design and simple access reduce the risk of hazards and injury risks. An adequate lighting design is essential to reduce the possible hazards. The emergency plan and management strategy must be done for a possible situation for health, fire, technological or natural, or human-caused hazards (I. W. B. Institute, 2020). Care should be taken that gases and wastes emitted not only in the building but also in the surrounding structures or nature do not pose any danger and cause damage (I. L. B. Institute, 2019). Table 5.12. shows the adaptable requirements of green building certificates to assisted living facilities for tolerance for error pattern.

Table 5.12. The adaptable requirements of green building certificates to assisted living facilities for tolerance for error pattern

	GREEN BUILDING CERTIFICATE CREDIT	THE ADAPTABLE REQUIREMENTS OF GREEN BUILDING CERTIFICATES TO ASSISTED LIVING FACILITIES
TOLARENCE FOR ERROR	LEED V4.1, Inclusive Design	Ensure that elevators are equipped with an identified manual feature to delay door closing
		Recess or protect with physical barriers (niches, rails, etc.), drinking fountains, vending machines, and wall-mounted elements such as fire extinguishers, lighting, and similar that protrude more than 10 cm from a wall.
		Emergency alarm signaling (audible/visual), safety zones, and clear wayfinding to ensure that emergency egress is inclusive.
	LEED V4.1, Minimum Indoor Air Quality Performance	Monitor carbon dioxide (CO2) concentrations within each thermal zone. CO2 monitors must be between 900 and 1 800 millimeters above the floor and within the thermal zone. CO2 monitors must have an audible or visual indicator or alert the building automation system if the sensed CO2 concentration exceeds the setpoint by more than 10%.
	WELL V2, Accessibility and Universal Design	Strategies that support easy access to all spaces and amenities and minimize the risk of injury, confusion, or discomfort (e.g., lighting or clear sightlines to increase feelings of security)
	WELL V2, Emergency Preparedness	A risk assessment is undertaken to address at minimum the following: • Identify project assets (e.g., employees, facilities). • Establish a pathway for occupants or groups who may be more vulnerable (e.g., older adults, people with disabilities, pregnant women, children) to confidentially identify specific needs they may have during an emergency.13 • Evaluate potential impacts of relevant hazards and identify high-risk hazards. Determine emergency management planning priorities.
		An emergency management plan is in place outlining response in the case of emergency situations within the building or surrounding community, addressing at minimum the following hazards: Natural (e.g., flood, tsunami, wildfire, earthquake, heatwave), fire, health (e.g., acute medical emergency, infectious disease pandemic), technological (e.g., power loss, chemical spill, explosion).

Low Physical Effort

Approaches aim to minimize the users' repeated movements or make them more comfortable being seen in the designed spaces. These are designing spaces with as few steps as possible and providing alternative access if there are steps. The stair heights of the designed stairs should be such that they do not tire the user, and there should be a landing. Minimizing activities that require grip and strength as much as possible also supports this parameter. Designing faucet handles, doors, and cabinets to require as little power as possible or turning to automatic systems is seen as an exemplary approach in assisted living facilities.

The window controls are located at a maximum of 1,7 meters high from the flooring. (I. W. B. Institute, 2020). Using auto-sensor methods provides low physical effort for the users (Council, 2021a). Table 5.13. shows the adaptable requirements of green building certificates to assisted living facilities for low physical effort pattern.

Table 5.13. The adaptable requirements of green building certificates to assisted living facilities for low physical effort pattern

	GREEN BUILDING CERTIFICATE CREDIT	THE ADAPTABLE REQUIREMENTS OF GREEN BUILDING CERTIFICATES TO ASSISTED LIVING FACILITIES
LOW PHYSICAL EFFORT	LEED V4.1, Inclusive Design	Provide ambient lighting at levels appropriate to space use controlled by occupancy, daylight, or other auto-sensor methods; include adjustable task lighting at work or public-use surfaces.
		Fitness spaces with accessible and inclusive activities and equipment Install drinking fountains, assistance animal areas, and bike racks that are easily accessed from all sides.
		Emergency alarm signaling (audible/visual), safety zones, and clear wayfinding to ensure that emergency egress is inclusive.
	LEED V4.1, Direct Exterior Access	Provide direct access to an exterior courtyard, terrace, garden, or balcony. The space must be at least 0.5 square meters per patient for 75% of all inpatients and 75% of qualifying outpatients whose clinical length of stay exceeds four hours.
	WELL V2, Enhanced Operable Windows	Controls for window operation are positioned not more than 1.7 m above the finished floor.

Size and Space for Approach and Use

It is essential to design the area where the seating units are as large as possible and leave spaces where wheelchair users can use them comfortably, such as conference halls or cinema rooms, where wheelchair users can position their chairs. The circulation areas should be designed wide enough to make a u-turn with a wheelchair when necessary. Access to places with upper shelves such as the library or kitchen should be designed to affect every user equally.

Using at least 0,9 meters wide doors and compared to a standard corridor width, design 20% wider spaces. The turning area for the user is designed at least 0,9 meters in radius. (WELL). A garden area of at least 5% of the indoor area should be designed to be easily accessible by all users. At least 70% of this space should contain natural elements such as plants. It is preferable to have a green area or a blue area open to the users' access within 200 meters of

the building. Table 5.14. shows the adaptable requirements of green building certificates to assisted living facilities for size and space for approach and use pattern.

Table 5.14. The adaptable requirements of green building certificates to assisted living facilities for size and space for approach and use pattern

	GREEN BUILDING CERTIFICATE CREDIT	THE ADAPTABLE REQUIREMENTS OF GREEN BUILDING CERTIFICATES TO ASSISTED LIVING FACILITIES
SIZE AND SPACE FOR APPROACH AND USE	LEED V4.1, Inclusive Design	- Install 0.91 meters wide doors, at minimum, in all occupied spaces. - Provide circulation paths that are 20% wider than required, at minimum. - Increase the size of turning space to 1.83 meters in diameter, at minimum. - Provide accessible routes that are 1.1 meters in width, at minimum. - Increase clear floor space at appliances and fixtures to 0.76 by 1.32 meters, at minimum.
	WELL V2, Site Planning and Selection	At least one functional building entrance opens to a pedestrian network (i.e., streets where pedestrians travel, featuring at minimum sidewalks) and one of the following requirements is met: • The project is located at an area (zip or postal code) with a minimum Walk Score of 70. • The project is located on a street with restricted vehicular traffic. • Within a 400 m walk distance of the project boundary, 90% of the total street length has continuous sidewalks present on both sides and two of the following: o At least eight existing use types are present within a 400 m walk distance of the project boundary. Uses o and restrictions are defined in Appendix V1. o There are speed limits of 40 kmh or less and buffer protections along sidewalks (e.g., curb extension, o bioswales, bike lane, parked cars, benches, trees, planters). Street segments intersect one another (excluding alleys) at least every 80-100 m.
	LBC 4.0, Universal Design Access	If the project's boundary is more than sixty meters long parallel to the waterway's edge, it must incorporate and maintain an access path to the waterway from the most convenient public right-of-way.
		Projects may not block sunlight to adjacent building facades and rooftops above a maximum height allotted for the Transect. The project might not shade the roof of an adjacent building unless that building was built to a lesser density than acceptable for the Transect.
		No project may block access to, nor diminish the quality of, fresh air, sunlight, and natural waterways for any member of society or adjacent developments. Projects must also appropriately address any noise audible to the public.

6. CONCLUSION AND RECOMMENDATION

Today, it has been determined that people spend an average of 90% of their time indoors. The decrease in mobility and physical difficulties of the elderly cause them to spend more time in their living spaces than the younger generations. Especially the world of the elderly living in assisted living facilities revolves within this area. During the pandemic period, when people could not communicate with the outside world and remains closed in the buildings where they lived, assisted living facilities were the places that severely cut their connection with the environment during this period.

The study aimed to design places close to ideal physiologically, psychologically, and sociologically for the elderly living in assisted living facilities. Biophilic design approaches have been investigated to transfer biophilic design, which is inspired by nature and evaluated in the restorative design field, to the assisted living. It has been determined that the studies in this field are generally theoretically based, and there are very general parameters in their transfer to practice. Because of their clearer lines compared to others, 14 parameters of Browning et al. were used in the study.

In the study, the assisted living facilities in Ankara were examined first, and the entrances provided by steep stairs, the existence of places not considered ergonomically suitable for the elderly, and the biophilic design in the assisted living facilities that are not accessible and ergonomic for everyone have been the result that alone cannot provide sufficient benefit. For this reason, seven parameters of universal design and 14 patterns of biophilic design were examined together.

After extensive research in the literature review, although it was determined that the 14-pattern biophilic design draws more explicit boundaries than other biophilic approaches, general and open-ended judgments were determined in its transfer to a physical space. For this reason, green building evaluation systems that put nature at the center of the design aim to examine the rules that must be provided for obtaining a certificate, identify those related to biophilic and universal design and transfer them to assisted living facilities. For this purpose, three certification systems were identified among GBRTs, including biophilic and universal design among their credits and an assisted living facilities that received these certificates. The most current versions of LEED, WELL, and LBC were examined within

the scope of the thesis. The intersections of each certificate with the biophilic and universal design were identified.

In the research, it has been observed that the state of green building certification systems, being a set of rules that focused on nature and more mechanically from an engineering point of view, has gradually evolved. Although it is still included as a pilot credit in certificates except for Living Building Challenge, the shortcomings of biophilic and universal design in loans have been noticed and tried to be included in the evaluation criteria. Including these criteria should prevent the sustainable design from taking nature at the center and seeing the human as a part of this central functioning. Taking the human to the center, human health, well-being, psychological, physiological, and sociological effects should be evaluated.

The following section is devoted to the six assisted living facility case studies. Three assisted living facilities have received green building certificates, and the other three have received awards in their field, showing biophilic and universal design characteristics were examined. How biophilic and universal designs were conveyed to each of these assisted living facilities, their positive aspects, and their shortcomings were examined with tables and supported by photos of the assisted living facility. At the end of the department, it was determined that the certified projects and selected non-certified projects would contribute to the assisted living facilities design guide to be created at the end of the section.

Later, the data obtained from green building certification systems and methods of transferring from theory to practice in sample assisted living facilities, and their application areas were brought together. These results were examined under separate headings for 14 biophilic design and seven universal design parameters, and a guide was created on how to use these parameters in future design and restoration studies in assisted living facilities.
This study aimed to determine which methods would be possible to design an assisted living facility designed for the elderly that would positively affect them psychologically, physiologically, and sociologically, and what design parameters should be considered. The answer to this research question was provided by a comprehensive analysis of biophilic and universal design parameters, the adaptation of the linked credits of green building certificates to these design methods, and the determination of the applied parameters of the certified and award-winning assisted living facility projects examined as an example.

Some restrictions were encountered in the study due to the pandemic. Although it was initially planned to conduct surveys in assisted living facilities in Ankara, due to the pandemic, assisted living facilities did not accept this request, and access to assisted living facilities was denied. For this reason, the study of assisted living facilities in Ankara was excluded from the scope of the thesis, and the samples were selected from the United States, where various climate types can be observed, and where there are certified and award-winning assisted living facilities.

In future studies, the absence of any examples of green-building certificates in Turkey's assisted living facilities and the limited number of suitable places can be examined in detail. This thesis's biophilic and universal criteria can be adapted to Turkey's green building certification systems. The assisted living facilities in Turkey can be examined within the scope of biophilic and universal design, and common deficiencies can be identified. A more regional guide can be created by making additions to the guideline determined in the thesis on how to improve them.

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APPENDICES

Appendix 1. LEED v4.1 Credits and Requirements Related to Biophilic Design Principles

PATTERNS OF BIOPHILIC DESIGN	RELATED LEED CREDIT	LEED REQUIREMENTS FOR RELATED BIOPHILIC PATTERN
Visual Connection with Nature	Quality Views	• Provide occupants in the building to view the outdoor natural or urban environment for 75% of all regularly occupied floor areas. Auditoriums, conference rooms and gymnasiums may be excluded. Views into interior atria may be used to meet up to 30% of the required area. • Views must be through glass with a visible light transmittance (VLT) above 40%. If the glazing has frits, patterns, or tints, the view must be preserved. Neutral gray, bronze and blue-green tints are acceptable. • Views must include at least one of the following: -Nature, urban landmarks, or art; or objects at least 7.5 meters from the glazing exterior. -Occupants must have direct access to the view and be within three times the head height of the glazing with no permanent interior obstructions between the occupant and the window or moveable furniture and partitions blocking the view. Exceptions: Vertical columns smaller than 0.3 meters wide and horizontal features smaller than 0.3 meters high are excluded.
Visual Connection with Nature	Places of Respite	• Provide places of respite that are accessible to patients and visitors, equal to 5% of the net usable program area of the building. • Provide additional dedicated places of respite for staff, equal to 2% of the net usable program area of the building. • Places of respite must be outdoors, or be located in interior atria, greenhouses, solaria, or conditioned spaces; such interior spaces may be used to meet up to 30% of the required area if 90% of each qualifying space's gross floor area achieves a direct line of sight to unobstructed views of nature. All areas must meet the following requirements. • The area is accessible from within the building or located within 60 meters of a building entrance or access point. • The area is located where no medical intervention or direct medical care is delivered. • Options for shade or indirect sun are provided, with at least one seating space per 18.5 square meters of each respite area, with one wheelchair space per five seating spaces. • Horticulture therapy and other specific clinical or special-use gardens unavailable to all building occupants may account for no more than 50% of the required area. • Universal-access natural trails that are available to visitors, staff, or patients may account for no more than 30% of the required area, provided the trailhead is within 60 meters of a building entrance. Additionally, outdoor areas must meet the following requirements. • A minimum of 25% of the total outdoor area must be planted with two or more adapted or native vegetation types, or have overhead vegetated canopy. Monocultures, such as conventional grass lawns or turfgrass, do not count towards this requirement. • The area is open to fresh air, the sky, and the natural elements. • Signage must meet the 2010 FGI Guidelines for Design and Construction of Health Care Facilities • Places of respite may not be within 7.6 meters of a smoking area
Non-visual Connection with Nature	Site Assessment	Complete and document a site survey or assessment that includes the following information: • Primary vegetation types • Greenfield area • Significant tree mapping • Federal or state threatened or endangered species lists; for projects outside the U.S., International Union for Conservation of Nature (IUCN) Red List of Threatened Species • Invasive plant species listed by regional, state, or federal entities • EPA Level III ecoregion description (or local equivalent)

Appendix 1. (Continued) LEED v4.1 Credits and Requirements Related to Biophilic Design Principles

	Direct Exterior Access	• Provide direct access to an exterior courtyard, terrace, garden, or balcony. The space must be at least 0.5 square meters per patient for 75% of all inpatients and 75% of qualifying outpatients whose clinical length of stay exceeds four hours. • Patients whose length of stay exceeds four hours, and whose treatment makes them unable to move, such as emergency, stage 1 surgical recovery, and critical care patients, may be excluded. • Places of respite outside the building envelope that meet the requirements are immediately adjacent to clinical areas or with direct access from inpatient units may be included. • Qualifying spaces must be designated as nonsmoking. The spaces must also meet the requirements for outdoor air contaminant concentrations and be located more than 30 meters from building exhaust air locations, loading docks, and roadways with idling vehicles.
	Open Space	• Provide outdoor space greater than or equal to 30% of the total site area (including building footprint). • At least 25% of the calculated outdoor open space must be vegetated with two or more vegetation types or have an overhead vegetated canopy. • The outdoor space must be physically accessible and be one or more of the following: social area, recreational area, diverse green space, garden, habitat area.
Thermal and Airflow Variability	Thermal Comfort	• Thermal Comfort Design: Design heating, ventilating, and air-conditioning (HVAC) systems and the building envelope to meet the requirements of Thermal Comfort Conditions for Human Occupancy with errata or a local equivalent. • Thermal Comfort Control: Provide individual thermal comfort controls for at least 50% of individual occupant spaces. Provide group thermal comfort controls for all shared multi-occupant spaces. Thermal comfort controls allow occupants, whether in individual spaces or shared multi-occupant spaces, to adjust at least one of the following in their local environment: air temperature, radiant temperature, airspeed, and humidity.
	Site Assessment	• Complete and document a site survey or assessment that includes the following information: o Solar exposure and shading opportunities o Heat island effect potential o Seasonal sun angles o Prevailing winds o Average monthly precipitation and temperature ranges
	Minimum Indoor Air Quality Performance	• Provide outdoor air monitors for all mechanical ventilation systems with outdoor air intake flow greater than 1000 cfm (472 L/s). The monitoring device must be capable of measuring the minimum outdoor air intake flow and be capable of measuring the design minimum outdoor air intake flow with an accuracy of +/–10%. An alarm must indicate when the outdoor airflow value varies by 15% or more from the setpoint. • Alternatively, for constant-volume systems that do not employ demand control ventilation, provide an indicator capable of confirming the intake damper is open to the position needed to maintain the design minimum outdoor airflow as determined during the system startup and balancing.
Thermal and Airflow Variability		• Provide a direct exhaust airflow measurement device capable of measuring the exhaust airflow. This device must measure the exhaust airflow with an accuracy of +/–10% of the design minimum exhaust airflow rate. An alarm must indicate when airflow values vary by 15% or more from the exhaust airflow setpoint. This strategy is not allowed for projects using Natural Ventilation Option 3. Historic building. • Provide automatic indication devices on all natural ventilation openings intended to meet the minimum opening requirements. An alarm must indicate when any one of the openings is closed during occupied hours.
Connection with Natural Systems	Protect and Preserve area	• Preserve and protect from all development and construction activity 40% of the greenfield area on the site. And Restore a portion of the site (including the building footprint) identified as previously disturbed and follow vegetation and soil requirements. Vegetated roof surfaces may be included in the habitat area calculations if the plants are native or adapted and provide habitat.

Appendix 1. (Continued) LEED v4.1 Credits and Requirements Related to Biophilic Design Principles

Connection with Natural Systems	Local Food Production (Pilot Credit)	• Provide a dedicated portion of the site for onsite food production: gardens or planters with vegetables and/or edible nut- and fruit-bearing plants appropriate to the site. The area calculated shall be the actual growing area used to produce food-bearing plants. Size the area using one of the following metrics: o At least 5% of the site's vegetated area (excluding preserved or restored habitat area) but no less than 23 m² (250 square feet). o Urban projects with a minimum density of 1.5 FAR, at least 15% of useable rooftop surface area (excluding mechanical equipment, skylights, roof drains, window washing staging, emergency egress routes, etc. and private balconies or decks) but no less than 18.5 m² (200 square feet).
Dynamic and Diffuse Light	Site Assessment	Complete and document a site survey or assessment2 that includes the following information: • Solar exposure and shading opportunities • Seasonal sun angles
	Daylight in non-regular occupied spaces (Pilot Credit)	• Achieve at least 100 lux for 25% of the non-regularly occupied floor area for 1-2 floor buildings, 20% for 3-4 floor buildings, and 15% for buildings 5 floors and above.
	Solar Access to green space	• Preserve Sunlight and Fresh Air to Surrounding Public Parks and Green Space Demonstrate through computer modeling that the annual sun hours in the darkest occupiable location of the surrounding affected public parks or green spaces achieved by the proposed envelope are at least 3 times the hours in the exact location under the baseline case. Ensure that no building exhaust terminations and openings face directly towards the surrounding public parks or green spaces. Additionally, given the building height above the public assembly or green space and the width of the surrounding affected public assembly or green space, exceed the baseline average daily hours of full sun obtained at the level of the public space for the appropriate height/width category.
Material Connection with Nature	Sourcing of Raw Materials	o *Extended producer responsibility.* Products purchased from a manufacturer (producer) participate in an extended producer responsibility program or are directly responsible for extended producer responsibility. Products meeting extended producer responsibility criteria are valued at 50% of their cost for the purposes of credit achievement calculation. o *Bio-based materials.* Bio-based products and materials other than wood must be tested using ASTM Test Method D6866 or equivalent method ISO 16620-2, or be certified to the USDA BioPreferred Voluntary Labeling Initiative that includes verification via ASTM 6866 testing. Exclude hide products, such as leather and other animal skin material. o Bio-based products that meet the criteria above: value at 50% of cost multiplied by the product's biobased content for the purposes of credit achievement calculation. o Bio-based products that meet the Sustainable Agriculture Network's Sustainable Agriculture Standard in addition to the testing requirements above: value at 100% of cost multiplied by the biobased content of the product for the purposes of credit achievement calculation. o *Wood products.* Wood products must be certified by the Forest Stewardship Council or USGBC-approved equivalent. Products meeting wood products criteria are valued at 100% of their cost for the purposes of credit achievement calculation. o *Materials reuse.* Reuse includes salvaged, refurbished, or reused products. Products meeting materials reuse criteria are valued at 200% of their cost for the purposes of credit achievement calculation.

Appendix 2. LEED v4.1 credits and requirements related to universal design principles

PATTERNS OF UNIVERSAL DESIGN PARAMETER	RELATED LEED CREDIT	LEED REQUIREMENTS FOR RELATED UNIVERSAL DESIGN
1. Equitable Use	Inclusive Design (Pilot Credit)	The sales and service counters have to design with an accessible height.
2. Flexibility in Use	Design for Flexibility	• Height adjustable desks, adjustable height counters (with fixtures, where applicable). • Include resting areas with seating at various heights, including seating with backrests and without armrests
		Increase building flexibility and ease of adaptive use over the life of the structure by employing at least three of the following strategies. o Use interstitial space. Design distribution zone utility systems and equipment including HVAC, plumbing, electrical, information technology, medical gases, and life safety systems to serve the occupied zones and have the capacity to control multiple zones in clinical spaces. o Provide programmed soft space, such as administration or storage, equal to at least 5% of departmental gross area (DGA). Locate soft space adjacent to clinical departments that anticipate growth. Determine a strategy for future accommodation of displaced soft space. o Provide shell space equal to at least 5% of DGA. Locate it such that it can be occupied without displacing occupied space. o Identify horizontal expansion capacity for diagnostic and treatment or other clinical space equal to at least 30% of existing floor area (excluding inpatient units) without demolition of occupied space (other than at the connection point). Reconfiguration of additional existing occupied space that has been constructed with demountable partition systems is permitted. o Design for future vertical expansion on at least 75% of the roof, ensuring that existing operations and service systems can continue at or near capacity during the expansion. o Designate space for future above-grade parking structures equal to 50% of existing on-grade parking capacity, with direct access to the main hospital lobby or circulation. Vertical transportation pathways that lead directly to the main hospital lobby or circulation are acceptable. o Use demountable partitions for 50% of applicable areas. o Use movable or modular casework for at least 50% of casework and custom millwork. Base the calculation on the combined value of casework and millwork, as determined by the cost estimator or contractor.
3. Simple and Intuitive Use	Inclusive Design (Pilot Credit)	• Door and drawer hardware that requires no grasping, pinching, or twisting of the wrist.
4.Perceptible Information	Inclusive Design (Pilot Credit)	• Voice or touch screen operated controls for devices and systems affecting occupancy of space and user comfort, including but not limited to lighting, window shades, and thermostats. • Include detectable warnings where pedestrian paths intersect with vehicular paths • Directional signage with non-text diagrams/symbols and Braille or active visual or audio signaling on dynamic signs. • Design the site with open sightlines to and from entries and public access points. • Haptic maps • Aromatic elements to guide users with limited sight • Patterns and color blocking to identify key public access spaces (e.g., entries, exits, restrooms) • Install monitors and lit screens with non-glare surfaces • Continuous linear path indicators

Appendix 2. (Continued) LEED v4.1 Credits and requirements related to universal design principles

4.Perceptible Information	Interior Lighting	Glare Control: For all regularly occupied spaces, meet one of the following requirements: • Use light fixtures with a luminance of less than 7,000 candela per square meter (cd/m)2 between 45 and 90 degrees • Achieve a Unified Glare Rating (UGR) rating of <19 using software modelling calculations of the designed lighting.
		Color Rendering: For all regularly occupied spaces meet one of the following requirements: • Use light sources that have a Color Rendering Index (CRI) of at least 90. • Use light sources that have a Color Fidelity Index greater than or equal to 78 and a gamut index between 97 and 110.
		• Provide dimmable or multilevel lighting for 90% of occupant spaces. • For at least 90% regularly occupied spaces, use interior finishes with a surface reflectance greater or equal to 80% for ceilings and 55% for walls. If included in the project scope, use furniture finishes with a surface reflectance greater or equal to 45% for work surfaces and 50% for movable partitions.
5.Tolerance for Error	Inclusive Design (Pilot Credit)	• Ensure that elevators are equipped with an identified manual feature to delay door closing • Recess or protect with physical barriers (niches, rails, etc.), drinking fountains, vending machines, and wall-mounted elements such as fire extinguishers, lighting, and similar that protrude more than 10 cm from a wall • Emergency alarm signaling (audible/visual), safety zones, and clear wayfinding to ensure that emergency egress is inclusive
	Minimum Indoor Air Quality Performance	• Monitor carbon dioxide (CO_2) concentrations within each thermal zone. CO_2 monitors must be between 900 and 1 800 millimeters above the floor and within the thermal zone. CO_2 monitors must have an audible or visual indicator or alert the building automation system if the sensed CO_2 concentration exceeds the setpoint by more than 10%.
6.Low Physical Effort	Inclusive Design (Pilot Credit)	Provide ambient lighting at levels appropriate to space use controlled by occupancy, daylight, or other auto-sensor methods; include adjustable task lighting at work or public-use surfaces Fitness spaces with accessible and inclusive activities and equipment Install drinking fountains, assistance animal areas, and bike racks that are easily accessed from all sides
	Direct Exterior Access	• Provide direct access to an exterior courtyard, terrace, garden, or balcony. The space must be at least 0.5 square meters per patient for 75% of all inpatients and 75% of qualifying outpatients whose clinical length of stay exceeds four hours. • Qualifying spaces must be designated as nonsmoking. The spaces must also meet the requirements for outdoor air contaminant concentrations and be located more than 30 meters from building exhaust air locations, loading docks.
7.Size and Space for Approach and Use	Inclusive Design (Pilot Credit)	• Install 0.91 meters wide doors, at minimum, in all occupied spaces. • Provide circulation paths that are 20% wider than required, at minimum. • Increase the size of turning space to 1.83 meters in diameter, at minimum. • Provide accessible routes that are 1.1 meters in width, at minimum. • Increase clear floor space at appliances and fixtures to 0.76 by 1.32 meters, at minimum.
	Places of Respite	• The area is accessible from within the building or located within 60 meters of a building entrance or access point. • The area is located where no medical intervention or direct medical care is delivered. • Options for shade or indirect sun are provided, with at least one seating space per 18.5 square meters of each respite area, with one wheelchair space per five seating spaces. • Horticulture therapy, specific clinical or special-use gardens unavailable to all building occupants may account for no more than 50% of the required area. • Universal-access natural trails that are available to visitors, staff, or patients may account for no more than 30% of the required area, provided the trailhead is within 60 meters of a building entrance.

Appendix 3. WELL V2 credits and requirements related to biophilic design principles

PATTERNS OF BIOPHILIC DESIGN	RELATED WELL CREDIT	WELL REQUIREMENTS FOR RELATED BIOPHILIC PATTERN
Thermal and Airflow Variability	Operable Windows	• At least 75% of the regularly occupied spaces have operable windows that provide access to outdoor air. • For each floor, the openable window area, is at least 4% of the net occupiable floor area. • Window operation: Indicator lights at windows (at least one per room with windows) cue occupants when the conditions outside are suitable for opening windows: • Dry-bulb temperature: within 8 °C of indoor air temperature setpoint. • Relative Humidity: 65% or lower.
	Enhanced Operable Windows	• Window design: Operable windows may be opened according to the following requirements: • At least 70% of operable windows may be opened such that at least half of the opening is not more than 1.8 m above the finished floor and the opening is at least 0.3 m in the smallest dimension. At least one such window is present in each room with operable windows. • If the project is equipped with heating, at least 30% of operable windows may be opened such that the entirety of opening is at least 1.8 m above the finished floor (preferably as close to the ceiling as possible). • At least one such window is present in each room with operable windows. • Controls for window operation are positioned not more than 1.7 m above the finished floor. • Window operation Option 2: Instructions for window operation are provided through signage or other communications to regular building occupants to indicate the following: • Windows with low openings are to be used during mild and/or warm weather. • Windows are not to be opened when mechanical cooling is in operation (not required if no mechanical cooling is present or if the mechanical cooling system is configured to disengage automatically when windows are open). • Windows with high openings (if present) are to be used in cold weather.
	Thermal Performance	• Dry bulb temperature is between 21-25 °C for at least 90% of standard occupied hours. The designed air velocity is not more 0.2 m/s at 1.7 m above the floor. • The dry-bulb temperature, relative humidity, air speed (only for projects that use elevated air speed method) and mean radiant temperature are monitored in regularly occupied spaces at intervals no less than twice a year.
	Thermal Zoning	The following requirements are met for at least 90% of regularly occupied spaces: • Control over the temperature in the space is available through either: 1. Thermostats present within the thermal zone. 2. A digital interface accessible to occupants on a computer or phone. • The maximum size of each thermal zone is 60 m² or 10 occupants, whichever is larger. • Temperature sensors are positioned at least 1 m away from exterior walls, windows and doors, direct sunlight, air supply diffusers, mechanical fans, heaters, or any other significant heat or cold sources.
	Humidity Control	• Humidity data for all regularly occupied areas, except high-humidity spaces covering at least the previous six months, are between 30% and 60% for at least 98% of all business hours of the year.
Connection with Natural Systems	Physical Activity Spaces and Equipment	• At least one of the following outdoor physical activity spaces is within 400 meters walk distance of the project boundary and available at no cost to regular occupants: o Green space (e.g., park, walking/biking trail). o Blue space (e.g., swimming area). o Recreational field or court. o Fitness zone that includes all-weather fitness equipment. o For projects with child occupants, play space geared toward children (e.g., playground).

Appendix 3. (Continued) WELL V2 credits and requirements related to biophilic design principles

Dynamic and Diffused Light	Light Exposure	• Daylight simulation: The project demonstrates, through computer simulations, that one of the following conditions are achieved: o Common spaces that have unassigned seating for at least 15% of regular occupants at any given time achieve one of the following targets: o At least 30% of the regularly occupied area is within a 6 m horizontal distance of envelope glazing on each floor and/or in each individual unit. o Common spaces have unassigned seating and can accommodate at least 15% of regular occupants at any given time. At least 70% of all seating in the spaces is within a 5 m horizontal distance of envelope glazing. • Building design: The following requirement is met: o The envelope glazing area is no less than 7% of the floor area for each floor level or individual unit. o The floor plate is no more than 20 m between opposite walls that each have transparent envelope glazing, and there are no opaque obstructions higher than 1 m within a 6 m horizontal distance of the transparent envelope glazing. • Facade design: The following requirement is met: o The envelope glazing area is no less than 7% of the regularly occupied floor area for each dwelling unit.
	Daylight Design Strategies	At the façade design, envelope glazing is no less than 25% of the regularly occupied floor area or individual unit. Visible light transmittance (VLT) of windows is greater than 40%.
	Visual Lighting Design	For, All Spaces except Dwelling Units Option 1: Visual lighting design: The following requirements are met: • The illuminance thresholds take into consideration the tasks and the age groups of the occupants. • At least 90% of the project area is comprised of the following space types and meets the associated illuminance thresholds: • Offices and classrooms: minimum 320 lux at task surface. • Lobby, atrium, and transition (including corridor and outdoor pathways): minimum 110 lux at floor level . • Storage spaces: minimum 110 lux at floor level. • Dining, Lounge and Restrooms: minimum 110 lux at task surface For, Dwelling Units • For spaces where lighting is not installed, the following is provided to all tenants: • Illuminance thresholds for common tasks conducted in spaces
	Circadian Lighting Design	For workstations used during the daytime, electric lighting is used to achieve the following thresholds: • The following light levels are achieved for at least four hours (beginning by noon at the latest) at the height of 45 cm above the work-plane for all workstations in regularly occupied spaces: • The light levels are achieved on the vertical plane at eye level to simulate the light entering the eye of the occupant. The following requirements are met in each dwelling unit: • Electric lighting is used to achieve the following light levels: • The light levels are dimmable. If automated lighting is used, it is automatically dimmed after 8:00 pm. • The light levels are achieved in living rooms and kitchens at the height of 140 cm in the center of the room. If workstations are present, light levels are achieved at the height of 45 cm above the work-plane.
Dynamic and Diffuse Light	Circulation Network	At least one staircase is open to regular occupants, services all floors and is designed through the inclusion of at least two of the following on each floor: • Music • Artwork • Light levels of at least 215 lux when in use • Windows or skylights that provide access to daylight
Material Connection with Nature	Enhanced Material Restrictions	• Furniture, millwork and fixtures At least 50% by cost of newly installed furniture, millwork and fixtures (minimum 10 distinct products), meet one of the following requirements: Textiles and plastics in products contain 100 ppm (0.01%) by weight or less of the chemical classes, unless higher amounts are mandated by local codes. For assessing compliance of a product, all pieces of each of the two material categories (textiles, plastics) are grouped together and each material category is assessed independently against the 100 ppm threshold.

Appendix 3. (Continued) WELL V2 Credits and Requirements Related to Biophilic Design Principles

Presence of Water **Visual Connection with Nature** **Non-visual Connection with Nature**	**Nature and Place**	• The project integrates the following throughout the space, including common circulation routes, shared seating areas and rooms (e.g., conference rooms, common spaces) and workstations (as applicable): o Natural materials, patterns, shapes, colors, images or sounds. o At least one of the following: • Plants (e.g., potted plants, plant walls) • Water (e.g., fountain) • Nature views
Material Connection with Nature **Biomorphic Forms and Patterns**		• Incorporating natural elements into buildings can support occupant relief from stress and mental fatigue and help establish a sense of place. • The benefits of nature access can be achieved through numerous pathways such as direct (e.g., plants in the office), indirect (e.g., window views) or representational (e.g., photographs). Additionally, incorporating other key aesthetic elements, such as local culture, materials and art can help celebrate the project's unique identity and further enrich the space for occupants and visitors.
Visual Connection with Nature **Non-Visual Connection with Nature**	Restorative Spaces	At least one designated restorative space is available to all regular occupants. Space may be indoor or outdoor and may be made up of a single space or multiple spaces that meet the following requirements: • Is designated for relaxation and restoration. Space may be multi-purpose but is not to be used for work. • Totals at least 7 m² plus 0.1 m² per regular occupant, up to a maximum of 186 m². • Provides a restorative environment that considers at least five of the following: • Lighting (e.g., dimmable light levels for indoor spaces). • Sound (e.g., water feature, natural sounds, sound masking) • Thermal comfort (e.g., sun-exposed and shaded areas for outdoor spaces). • Seating arrangements that accommodate a range of user preferences and activities (e.g., movable lightweight chairs, cushions, mats) • Nature incorporation • Calming colors, textures and forms • Visual privacy • Includes signage, education materials or other resources explaining the purpose and intended use of the space.
Visual Connection with Nature **Non-visual Connection with Nature** **Connection with Natural Systems**	Enhanced Access to Nature	The project provides a combination of indoor plants (e.g., potted plants, plant beds, plant walls), water feature(s) and/or view(s) comprising of natural areas, such as green spaces (e.g., park, forest) or blue spaces (e.g., ocean, lake) that meet a combination of the following requirements: • Within the direct line of sight of at least 75% of all workstations and seats within conference rooms, lecture halls or classrooms. • Within 10 m of all workstations and seats within conference rooms, lecture halls or classrooms.
		One of the following requirements is met: • Outdoor nature access facilitated by the conditions below: • Outdoor space of at least 5% of the interior project area must be accessible to all regular occupants. •At least 70% of the accessible outdoor space as viewed from above must include plants or natural elements, including tree canopies. Nearby nature access facilitated by the conditions below: • At least one green space or blue space is within a 200 m walk distance from the project boundary and available to all regular occupants during open hours of the space(s). • Green spaces must be a minimum of 0.5 hectares. • Occupants are encouraged to access outdoor nature (e.g., presence of signage or maps to outdoor nature, availability of breaks during the workday to visit outdoor nature).
Biomorphic forms and Patterns **Material Connection with Nature** **Complexity and Order**	Site Planning and Selection	• All exterior building walls incorporate combination of the following design elements on the street level façade (i.e., first floor or first 5.5 vertical m, whichever is less): o Windows or glazing that provide transparency into the space. o Overhangs such as canopies, awnings, eaves or shades. o Murals or other artistic installations. o Biophilic design elements (e.g., plants, water features, nature patterns, natural building materials). o Mixed building textures, colors and other design elements

Appendix 4. WELL V2 Credits and Requirements Related to Universal Design Principles

UNIVERSAL DESIGN PATTERN	RELATED WELL CREDIT	WELL REQUIREMENTS FOR RELATED CREDIT
1. Equitable Use	Accessibility and Universal Design	• Physical access: entry, exit and key interaction points that enable inclusive entrance to the project and strategies that enable flexible usability of the space to accommodate change as needed (e.g., stair-free entrances, step-free egress, operable windows, automatic doors)
	Diversity and Inclusion	• A comprehensive evaluation of the project or organization's current diversity representation is conducted, and goals for improvement are established and annually tracked, that includes at least four of the following diversity types: o Gender (assigned, identity and/or expression). o Sexual orientation. o Race/Ethnicity. o Age. o Socioeconomic background. o Level of ability o Other metric(s) as identified by the project or organization.
	Diversity and Inclusion	A comprehensive diversity, inclusion and non-discrimination policy is established and made available to all employees that meets the following requirements: o Connects diversity and inclusion to the project or organization's goals and objectives, including the project's health-oriented mission, considering many aspects of diversity including at minimum: ethnic, racial, gender and gender identity, cultural, neurological, ability and age. o Includes a hiring policy that bans the request of salary history and requires blind resume reviews (i.e., at minimum removes information such as name and home address that could indicate factors such as race/ethnicity, gender and socioeconomic background). o Establishes employee evaluation protocols with equitable and transparent performance standards. o Connects diversity and inclusion goals to performance evaluation for hiring managers. o Incorporates reporting protocol that allows occupants to anonymously report observed or experienced discrimination, and that requires follow-up review by a human resource professional with the offending individual to help reduce bias and mitigate future incidents. o Incorporates penalties for falsifying or retaliating against reports of bias. o Establishes annual goals for diversity representation in mid- and executive-level leadership positions. o Results of progress on diversity and inclusion goals are made widely available to all occupants and publicly available on-site and/or on the organization's website. Goals for improvement of diversity and inclusion policies and outcomes are established and reviewed on an annual basis.
2. Flexibility in Use	Occupant Lighting Control	Each lighting zone meets the following requirements: • Lighting systems have at least three lighting levels or scenes that allow for changes in light levels and change at least one of the following: o Color o Color temperature o Distribution of light by controlling different groups of lights or through preset scenes • All regular occupants have control over their immediate lighting environment through at least one of the following: o Manual controls (e.g., switches or control panels) located in the same space as each lighting zone. o Digital interface available on a computer or phone. • Lighting for presentation or projection walls are separately controlled.
3. Simple and Intuitive Use	Circulation Network	At least one staircase is open to regular occupants, services all floors of the project and is supported by the following: • Point-of-decision signage is present at the following locations: • Near the main building entrance or the reception desk. • At elevator or escalator banks on each floor.

Appendix 4. (Continued) WELL V2 credits and requirements related to universal design principles

4.Perceptible Information	Daylight Design Strategies	All vertical transparent envelope glazing has shading that meet one of the following: o Manual shading controllable by regular occupants at all times. Shades are regularly opened once a day for all days that the project is in use o Shading is automated to prevent glare
	Accessibility and Universal Design	• Developmental and intellectual health: strategies that use color, texture, images and other multi-sensory visually perceptible information (e.g., to accommodate sensory requirements of neurodiverse individuals • technology (e.g., audio and visual equipment, web access) that helps individuals fully utilize a space (e.g., to assist blind or deaf individuals, or those who do not speak the native language), made available to all occupants • Wayfinding strategies that use color, texture, images and other multi-sensory visually perceptible information (e.g., to accommodate sensory requirements of neurodiverse individuals) • strategies that help individuals intuitively navigate through the project (e.g., signage, tactile maps, symbols, auditory cues, information systems) • At least one staircase is open to regular occupants, services all floors of the project and located physically and/or visibly before elevators/escalators as measured from the main entry point to the building.
		Strategies that support easy access to all spaces and amenities and minimize the risk of injury, confusion, or discomfort (e.g., lighting or clear sightlines to increase feelings of security)
5.Tolerance for Error	**Emergency Preparedness**	A risk assessment is undertaken to address at minimum the following: • Identify project assets (e.g., employees, facilities). • Establish a pathway for occupants or groups who may be more vulnerable (e.g., older adults, people with disabilities, pregnant women, children) to confidentially identify specific needs they may have during an emergency.13 • Evaluate potential impacts of relevant hazards and identify high-risk hazards. • Determine emergency management planning priorities.
		An emergency management plan is in place outlining response in the case of emergency situations within the building or surrounding community, addressing at minimum the following hazards: • Natural (e.g., flood, tsunami, wildfire, earthquake, heatwave). • Fire. • Health (e.g., acute medical emergency, infectious disease pandemic). • Technological (e.g., power loss, chemical spill, explosion).
6.Low Physical Effort	Enhanced Operable Windows	• At least 70% of operable windows opened such that at least half of the opening is not more than 1.8 m above the finished floor and the opening is at least 0.3 m in the smallest dimension. At least one such window is present in each room with operable windows. • If the project is equipped with heating, at least 30% of operable windows may be opened such that the entirety of opening is at least 1.8 m above the finished floor (preferably as close to the ceiling as possible). • • At least one such is present in each room with operable windows. • Controls for window operation are positioned not more than 1.7 m above the finished floor.
7.Size and Space for Approach and Use	Site Planning and Selection	At least one functional building entrance opens to a pedestrian network (i.e., streets where pedestrians travel, featuring at minimum sidewalks) and one of the following requirements is met: • The project is located in an area with a minimum Walk Score of 70. • The project is located on a street with restricted vehicular traffic. • Within a 400 m walk distance of the project boundary, 90% of the street length has continuous sidewalks on both sides and two of the following: o At least eight existing use types are present within a 400 m walk distance of the project boundary. o There are speed limits of 40 kmh or less and buffer protections along sidewalks (e.g., curb extension, bioswales, bike lanes, parked cars, benches, trees, planters). o Street segments intersect one another at least every 80-100 m.

Appendix 5. LBC 4.0 credits and requirements related to biophilic design principles

PATTERNS OF BIOPHILIC DESIGN	RELATED LBC CREDIT	LBC REQUIREMENTS FOR RELATED BIOPHILIC PATTERN
Connection with Natural Systems	Ecology of Place	• All projects must avoid building on pristine greenfield, wilderness, prime farmland, or in a floodplain unless they meet an exception. Projects must preserve thriving, vibrant ecological environments and habitats. • All project teams must document site and community conditions before starting work, including identifying the project's "reference habitat(s)." • All projects must demonstrate that they contribute positively to the ecology of their place and restore or enhance the ecological performance of the site towards a healthy ecological baseline. The on-site landscape must be designed to mature and evolve and emulate the functionality of the reference habitat, as appropriate to the project's transect. • All project teams must assess cultural and social equity factors and needs in the community and consider those identified needs to inform design and process decisions. • No petrochemical fertilizers or pesticides can be used to maintain the on-site landscape, including urban agriculture.
Non-Visual Connection with Nature	Urban Agriculture	• All projects must dedicate a portion of their total project area to growing food or a smaller portion of their total project area to growing food and directly providing weekly community access to healthy local food that addresses community needs through farmers markets or other local food producers.
Thermal and Airflow Variability	Healthy Interior Environment	All projects must: • Prohibit smoking within any buildings or enclosed spaces, and within 25' of any building opening, including air supply vents. • • Develop a Healthy Indoor Environment Plan specific to the project's building type and location. • The plan must address cleaning protocols, the prevention of particulates and toxins through an entry approach and implementation of at least one strategy to improve air quality. • Provide views outside and daylight for 75% of regularly occupied spaces. • Provide direct exhaust for kitchens, bathrooms, and janitorial areas.
	Healthy Interior Performance	To promote good indoor air quality performance, all projects must: • Provide the results from an Indoor Air Quality test one to six months after occupancy or provide readings from an ILFI-approved continuously monitored indoor air quality system. • Comply with the CDPH Standard Method v1.1-2010 (or international equivalent) for 90% of interior building products that have the potential to emit volatile organic compounds (VOCs). All projects must provide access to views and daylight from 95% of regularly occupied spaces and opportunities for those occupants in the remaining five percent of regularly occupied spaces to move to compliant spaces for a portion of their day. Besides, all projects must provide at least two of the following: • Sufficient operable windows to provide natural ventilation for at least six months of the year. • Ability for the occupants to influence their local airflow and temperature through direct input or controls. • Flexible options for working and learning, such as sit/stand options or varied sensory experiences for living, working, or learning. Residential projects must provide operable windows for 100% of the project occupants.

Appendix 5. (Continued) LBC 4.0 credits and requirements related to biophilic design principles

Visual Connection with Nature	Access to Nature	All projects must connect people and nature by providing sufficient and frequent human-nature interactions in both the interior and exterior of the project to connect the majority of occupants with nature directly. All projects must complete a post-occupancy evaluation that addresses the project's health benefits, including the benefits of daylight, fresh air, and access to nature at least once within six to twelve months of occupancy.
Dynamic and Diffuse Light **Biomorphic Forms and Patterns**	Beauty and Biophilia	Projects must be designed to include elements that nurture the innate human/nature connection. Each project team must engage in a minimum of one all-day exploration of the biophilic design potential for the project. The exploration must result in a biophilic framework and plan for the project that outlines strategy and implementation ideas for the following: • How the project will be transformed by deliberately incorporating nature through Environmental Features, Light and Space, and Natural Shapes and Forms. • How the project will be transformed by deliberately incorporating nature's patterns through Natural Patterns and Processes and Evolved Human-Nature Relationships. • How the project will be uniquely connected to the place, climate, and culture through Place-Based Relationships. The project must meaningfully integrate public art and contain design features intended solely for human delight and the celebration of culture, spirit, and place appropriate to the project's function.
Material Connection with Nature	Responsible Sourcing	All projects must advocate for: • The creation and adoption of third-party certified standards for sustainable resource extraction and fair labor practices for extraction of rock, metal, minerals, and timber. • Certification under the Natural Stone Council 373 Standard by quarries or manufacturers of all dimension stone products used within the project.[31] All projects must either source 80% or more of all wood, by cost or volume, as Forest Stewardship Council certified, or as salvaged, or from the intentional harvest of on-site timber for the purpose of clearing the area for construction or restoring/maintaining the continued ecological function of the on-site bionetwork, and the remaining 20% of wood must be from low-risk sources. Alternatively, the project may achieve FSC Project Certification. All projects must contain two Declare labeled products per 200 sqm of gross building area, or project area, whichever is smaller, up to forty products, and advocate to all manufacturers that are not in Declare that they register their products in the Declare database. All projects must incorporate one product certified under the Living Product Challenge per 1,000 sq. m of gross building area or project area, whichever is smaller, up to three products. Residential projects must incorporate one product certified under the Living Product Challenge.

Appendix 6. LBC 4.0 credits and requirements related to universal design principles

UNIVERSAL DESIGN PATTERN	RELATED LBC CREDIT	LBC REQUIREMENTS FOR RELATED CREDIT
1.Equitable Use	Universal Access	Projects must provide for and enhance the public realm through design measures and features accessible to all members of society, such as street furniture and public art gardens, and benches All projects must make all primary transportation, roads and non-building infrastructure that are considered externally focused (e.g., plazas, seating, or park space) equally accessible to all members of the public regardless of background, age and socioeconomic class with reasonable steps taken to ensure that all people can benefit from the project's creation. All projects must safeguard access for those with physical disabilities through designs meeting either the Principles of Universal Design (the United States Access Board), the Americans with Disabilities Act (ADA), and the Architectural Barriers Act (ABA) Accessibility Guidelines, or international equivalent.
2.Tolerance for Error	Universal Design Access	Projects may not restrict access to the edge of any natural waterway, except where such access can be proven to be a hazard to public safety or severely compromise the project's function Projects must protect adjacent property from any noxious emissions that would compromise its ability to use natural ventilation. All operational emissions must be free of Red List items, persistent, bioaccumulative toxicants, and known or suspected carcinogenic, mutagenic and reprotoxic chemicals.
3.Size and Space for Approach and Use	Universal Design Access	If the project's boundary is more than sixty meters long parallel to the waterway's edge, it must incorporate and maintain an access path to the waterway from the most convenient public right-of-way. Projects may not block sunlight to adjacent building facades and rooftops above a maximum height allotted for the Transect. The project might not shade the roof of an adjacent building unless that building was built to a lesser density than acceptable for the transect. No project may block access to, nor diminish the quality of, fresh air, sunlight, and natural waterways for any member of society or adjacent developments. Projects must also appropriately address any noise audible to the public.

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