BIOPHILIC DESIGN: CREATING BIOPHILIC HEALING SPACES

MASTERS OF DESIGN THESIS

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“This thesis is dedicated to

my brother Dr. Koushik Ram.”
1 ACKNOWLEDGEMENT

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Healthcare space are spaces that are meant for the healing; it is important to create an environment which helps to facilitate the healing in these places. In theory, the concept of biophilia has proven to improve the well-being of the occupant in any built spaces. This study focuses on understanding the importance of incorporating the concept of biophilic architecture in healthcare setting. The practical implication of applying this concept was verified through specific literatures about biophilic architecture in healthcare and stakeholder interviews with experts from the field, which helped in understanding the importance of introducing a healing environment in healthcare design. In this research, a new perspective to the biophilic architecture was explored, which is the cultural dimension. For this, the local culture specific to New Zealand was considered and cultural expert Ron Bull was contacted to understand how people can connect themselves to New Zealand. Furthermore, the cultural context was compared to the concept of biophilia which helped in developing a conceptual framework that can be applied to a design. This thesis explores the role of culture in improving the health and well-being of a person in a healthcare environment.
3 ABBREVIATIONS

AQI: Air Quality Index

ASMS: Association of Salaried Medical Specialists

CHBR: Centre for Healthcare and Building Research

GBCI: Green Building Council Incorporation

ICU: Intensive Care Unit

IPC: Infection Prevention and Control

IV: Intra-Venous

KTO: Kaitohutohu

LBC: Living Building Challenge

LEED: Leadership in Energy and Environmental Design

MCC: Maggie’s Cancer Centre

NHAPS: National Habitat Activity Pattern Survey

PMO: Programme Management Office

PTSD: Post-Traumatic Stress Disorder

PVC: Poly-Vinyl Chloride

SDHB: Southern District Health Board

SWOT: Strength Weakness Opportunity and Threat

TV: Tele-Vision

UK: United Kingdom

US: United States

VIP: Very Important Person

VR: Virtual Reality
4 GLOSSARY

**Bed occupancy**: the number of hospital beds occupied by patients expressed as a percentage of the total beds available in the ward, specialty, hospital, area, or region.

**Biophilia**: the innate affinity of the humans to connect with the nature and natural organism.

**Circadian rhythm**: an internal body process that regulates the sleep-wake cycle of a person according to their time zones.

**Eco-Therapist**: therapist in the medical field who believe connecting to nature can improve the physical and mental health of a person.

**Koru**: a Māori art symbol which is used to symbolise creation, it is shaped like an unfolding fern.

**Lexicon Medicum**: a medical dictionary containing explanation of terms in anatomy, botany, chemistry, materia medica, midwifery, mineralogy, pharmacy, physiology, practice of physic, surgery, and the various branches of natural philosophy connected with medicine.

**Māori**: Members of the aboriginal community of New Zealand.

**Mental health**: a person’s health condition with regards to their psychological and emotional state.

**Palliative care**: the nursing care provided to the terminally ill patients of cancer, who have tried all the treatment related process and still under nursing care.

**Post-Occupancy Evaluation**: the process of evaluating a building in a systematic and rigorous manner after they have been built and occupied for some time.

**Sterile**: an environment free of bacteria or microbes.
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1 INTRODUCTION

The health and well-being of a person can be influenced by the surrounding elements including light, colour, plants, space (which includes the colour, shape and size of a defined area), construction methods and material (this includes using materials that help in maintain thermal comfort); this can be regarded as architectural psychology (Margarete, 2018). By definition, architectural psychology is defined as the science of human experience and behaviour in a built environment (Abel, 2021). In a healthcare setting, where health and well-being are the priority, it is important to consider including elements that would impact psychology. Research findings suggest that biophilic design can reduce stress, improve well-being and expedite the healing (W. Browning et al., 2014). In this study, the focus is on understanding the impact of a healthcare design on the health and well-being of the occupant, in order to understand the practical aspect of the biophilic design.

1.1 PROJECT OUTLINE

The health and wellbeing of a person can often be influenced by the surrounding elements. More than 600 rigorous studies have verified that in a healthcare setting the building environment is linked to patient and staff stress levels, healing and that overall healthcare quality is influenced by the environment (R. Ulrich & Quan, 2004). The National Habitat Activity Pattern Survey (NHAPS) of the United States has shown that an average a person spends about 87% of their time indoors in enclosed spaces and 6% of the time in closed cars (Klepeis et al., 2001). Unlike most developed countries, there is no time-use microenvironment study in New Zealand (Baker et al., 2007; Khajehzadeh & Vale, 2017). In one of the studies, it was revealed that New Zealanders spend around 69.7% of their time indoors (Baker et al., 2007).

It is important to consider the psychological impact a space has on its occupants. Studies have shown that sterile, concrete landscapes and buildings that lack an imaginative design cause higher levels of stress (Vangelatos, 2019). The pivotal moments of a person’s life: ‘birth’, ‘death’ and some parts of life, are medicalised in a hospital environment. However,
the architecture for health was extracted from the construction of a modern hospital with a sterile environment (Heathcote, 2018). It is important to consider the impact of healthcare design on the patient’s health and mental well-being. In a study conducted to assess the stress levels across different areas of the hospital classified high and low stress zones in a hospital, it was revealed that Intensive Care Unit (ICU) and treatment areas (where most of the medical procedures takes place) were classified as high stress zones, whereas gardens and cafeterias were classified as a low stress zones (Abdelaal & Soebarto, 2019). On average 10% of the patients in an ICU experience Post Traumatic Stress Disorder (PTSD) as a result of the experience in ICU (Marra et al., 2017). But it is equally important to consider that hospitals are not just a space for the patients to be treated but also act as a work-place for medical staff. A study conducted to understand the burnout and stress levels of medical staff reported that 7.4% of nurses are absent for work during a week due to the stress from work, and this absenteeism record is 80% more than that in many other professions (Nourbala et al., 2002; Salari et al., 2020). According to the Association of Salaried Medical Specialists (ASMS), medical professionals in New Zealand coping with the rising COVID-19 pandemic reported a high work-related stress of 60.4% in the year 2020, this is over 21.9% higher compared to the stress level reported in a survey in 2015 which reported 38.5% work-related stress (Chambers, 2021; Houlahan, 2021).

Traditionally in a healthcare setting the bed spread colours, wall colours, screen colours and uniforms are mostly in green or blue colour in most hospitals with dim lighting throughout the built space. The colour green has been used to distract the patients from looking at the blood stains and to help doctors to clearly see the red colour as they are opposite colours on the colour wheel (Locke, 2008). The over-usage of this colour has created a boring non-vibrant environment for both the patients and staff to dwell in. The monotonously lit environment makes it hard for the patients to differentiate between day and night, especially when they are highly medicated and drowsy.

In this study, the focus is on understanding how architecture can be potentially used as a tool to abate the stress levels induced in a healthcare environment. With development in urban areas, people have been distanced from nature, so establishing this connection
could potentially impact the wellbeing of the users of a space (S. R. Kellert, 1993; Newman, 2014; Pedersen Zari, 2019). Several studies have proven that exposure to natural environments can help in reducing psychological stress (Ewert & Chang, 2018). It was stated in Lexicon Medicum (1839), the “medical dictionary” about the “healing power of nature”: discussions were about how the surrounding environment can impact the healing process (Heggie, 2014; Totaforti, 2018). Some studies suggests that even speaking the indigenous language has an impact on the health of the indigenous people (Ventura & Rueter, 2018).

The need for a more therapeutic environment in healthcare has been increasing over the last decade (Grinde & Patil, 2009). An emerging global trend in architectural design is the concept of biophilic architecture (Zielinska-Dabkowska, 2019), which aims to establish a better human-nature connection to achieve a therapeutic environment. This research will inform design decisions on how effectively the biophilic concept can be applied to healthcare design. This research focuses on making this design more inclusive, by including the indigenous people as part of the design. The term ‘Biophilia’ was first coined by a social psychologist Eric Fromm in 1964. Fromm defined it as the “love for life or living organism” (Eckardt, 1992; Fromm, 1973).

1.2 NEED FOR THE STUDY

The World Health Organisation states that “there is no health without mental health” (Herrman et al., 2005). According to the New Zealand sovereign well-being index, the mental health study of 2015, it has been reported that 25% of New Zealanders have a good mental well-being (Mackay et al., 2015; Mental Health in New Zealand, 2015). An estimated 636,000 (17%) of adults have been diagnosed with mood disorder and anxiety, also 225,000 (6.5%) of adults have been diagnosed with mental distress (Annual update of key results 2014/15 New Zealand health survey, 2015). Most of existing healthcare facilities have been designed as functional environments which are patient centric in design, but the stress levels undergone by occupants other than the patient have been not been the main drivers of design of these spaces. It is important to create an
environment which adheres to the mental and physical well-being of both the medical staff and patients are taken care of in a healthcare design. There is a need to create a healthcare setup which can impact the well-being of the occupants in New Zealand.

1.3 RESEARCH QUESTION

The central theme of research is to understand about designing a healing environment in healthcare spaces which facilitates recovery of the patients and improves the well-being of the staff in the built space. The concept of biophilia is an emerging concept which has shown a positive trend towards improving the physical and psychological wellbeing of occupants (Grinde & Patil, 2009). The literature was considered to understand how the biophilic environment contributes to the well-being of the occupants of the building. The research questions which have been posed in this theoretical thesis are:

*How can biophilic design strategies be used to create a healing environment for the patients in healthcare settings?*

1.4 SCOPE

Biophilic architecture is a vast topic to be explored, so the scope of this thesis is limited to understanding how the biophilic design contributes towards improving the well-being of the occupant in a space and developing framework for a biophilic healthcare design which focuses on including the cultural aspect of the local area into the design. In this thesis, the benefits of biophilia have been explored through various case studies and expert interviews which have demonstrated how biophilia can help contribute to an improved well-being in a space. A thorough literature review of how the biophilic design has impacted the well-being of occupants in different built typologies has been reviewed and only relevant literature has been discussed in the thesis. The findings from the literature have helped develop a design framework. The findings have helped formulate an additional theory of how the biophilic design can be enhanced by adding a cultural
perspective. This thesis is restricted to understanding the impact of biophilia on health theoretically and a design framework was developed that can be applied to healthcare design. A new area of design has been explored in this research thesis; the integration of biophilic design with a cultural perspective has been considered as a key pointer in this research. This thesis aims at integrating the biophilic elements to the local context by connecting the user to the space.

1.5 THESIS OVERVIEW

The thesis has been designed to understand how the biophilic environment can influence the health and well-being of the patients in healthcare, and help in a faster recovery. In this thesis, the first chapter establishes a need to design healthcare spaces that focuses on improving the physical and mental well-being of patients and staff. To achieve this, an understanding of the concept of biophilic architecture has been made. The central research question for the thesis has been introduced in chapter 1. The second chapter introduces the concept of biophilia, the literature has been thoroughly analysed to understand how biophilic architecture impacts health. In Chapter 2, the application of the concept of biophilia in various areas of design and the benefits of its application for physical and mental well-being have been discussed in detail. Chapter 3, discusses the methods and methodology used in this research thesis. In Chapter 4, the case studies relevant to biophilic architecture in healthcare have been discussed. This chapter also helps in understanding the difference in the health impact of biophilic and non-biophilic hospitals. The opinions of the experts from various professional backgrounds were taken to understand the practical implications of using biophilia in a healthcare design, this has been discussed in detail in Chapter 5. The research question raised in Chapter 1 has been extensively discussed in Chapter 6. This chapter also discusses the design framework specific to biophilic architecture in healthcare, the framework has been critically reviewed in Chapter 7. In chapter 7, the discussion is around the need for linking culture and biophilia in healthcare design to impact the well-being of the occupants in the space. The final chapter summarises the whole research thesis and suggests recommendations for future research.
1.7 LIMITATION

The thesis was started as an experimental thesis which focused on including patient surveys and staff surveys of people who have used the biophilic healthcare environment. However, it evolved into theoretical design research which was based on the expert interviews, considering the pandemic situation that was widely prevalent during the time. Only ten experts who belonged to various professional backgrounds were interviewed. Considering the process and the length of the ethics approval process it was impossible to include the patient surveys as part of the scope. In this thesis no particular patient group has been studied, because although biophilic design has been widely applied in multi-speciality hospitals very few speciality hospitals (including Maggie’s Cancer Care) have a biophilic design.
The discussions in Chapter 1 revolves around describing the need for introducing biophilic environments in healthcare. The scope and limitations of this project has been discussed with the timeline that was available for completing this thesis. This chapter establishes a need to look into the previously available literature that helps in understanding the impact of biophilia in healthcare environments. In Chapter 2, the literature available on the topic will be thoroughly analysed to develop a better understanding of the concept.
2 LITERATURE REVIEW

The biophilic design concept has found application in educational institutes, workplaces, residences, and healthcare since the 1980s (W. D. Browning et al., 2012). It is important to understand the impact of a biophilic environment in healthcare, and how the application of biophilia has impacted the well-being factor of healthcare spaces. The literature suggests that the application of a biophilic environment in a workplace has improved the productivity of the staff and absenteeism due to sickness has reduced considerably (Lerner & Stopka, 2016), whereas in an educational institute a biophilic application has increased the attentiveness of the students (Mustafa & Yaseen, 2019) and in healthcare the patients have been discharged earlier (W. D. Browning et al., 2012; R. S. Ulrich, 1979). This thesis aims to investigate the impact of biophilic environments in healthcare set ups with relevant case studies and literature.

2.1 BIOPHILIA – AS CONCEPT

The term ‘Biophilia’ was first coined by a social psychologist Eric Fromm in 1964. Fromm defined it as the love for life or living organism (Eckardt, 1992; Fromm, 1973). The theory was first formulated when the concept of Necrophilia (which is an affinity towards the dead organism) was compared to Biophilia (affinity towards living organism). In 1984, a Harvard Entomologist Edward O. Wilson, in his hypothesis defined biophilia as “innate affiliation of human beings to other organism” (Gullone, 2000; S. R. Kellert & Wilson, 1993). Wilson believes that hereditary connection to nature has been lost with the urban developments as more time is spent indoors than outdoors (S. R. Kellert & Wilson, 1993). Several famous architects have worked on introducing a closer human-nature connection in buildings, but these works were not termed biophilia, as the concept has gained momentum only very recently. Few of the famous works of architects such as Geoffrey Bawa, Frank Lloyd Wright, BV Doshi and Charles Correa have aimed at bringing in a closer human-nature connection and creating a more sustainable living environment but their works are not credited as biophilic designs as the concept was not popular then. Some famous designs including Falling Waters
designed by Frank Lloyd Wright, Champalimaud Cancer Centre by Charles Correa, Lunuganga by Geoffrey Bawa and Indian Institute of Management, Bangalore by B.V. Doshi have a biophilic character in them. A social ecologist Stephen R. Kellert from Yale University believes that “[b]iophilic design is not just about greening our buildings or increasing aesthetic appeal with the help of trees and shrubs. It is about humanity’s place in nature and natural world” (S. R. Kellert et al., 2008; p.vii ; Salingaros, 2019; p.4). The concept of biophilia has been applied mostly in schools (Mustafa & Yaseen, 2019), workplaces (Lerner & Stopka, 2016), and residences, and the results have shown considerable difference in the well-being of the people who use these places (W. D. Browning et al., 2012). The application of biophilia in workplaces has resulted in increased productivity of the staff and helped reduce absenteeism due to sickness, resulting in financial gain for the company (Ayuso Sanchez et al., 2018; Lerner & Stopka, 2016).

In educational institutes the design has helped improve the concentration span and attentiveness of children thereby increasing their performance in exams (W. D. Browning et al., 2012). In healthcare, there are very limited biophilic applications but study of the impact of well-being in healthcare has shown that there is a significant impact on health in a biophilic environment (W. D. Browning et al., 2012; Gullone, 2000; R. Ulrich, 1984). A key researcher of biophilic environments in healthcare design Roger S. Ulrich, a professor of architecture at the Centre for Healthcare and Building Research (CHBR) in USA, has performed various experimental studies to assess the impact of biophilic environments on health of patients in healthcare. Most of these experiments were conducted in functional hospitals with exposure to artificial or natural biophilic environments. It has been observed that contact with nature helps in faster healing from illness and surgical procedures (Grinde & Patil, 2009; R. S. Ulrich, 1979).

According to some cultures, for instance, New Zealand’s indigenous population the ‘Māori’, it is believed that the well-being of a person is affected based on a human’s connection to nature (Hatton et al., 2017). In other cultures, including the Maharishi Vastu Architecture (MVA) a branch of the Indian Vastu sastra deals with aligning nature’s intelligence to improve human health through architecture (Lipman et al., 2022). In the Chinese culture, the practice of Feng shui helps in aligning oneself to the benefit of
nature’s energy, this is also regarded as the art and science of healing spaces (Lupone, 1999). Different cultures have tried to establish the fact that the connection to nature can improve the physical and mental health of the occupants.

Most architecture designs are based on a concept. The design concept can be anything ranging from the function of the building, to nature inspired concepts like biomimicry and zoological morphism. Likewise, it is essential to explore the possibilities of using biophilia as a design element in a built spaces like hospitals and establish a better human-nature connection inside the built space. The Terrapin Bright Green group has formulated fourteen patterns of biophilia (W. Browning et al., 2014) which make biophilic application in a design easier (Figure 2).

The concept of biophilia helps in bringing a human-nature connection. The Terrapin Bright Green group has classified the application of fourteen patterns biophilic design under three broad headings: nature in space, nature of space and nature analogues (W. Browning et al., 2014; S. Kellert & Calabrese, 2015; Olmsted, 2014). The patterns are designed to help the users of the space connect to nature in a direct or indirect form, for instance, the indirect forms involve sensory connection to nature, a biomorphic pattern (replication of nature) which reminds us of nature and establishes an indirect connection to natural landscapes. While a direct connection to nature can be introduced by bringing in real plants, water bodies or representations of nature and elements present in nature. The biophilic design aims at achieving six major goals which include interdependence, orientation, control, meaningful connections, environment restoration and information richness (Craanen, 2018).

Studies and research across the concept of biophilia have suggested that constant routine connection with nature helps in restoring mental health (Sakallaris et al., 2015), which is essential in the current healthcare systems. The neurological response of people to biophilic design has enormous positive psychological responses, measurable medical changes including change in skin temperature and adrenaline levels (Salingaros, 2019). The contribution of Kellert, Ulrich, Nikos A. Salingaros and Terrapin Bright Green group have been extensive, including formulating metrics that can be used to measure the biophilic quality of a building.
Figure 2: 14 Patterns of Biophilic design based on the Terrapin Bright Green group.

Source: Own image created in photoshop (2020), after referring Terrapin Bright Green group publication (2014).

According to Nikos A. Salingaros the biophilic quality of a building is measured by an index ‘B’, which helps in assessing the effect of biophilia in a particular building and how each concept has contributed individually for enhancing the design quality of the space. The key attributes of biophilic designs in a space are defined in this index. The findings of Kellert are similar to the biophilic patterns formulated by Terrapin Bright Green group. According to Kellert there are 25 attributes and experiences that can be classified broadly under three headings which are the direct experiences of nature, indirect experiences of nature and nature analogues that help replicate and remind us of nature (S. Kellert & Calabrese, 2015). The biophilic index created by Salingaros helps in assessing the effect of a biophilic built environment on well-being. For the assessment of the biophilic index ‘B’ the biophilic design is divided into ten components which include sunlight, colour, gravity, fractals, curves, detail, water, life, representation of nature and organised complexity (Salingaros, 2019). The impact of these biophilic components put together were measured on a scale of 0 to 20, where the individual score of each component does
not exceed ‘2’, which helped in understanding the level of impact. The scores are based on the positive impact the space has on its end-user (Salingaros, 2019).

2.2 DIRECT EXPERIENCES OF NATURE

It is the natural tendency of humans to get attracted to nature. Wilson in his hypothesis of biophilia mentioned that human connection to nature is hereditary (S. R. Kellert & Wilson, 1993). The experiences of nature can be direct or indirect, where direct exposure means experiencing the presence of real plants, being with other living organisms, introducing images or representations of nature in space and visually connecting to nature through technology including Virtual Reality (VR). Whereas, indirect experiences could mean the sensory connection to nature or things which symbolize and represent nature (E. Wilson, 1993).

2.2.1 IMPACT OF BIOPHILIA ON PHYSICAL HEALTH ON EXPOSURE TO DIRECT NATURE

The first experimental study of biophilia in a healthcare setting was conducted by Ulrich during the period 1972 to 1981, among 46 patients recovering from gall bladder surgery (R. Ulrich, 1984; R. S. Ulrich, 1979). In a hospital there were two types of patient rooms, one with a view of a garden area with trees and another with a view of a brick wall. For the study 23 patients with a view to nature and 23 patients with a view to brick walls were selected. The patients were monitored for pain medications, anxiety medications, minor complications including nausea, headache, blood pressure levels and length of stay at the hospital. The 46 patients selected for the study were split in 23 pairs with fifteen pairs of females and eight pairs of males. The study revealed that the average length of stay for the patients with views of garden area was 7.96 days, whereas for the patients with views to brick wall recovered in 8.7 days. It was also observed that the patient room with nature view required lesser pain medication in comparison to the patients with view to brick wall (R. Ulrich, 1984; R. S. Ulrich, 1979). The patients with views to nature stayed 0.74 days lesser on an average compared to the patients with view to brick wall. The reduced length
of stay can be attributed to various factors including the gender, age of the participants, previous medical conditions and other factors. Though the result cannot be attributed only to the presence of a biophilic environment, it is one of the key factors for this result. It is essential to understand the cost factor involved in designing a space with a biophilic environment. It important to know if it is cost-efficient or costly to design a space with a biophilic concept. In a study to understand the economic benefits of the biophilic environment, the scenario of the Ulrich’s study on 46 gallbladder surgery patient was considered. The economic benefit was calculated for a public hospital in USA for the year 2004. The aim was to understand how much the hospital would save when 46 patients left the hospital 0.74 days earlier (in this study the example of Ulrich’s gallbladder study was considered to calculate the cost saving). The total cost saving from creating a biophilic environment turned out to be US$161,000 which was a significant amount for the hospital, as this reduced the usage of hospital supplies and freed up a bed for a new patient (W. D. Browning et al., 2012; Machlin & Carper, 2007).

In the 1980s, a Japanese traditional treatment method ‘Shinrin Yoku’ (or Forest bath) was used to help patients exercise their body and mind, an unconventional method which focused on an overall healing of the body. In this method people were exposed to a forest environment for walks and other exercises which could help improve their well-being. A study on the impact of this treatment on their health was conducted on 87 insulin dependent diabetic patients of a similar age group and with a similar medical history. People were made to walk at least three to four kilometres inside the forest and their blood sugar levels were recorded before and after the walk. This was compared to their sugar levels before and after they had completed walking the same distance on a treadmill with similar elevation inside a closed room. In the former method it was observed the blood sugar levels had reduced by 39.7%, and in the treadmill environment the blood sugar was reduced by 21.2%. The walk inside a forest environment proved to be more effective by reducing the sugar levels 1.87 times more in comparison to the walk on the treadmill inside a room. This difference in the sugar level across different environments could be attributed to the presence of a biophilic environment (W. D. Browning et al., 2012; Ohtsuka et al., 1998). This healing technique showcases a connection to the cultural roots.
2.2.2 IMPACT OF BIOPHILIA ON MENTAL HEALTH ON EXPOSURE TO DIRECT NATURE

Studies have suggested that exposure to biophilic design not only improves the patient’s health, but it can also reduce the stress of patient attendees (R. S. Ulrich et al., 2020). Ulrich and co-workers studied the impact of a biophilic environment on the stress levels of patient attendees. In this study, 42 families of the ICU patients participated and their preferences of location to relax when they wait for the ICU patient were recorded. This was done to understand the preferred break locations of the patient attendees when they are waiting for the ICU patients. The places visited by the patient attendees during the wait times were recorded and three major break locations were identified. The major break locations are waiting room, garden and café. In total 42 families recorded a total of 128 breaks, 82 of these were spent in the garden for an average time of 34 minutes. Of the other two locations, a total of 35 breaks were spent in café with an average break time of 39 minutes and 11 breaks times were spent in the ICU waiting rooms with an average break time of 16 minutes. In this study, the preferred break location was identified as the garden area, the patient attendees preferred this over the café and waiting room as it had a significant impact on their stress level. It was found that the pre-stress levels (the pre-stress levels were measured based on the survey questionnaire which included questions that helped identify their mental state before choosing the location) did not have any impact on the choice of break location (R. S. Ulrich et al., 2020).

2.2.3 IMPACT ON PARTICIPANT’S HEALTH ON EXPOSURE TO VIRTUAL ENVIRONMENTS

In places where there is no scope for introducing the real nature, J. Yin et.al (2020) conducted a study to experimentally understand the impact of biophilic environments on patient health with a Virtual Reality (VR) based approach. In this study a group of 100 participants were randomly allotted four different VR environments, of which one was a non-biophilic office space, and three other environments had a biophilic element in each of the designed spaces. To understand the impact on the health and the restorative effect
such an environment creates on the users, their stress reactions were monitored with the help of indicators including heart rate variability, skin conductance level and blood pressure using bio-monitoring sensors. It was found that the restorative impact of the biophilic environments were much more than that of the non-biophilic environment. The research suggests that this could be used as a tool to allow people to get an authentic experience of nature in places where it is not possible to introduce real nature, including the sterile environments in hospital (Yin et al., 2020).

2.3 INDIRECT EXPERIENCES OF NATURE

In a biophilic design, the indirect nature experiences include non-visual connection to nature, non-rhythmic sensory stimuli, prospect, refuge, and mystery. The non-visual connections can include images or paintings of nature, visual representations of nature and natural environments, and biomorphic patterns which remind us of nature (Olmsted, 2014). The sensory connections to nature include smell, sound, touch and feel of nature, which are naturally present or artificially created in a space, including the sounds of birds and smell of natural flowers. These can be classified as sensory connection. The impact of these sensory stimuli was measured on patient health using various experimental studies (R. S. Ulrich et al., 2003; Yin et al., 2018, 2020).

2.3.1 IMPACT OF BIOPHILIA ON MENTAL HEALTH ON INDIRECT NATURE EXPERIENCE

To understand the impact of biophilic environment in a blood donation room, Ulrich in 2003 conducted a study to understand the impact on the stress levels of blood donors (R. S. Ulrich et al., 2003). Clinically this is classified as a stressful activity. For this study 872 participants were selected, of which 68% were male and 32% were female, and the average age of the participants was 40. The donors were randomly assigned to four different rooms with different environments. The environment used for the study included a room with a blank television (TV), a room with a TV playing a recorded video of nature, a room with TV playing recorded video of urban setting, and a room playing
regular daytime TV. The study concluded that the stress levels were significantly lower for the donors in the room with a blank TV compared to the donors in a room with a regular daytime TV; similarly, the donors in room with TV displaying nature had lesser stress in comparison to the donors with a TV displaying pictures of urban settings. This difference could be attributed to the effect of nature, as it is mentioned in the literature (R. S. Ulrich et al., 2003).

2.3.2 IMPACT OF BIOPHILIA ON PHYSICAL HEALTH ON INDIRECT NATURE EXPERIENCE

The application of art in hospital settings has been explored as another design strategy. Some studies have revealed that art can impact the well-being of occupants in healthcare (Lankston et al., 2010). A comparative study was conducted to understand the difference in health impact of an artistic environment and a biophilic environment. To understand this, patients were put in two different environments: one with an abstract art painting and another with scenic painting depicting nature. It was found that the patients in the room with the scenic nature painting responded better to the medical treatments. It is important to understand that a person’s psychological response to different colour, hues and shade may differ. Patients in a stressed mindset preferred a blue green landscape over abstract art as it comforts them (Lankston et al., 2010).

2.3.3 EXPERIMENTAL STUDIES COMPARING DIRECT AND INDIRECT NATURE EXPERIENCE

In another study, J. Yin et. al in 2018 tried to experimentally understand the impact of a biophilic environment on a person’s physiological and cognitive performance by exposing them for a period of five minutes in an actual biophilic environment and a VR created biophilic environment. A wearable sensor which measures blood pressure, galvanic skin response and heart rate was given to 28 participants chosen for this study. The difference in the participants health before and after the study was compared to understand the change in health, but there was no significant difference for participants who were placed in actual biophilic environments and VR created biophilic environments (Yin et al., 2018).
This may mean that in spaces like healthcare where there are limitations on using actual natural environment elements the VR created environment can be substituted.

To compare the impact of indirect and direct nature experience on the physical and psychological health of the participants a study was designed by Jeon et al in Chung Buk National University campus in South Korea. For this study, 30 participants between the ages of 18-27 with no prior medical conditions or medications were chosen. The participants were exposed to two different settings. For the direct nature experience they were exposed to a park close to the university campus and for indirect nature experience they were introduced to a room conditioned to be maintained at 25°C with 50% relative humidity. The humidity and the temperature in the room was artificially created with devices. The experiences of the participants in both these environments were monitored using profile of their mood states by including tension and anxiety, depression, anger and hostility, vigour, fatigue, and confusion as factors. The study revealed that at the end of eight weeks, exposure to the direct natural environment proved to be more beneficial than that of an artificially created nature setting (Jeon et al., 2018).

2.4 APPLICATIONS OF BIOPHILIA

Literature studies have revealed the impact on the health and well-being of an occupant when a biophilic environment is introduced in a space. It was important to investigate the application of biophilic design, and it was quite fascinating to note that the building certifications like the Living Building Challenge (LBC) and WELL certifications have focused on introducing biophilia as one of the criteria (or) considerations of the certification. It is important to understand why biophilia has been introduced as a concept in these certifications which focus on improving the occupant well-being in a built environment.

2.4.1 LIVING BUILDING CHALLENGE (LBC)

The LBC certification aims at creating buildings which can operate without heavily depending for their energy consumption on non-renewable resources. The aim of the
Certification is to make the building less dependent on non-renewable energy resources. It was conceived as a concept which will allow the building to have a regenerative built environment. The certification helps in moving towards a more sustainable future by reducing the dependence on natural resources. Buildings are certified based on seven major categories called the petals and twenty imperatives which define how effectively the petals can be applied to a design. The LBC concept can be applied to a new construction, retrofit to an existing building, and can be used in interior projects. Based on the number of petals which are achieved in the certification there are different certification types: zero carbon certification, zero energy certification, core green building certification, petal certification and living building certification. It is intriguing that biophilia is an important imperative of this certification process. The LBC believes that the innate connection of the humans to nature is beneficial and helps in nurturing them and create a meaningful design. When creating a self-sustainable building, LBC feels the need to include biophilia as one of the contributing factors in achieving this. In Figure 3, the petals and the imperatives of the LBC certification can be seen, where the major seven petals are place, water, energy, material, equity, beauty, and health and happiness (LIVING BUILDING CHALLENGE 4.0, 2019).

Figure 3: Petals and imperatives of living community challenge

Source: https://living-future.org/lbc/basics4-0/

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It can be seen in the Figure 3 that biophilia is classified as an imperative under the beauty petal and it is also classified as a core imperative. Biophilia components include all five natural elements light, air, water, space, and earth (Olmsted, 2014). The direct inclusion of nature could include introducing more ‘natural light’ which reflects on the ‘energy’ petal. Altering the ‘thermal dynamics’ can also be a component which also reflects on the ‘energy’ petal. When ‘natural material’ like wood and stone are included in a design it establishes a nature connection and this can be classified under the ‘material’ petal. A ‘water component’ like a pond or a waterfall adds an aesthetic element to the design and can be classified under ‘presence of water’ petal. In LBC the biophilia is classified as an imperative under the beauty petal, but it adds more value to the design than just the aesthetics.

The LBC certification aims at creating a more sustainable future environment. When such certifications consider biophilia as a key design component it warrants that the biophilia can contribute to a healthier environment to dwell in. The petals and imperatives of this certification will be taken as a reference for developing the design framework of my work.

2.4.2 WELL CERTIFICATION

The WELL building certification was launched in 2014 as a third-party certification for the Green Building Council Incorporation (GBCI). Aimed at creating a healthy built environment, the certification focuses on the post-occupancy well-being of the occupants of the built space. This certification as the name suggests focuses on well-being. After six months to one year of building occupancy, the well-being of the occupant is measured through specific surveys and studies after which the certification is issued. The WELL buildings focus on each of the body parts which includes the endocrine system, the nervous system, cardiovascular system, digestive system, etc. where every WELL building concept targets a specific system of the human body. The WELL building standard classifies the well-being under ten major concepts. The ten concepts of WELL are further classified to preconditions and optimisations, which focus on improving the well-being of the occupants. There are 23 preconditions in total which are to be met for a building to certified under this certification. The ten WELL concepts are air, water, nourishment, light, movement, thermal comfort, sound, material, mind, and community (WELL Building
Standards, 2020). These concepts are formulated based on the principles of the WELL building community, which are equitable, global, evidence-based, technically robust, customer focused and resilient. This helps in optimising the design and improving the well-being of the occupants. The well-being benefit of each concept was weighed, put to vote among the experts committee and the final concepts were chosen for this certification. This certification is issued under different categories as bronze, silver, gold, and platinum, based on the concepts which are being used in the built typology (WELL Building Standards, 2020). The total concept scores are calculated individually for each of the elements and the final score determines the certification type of the building.

In the ten concepts of the WELL building certification (Error! Reference source not found.), biophilia is classified as a precondition under the mind concept. The goal of the mind concept is to have an improved mental health. Biophilia has been listed as a component under the ‘access to nature’ precondition of the mind concept in WELL V2 pilot version 2021 (WELL Building Standards, 2021). The ‘access to nature’ component ensures that the occupants of the building are exposed to natural environments both indoor and outdoor which helps in having an improved well-being. If the concepts are looked in closely, it can be seen that each element of nature is classified as a concept, The ‘dynamic lighting’ is a component of the biophilic patterns as well.

According to the WELL standards light is considered as an essential component as it influences the ‘circadian rhythm’ of a person. When sufficient lighting is not provided in a space, the person is unaware of the difference between day and night, which could lead to various sleep and health related issues. It is important to have a healthy physical environment to live in: ‘thermal comfort’, ‘sound’ and ‘mind’ are few concepts which can contribute to a better mental and physical health of the occupant. The ‘thermal comfort’, ‘water’ and ‘access to the nature’ are also classified as patterns under the fourteen patterns of biophilia. The goal of WELL certification is to create a design which focuses on the overall health and well-being aspect of the occupant. The WELL certification is based on a minimal pass score attached to each of the concepts and preconditions which are achieved. This score helps in determining the kind of WELL certification a building would be offered. There is an overlap in the concepts of WELL and patterns of biophilia. Some of
the concepts including air, water, light, thermal comfort, and materials were also part of
the biophilic patterns. It is important to note that like the WELL certification, biophilia also
focuses on improving the well-being of the occupant in a space.

It would be relevant to apply the concept of biophilia in a healthcare environment, where
the focus is primarily on improving the health of the patients, but reducing the stress
levels of the staff and absenteeism will also be additional benefits of introducing biophilia
in healthcare settings. The aim of the project is to design a healthcare space in which the
primary focus is about the well-being of occupants, and it is evident that biophilia could
act as a tool which promotes well-being.
3 RESEARCH METHODS

Research methods are broadly classified under qualitative, quantitative, and mixed methods. This research uses a qualitative mixed-method approach, including stakeholder interviews and case study research. This research started as a ‘research about design’, where the initial plan was to collect quantitative data by interviewing different stakeholders and patients at the hospital. This research further developed into a ‘Research for design’, the central research question was partially answered through the literature and a framework was developed to make it easier to translate the concept of biophilia into a healthcare design.

3.1 RESEARCH METHODS

In this research, the primary aim is to understand how biophilic architecture could potentially be used as a tool to facilitate faster recovery in healthcare. The literature was reviewed to understand how biophilia has been used as a design concept in healthcare and the gaps in the existing framework were identified. It was important to investigate studies that have tested the application of biophilic design in healthcare and conducted experimental studies to understand how the design impacts patient health. To achieve this, it is important to conduct the research methodically. The research methods have been broadly classified as qualitative, quantitative, and mixed methods (Brent & Leedy, 2015). Quantitative research involves numerical and statistical data sets, whereas qualitative research involves describing, explaining, and interpreting the collected data (Brent & Leedy, 2015; Webster, 2007). Mixed methods are deemed useful when there is a combination of qualitative and quantitative data collection involved. The research method used for this study is the qualitative method. In the book Practical Research: planning and design (2015), Leedy and Brent classify qualitative research broadly under five categories: case studies, ethnographies, phenomenological approaches, grounded theory, and content analysis. Several strategies can be used to conduct qualitative research including sampling, making observations, and interviews (Brent & Leedy, 2015).
The case study method and content analysis were included as part of the literature review in this research. Content analysis is defined as a method in which the contents are systematically analysed to detect patterns, themes, or biases (Brent & Leedy, 2015). According to A. Sturman “[a] case study is a general term for exploration of an individual, group or a phenomenon” (Mohajan, 2018; Sturman, 1997). In the book *Case study Research Methods*, Robert Yin (2003) describes a case study as “the essence of a case study, the central tendency among all types of case study, is that it tries to illuminate a decision or a set of decisions. Why they were taken? how they were implemented? and with what results?” (Yin, 2003; p.12). For this research, a comparative case study was done to compare KTPH hospital (a biophilic) and Changi hospital (a non-biophilic), a public hospital in Singapore. In this study, the hospitals were compared to understand how they function differently in terms of bed capacity, bed occupancy, length of stay, cost of stay factor, and other factors that could potentially help understand if the biophilic environment contributes to the recovery rate. This comparative analysis helps in understanding the impact of the built environment on patient health. A psychiatric clinic in Sweden, Ostra psychiatric clinic was chosen for the content analysis study, where a case study of the hospital was interpreted with the data sets available online.

The research aims at understanding how architecture could potentially impact the health of patients in healthcare, for this it was important to understand if it is medically possible to alter the health of the person by changing the kind of environment to which they are exposed. It is equally important to understand from the experts in the field of architecture and experts from academia who research the importance of introducing a biophilic environment in healthcare settings. From the literature review (chapter 2), it was evident that the hospital can be divided into different zones and the stress levels and sterility concern of each zone is different (Abdelaal & Soebarto, 2019). The research was designed to include these expert opinions, where a qualitative survey was conducted through expert interviews and stakeholder discussions. These interviews along with the literature reviews, content analysis, and case studies were used as a basis to understand how biophilic architecture can be effectively applied to a healthcare design to obtain the desired outcome. The literature chosen for this study included both qualitative and quantitative data sets, and some of the literature in Chapter 2 has shown cases where the biophilic environment has a significant impact on the physical health of the patients.
In the book *Design Research* (2003), Downton explores the usage of design as a way of inquiry in research, for which he classifies the relationship of research to design as ‘Research for design’, ‘Research about design’ and ‘Research through design’. ‘Research for design’ includes any study that has been done as groundwork for design research, including literature reviews and case studies. ‘Research about design’ refers to an extensive study about a particular design, which paves way for understanding the ‘what’s and ‘how’s of the design chosen. ‘Research through design’ according to Downton, means a person can more deeply understand a design by designing it themselves (Downton, 2003). This research started as a ‘Research about design’, where an inquiry of the existing biophilic hospital in Singapore KTPH was to be made. This eventually evolved into a ‘Research for design’ where an extensive literature review and stakeholder interviews were done to understand the impact of biophilic architecture in healthcare. It was important to apply the learning from this research to a design, so a framework was developed to help with the easier application of the biophilic concept into design.

A diagram of the research method (Figure 4) visually describes the process by which the design framework has evolved. First, the literature was reviewed, following which similar case studies were identified and studied. The experts in the fields of architecture and academia who have contributed to biophilic design were interviewed, and to add a cultural perspective to biophilic design a local culture expert was interviewed. The medical experts were interviewed to understand the impact of biophilia on mental health. A design framework was generated based on the stakeholder interviews and literature reviews, and the data were further analysed to identify gaps in the existing frameworks or theories of biophilia. A reflection based on the entire process has been made, analysis and interpretation of the available data sets were made, and the expert opinions were considered to formulate the conclusion and recommendations for this research.
3.2 RESEARCH METHODOLOGY

The initial research design for this thesis was to conduct a qualitative study at the KTPH, Singapore, and based on the findings from the study, set up experimental research at the Dunedin hospital to test the impact of a biophilic environment in healthcare. But, following the developments in the study, the main research question of ‘Does biophilic design influence the well-being of the occupant? How biophilic design strategies can be used to create a healing environment for the patients in healthcare settings?’ was thoroughly researched. The process started by understanding the different definitions of biophilia proposed by various authors over the decades to see how the definition has changed over the years. Following this an extensive literature review and case study was done to explore the application of biophilic design in healthcare settings, in this review, the qualitative and quantitative data sets were analysed to understand how biophilic architecture affects the health and well-being of the occupants in healthcare.

In Chapter 2, the literature reviews and case studies pointed to the fact that the change in heart rate, skin conductance levels, blood pressure levels, and the stress levels of the
participants can help identify the impact of the biophilic environment on physical health. Most of the literature suggests that patients experience improved physical and psychological well-being in a biophilic healthcare environment (Jeon et al., 2018; Ulrich et al., 2003; Yin et al., 2018, 2020). Consequently, the sustainability tools in architecture were looked at to understand if the concept of biophilia has been used previously in any of the certifications including, the Leadership in Energy and Environmental Design (LEED) certification, LBC, and WELL certifications. It was equally important to understand how the biophilic concept is being applied to a design, for which the standards and principles relating to biophilic design were also studied as part of the literature. It was essential to compare these certifications to the biophilic design to understand how they differ from each other, as both LBC and WELL aims to create an environment that can improve the well-being of the occupant. When these were compared, it was interesting to note that certifications like LBC and WELL (the certifications which focus on occupant’s health) consider biophilia as an important imperative for their design certification. Further to this, colour theory (a study in which the psychological impact of the colours on the person’s mood was studied), plants that can be used inside healthcare, fragrances that have an impact on the mood of a person, and the psychology of a person in healthcare were considered to understand how slight attention to detail could have a significant impact on the mental health of people. Correspondingly, some case study analyses of biophilic hospitals were identified as part of the literature review to understand various aspects that are involved when designing biophilic healthcare which includes the cost and maintenance factors involved, and the limitations in including certain ideas concerning the sterility (or) hygiene of the space that needs to be considered.

It was important to consult experts in the field of biophilia to understand the practical implications of the design in a healthcare setting. Experts in the field of biophilia were identified and a list was made. Lists were made of the all the hospitals in New Zealand, WELL professionals, LBC experts, medical professionals, architects practicing biophilic design, hospital management of KTPH, and environment-based healing therapists for the initial process. It was essential to obtain ethics approval from the polytechnic to proceed with this process, a part of the ethics approval included Kaitohutohu (KTO) consultation. A KTO is a representative of the Māori (indigenous people of New Zealand) population.
who verifies if this research is of relevance to them and makes sure this is inclusive of the Māori population. Māori have a very strong cultural history, so it was important to understand the cultural connection of Māori to the land, and an expert in the cultural area was contacted. Literature suggests that the health of a person and culture are complexly linked, manifested through physical, spiritual, and cultural relationship to the land (K. Wilson, 2003). Māori consider the ecological environment as a source of their physical, emotional, and psychological well-being. Also, creating places that include a natural environment is beneficial for both Māori and non-Māori people in general (Hatton et al., 2017). Inclusion of a cultural aspect to the design and relevant literature which has talked about the impact of cultural images or spiritual connections on the health of a person were considered. It was important to understand from the Māori cultural expert Ron Bull, a Tumuaki Whakaako (principal of teaching) at Otago Polytechnic, Dunedin, New Zealand the cultural considerations that must be made about the design and how the Māori symbols can be used to make a cultural connection to the place.

After the ethics approval was obtained, the interviewees were contacted to set up an interview. It was difficult to contact some of the experts for the interview considering their unavailability and the heavy workloads of the medical staff because of the COVID-19 pandemic. The snowballing technique was used for this research, it is a ‘conventional method of sampling used when it is difficult to access subject with target characteristics’ (Naderifar et al., 2017); p.2). Some of the experts contacted for the interview had referred and directed to the experts whom they thought would be more helpful for this study. This proved to be a beneficial technique especially in identifying some of the WELL and LBC experts. The experts contacted for these interviews had different areas of expertise. Some of them were architects who have designed biophilic residences, academics who have researched biophilia, an LBC founder, an LBC light concept lead, a WELL mind concept lead, an eco-therapist, clinical psychiatrists, cultural experts, and KTPH hospital management. The interviewees were not restricted to New Zealand. Some experts belong to Australia, Canada, the United States, and Singapore. Although not everyone was available for an interview, however ten experts from different areas of expertise were available to be interviewed. The main intent of this interview was to obtain an idea of the practical implications of a biophilic design in healthcare and to understand why this concept has not been chosen for healthcare design for a long time now. A set of
questionnaires was designed for each of the experts individually. Some questions were unique to architects, some of them were unique to medical professionals and some of them were specific to the LBC and WELL certification people. The interview was rolled out in a semi-structured format, this helped to include questions that were specific to their area of expertise (APPENDIX I).

The resulting expert interviews were further analysed and their opinions along with the literature reviews, Strengths Weaknesses Opportunities, and Threats (SWOT) analysis of the existing biophilic design guidelines were done and used to develop a design framework for this thesis. The design framework was specifically made for healthcare design, trying to identify the gaps in the existing frameworks, and those concerns were resolved with this proposed framework. The framework was critically reviewed to understand it’s the practical difficulties. The framework is applicable for all hospital design types, and no particular ailment was chosen to include as a specialty hospital. Every specialty hospital has a different requirement, but the proposed framework is meant for the general hospital design.

The methods and methodologies of how this research has been methodically carried out has been discussed in detail in Chapter 3. As discussed in this chapter, the data collection not just involves the literature review, it also includes expert interviews. In Chapter 4, the expert interview has been discussed and analysed in detail.
4 CASE ANALYSIS

The literature suggests experimental evidence of biophilic design application, where the concept was applied to a room in a hospital or in an artificially created environment in which the impact on health of the patients were measured. It is essential to understand the large-scale application of this concept in a built healthcare space. For this study, the cases of Khoo Teck Puat Hospital (KTPH) in Singapore and Ostra psychiatric clinic in Sweden were selected. The rationale behind selecting these hospitals were that these were the only existing hospitals designed in a biophilic manner that are familiar. There are some more hospitals in the world that have a biophilic character in some spaces, but they are not fully biophilic like these hospitals which are selected for the study. A case study of the Ostra psychiatric clinic in Sweden that was built in 2005 was considered (Ostra Psychiatric Hospital - Case Study, 2015); this was built much before the KTPH in Singapore that was built in 2011 (Yen, 2012). The impact of introduction of biophilic environments in these hospitals on the patient and staff well-being were studied on the grounds of absenteeism in staff, days of stay of patients and dependence on medications were observed. But the data availability was limited by the fact that they are based on the official hospital reports which were available online and no actual visits to these facilities were made.

4.1 KHOO TECK PUAT HOSPITAL, SINGAPORE

The KTPH is a public hospital in Singapore which was built in 2011 with a 550-bed capacity serving a population size of 700,000 people (Yen, 2012). The hospital was built based on a competition design entry with the title ‘hospital as a healing garden’. This design was then implemented with certain modifications retaining its original concept. A patient centric approach has been the central aim of the management and staff of this hospital. More emphasis was given to achieving shorter waiting time, more efficient service, increasing energy efficiency and using natural ventilation to reduce energy consumption. The design of this space was based on seven principles of life-enhancing design proposed
by Danish architect Erik Asmussen which are unity of form, living wall, polarity, metamorphosis, harmony with nature and site, dynamic equilibrium of spatial experience and colour luminosity and perspective (Yen, 2012). The site is surrounded by a natural waterbody the Yishun Pond, so it was made sure the design utilised the beauty of the pond. The green to build ratio is a measure of the total leaf area present in the building, including vertical garden, terrace gardens, and flat green areas existing in the building, to that of the concrete-built floor space index of the building. This helps to understand the extent of green spaces present in the building in comparison to the concrete-built structure. In KTPH this ratio is about 1: 3.92, which means there are 3.92 times more leaf area (green area) in comparison to the concrete-built spaces. Singapore being in a tropical climate zone had scope for more energy efficient aerodynamic design with a huge scope for natural ventilation. The hospital is designed with private rooms, Very Important Person (VIP) suite rooms, twin sharing rooms, four sharing rooms and general wards. It was made sure the VIP suite and private rooms had views to the pond and the other rooms had view to the terrace garden located in the floor (“Healing through Nature: Khoo Teck Puat Hospital,” 2018; Yen, 2012). It is essential to assess the impact of these kind of biophilic environment on the patient well-being, for which a post-occupancy study was conducted. This is done six months to one year post occupancy of the building so a clear perspective of the end-user is obtained. A survey was conducted post occupancy of the building in 2016 among 200 patients. Findings conclude that more than 80% of the users were much more peaceful and calm when visiting the hospital. The respondents replied that the environment of the hospital did have a healing effect on the patients. (“Healing through Nature: Khoo Teck Puat Hospital,” 2018).

<table>
<thead>
<tr>
<th></th>
<th>Number of beds</th>
<th>Bed occupancy</th>
<th>Length of stay</th>
<th>Inpatient admissions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2015-16</td>
<td>2016-17</td>
<td>2015-16</td>
<td>2016-17</td>
</tr>
<tr>
<td>Khoo Teck Puat</td>
<td>659</td>
<td>659</td>
<td>96%</td>
<td>92%</td>
</tr>
<tr>
<td>Changi Hospital</td>
<td>1006</td>
<td>1020</td>
<td>86%</td>
<td>86%</td>
</tr>
</tbody>
</table>
For this case study, it was essential to make a comparative analysis to a non-biophilic hospital of the same scale and nature to understand the impact of a biophilic environment at a hospital setting on the patient’s health. For this, a list of public hospitals in Singapore of similar scale and nature was made. There are thirteen public hospitals in Singapore, unfortunately not all of these could be compared to KTPH. To make the process simpler the hospitals of similar nature as the KTPH were initially shortlisted. For further refinement, the hospital size, bed numbers, surrounding populations were also considered and finally Changi Hospital in Singapore was chosen for the comparative study.
There is a theory that when a healthcare space is designed in a biophilic manner the cost per bed per day will also be increased. This has been speculated keeping in mind that the additional cost incurred for the hospital would be added to the patient bed cost. To understand the ground reality this aspect was taken into consideration. In a comparative study of factors including length of stay at the hospital, bed occupancy, number of beds and inpatient admissions in a year at KTPH and Changi hospital have been made for the years 2015 – 2017. The study is based on the official reports which have been published in the hospital websites. The study is limited to these years considering the fact that both the hospitals had access to records for the above-mentioned years. It can be clearly seen from that in KTPH there was a reduction in the bed occupancy rate in 2016-17 period in comparison to that in 2015-16, whereas in Changi hospital this factor has remained constant. The bed occupancy rate is calculated by dividing inpatient days against bed days, which when low indicates that the length of stay of patients is less. It is relevant if there was an increase in the bed numbers during the period, and the change in bed occupancy could be attributed to that. Interestingly the bed numbers remained constant in the case of KTPH whereas in Changi hospital, there was an increase in the number of beds. The length of stay in the hospitals were taken as a factor, based on our literature review. It was found that the length of stay would directly impact the monetisation, and the reduction in length of stay was 8.9% in case of KTPH, whereas in Changi hospital it was 4.5% which is a significant difference.

Table 2: Comparing cost per day of stay across different room types in Khoo Teck Puat and Changi hospital Singapore

<table>
<thead>
<tr>
<th></th>
<th>KHOO TECK PUAT HOSPITAL</th>
<th>CHANGI HOSPITAL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A1</td>
<td>B1</td>
</tr>
<tr>
<td>Singapore Citizen</td>
<td>450</td>
<td>215</td>
</tr>
<tr>
<td>Permanent Resident</td>
<td>450</td>
<td>268</td>
</tr>
<tr>
<td>Resident Foreigner/</td>
<td>450</td>
<td>268</td>
</tr>
<tr>
<td>Singapore Citizen</td>
<td>930</td>
<td>668</td>
</tr>
<tr>
<td>Permanent Resident</td>
<td>930</td>
<td>802</td>
</tr>
<tr>
<td>Resident Foreigner/</td>
<td>930</td>
<td>930</td>
</tr>
</tbody>
</table>
The objective of this study was to understand the impact of a biophilic and non-biophilic environment on the patient well-being, it can be clearly seen that the biophilic hospital performs better than a non-biophilic one in this case. To recover the initial cost occurred for the hospital the cost per bed charges is increased and used for the maintenance of the building generally. Across the public hospitals in Singapore, there is a cap on the maximum amount a patient spends per day per bed in any public hospital, cost per day charges across different room types in both the hospitals are compared. It is interesting to note that cost per day charges is significantly lesser in KTPH compared to Changi hospital even though the former is designed in a biophilic manner.

Environmentally this design is proven to be beneficial in the case of KTPH, where the garden has helped in restoring the natural environment in this area. More than 83 species of butterflies which are native to this area went missing for an extended period because of the urban developments; but this restoration of the Yishun Pond has helped in bringing them back and made the area more enjoyable for its users (“Healing through Nature: Khoo Teck Puat Hospital,” 2018).

4.2 OSTRA PSYCHIATRIC CLINIC, SWEDEN

The Ostra psychiatric clinic in Sweden is a hospital designed in biophilic concept. It was built in the year 2005, and it is specifically designed for patients with psychiatric illness. In this design biophilic patterns including visual connection to nature, refuge, complexity and order, and dynamic and diffuse lighting were used (Ostra Psychiatric Hospital - Case Study, 2015). The design considers varying needs of both patients and the healthcare professionals, creating an environment that cares for all its occupants. The average patient stay days at the hospital is around nineteen days, it was made sure the people feel connected to the space which makes them comfortable to adapt to the environment (Ostra Psychiatric Hospital - Case Study, 2015). It was designed in such a way that is inescapable for patients, it would otherwise encourage escape attempts. The facility also offers enormous scope for daylight which gives it a home like environment for the patients, so that they feel comfortable. While it is imperative to assess the impact of the
biophilic environment on patient health, it must be noted that one factor for this study was a dependence on compulsory injection. The compulsory injections are given to the patients to make them calmer once they enter the hospital, as some patients of psychiatry tend to show aggressive behaviour which was controlled to an extent with the compulsory injection. The hospital was retrofitted to become a biophilic facility, so the data of compulsory injection dependence before and after the facility was converted to biophilic setting was compared for the study.

It is noteworthy that the dependency on the compulsory psychiatric injection reduced by about 30%. Also, the sick listing of the staff was compared as a factor. The absenteeism in the workplace has an economic value attached to it, this sick listing of the staff is one such factor. It was noted that there was a reduction in the sick listing of the staff from 9% (non-biophilic setting) to 6% (biophilic setting) which proves to be a big positive impact for the hospital economy (Ostra Psychiatric Hospital - Case Study, 2015).

Figure 7: Garden area in Ostra psychiatric hospital, Sweden © Copyright International Living Future Institute.

Though there are several literatures, that discusses the importance of using biophilia in different built typologies are available, only those that discusses the importance of using biophilia in healthcare environments are discussed in Chapter 2. Every research is conducted in a methodical manner, this thesis has also followed a methodology to arrive at this concept of using only healthcare related literatures the methods and methodologies used for this thesis will be discussed in Chapter 3.
5 FIELD STUDY

In this research, the expert opinions and literature that are specific to biophilia have been thoroughly analysed to develop a framework for the design application. To conduct the interviews, the experts across various fields who have previously worked on biophilic design were listed and contacted for a personal interview. The experts in the field of architecture were selected based on their expertise in either healthcare design or biophilic design, the researchers in the academic area were selected based on their previous research on this topic, and the researchers who work with certification boards including LEED, LBC and WELL were contacted for the interview to understand how they value the usage of biophilia in healthcare design. From the literature review, there were experiments which proved that biophilia affects the physical and psychological well-being of the occupants (Chapter 2), so it was important to understand how a design can impact the mood or mental health of a person. The healthcare professionals and alternative medical practitioners including eco-therapists were approached and asked to participate in a semi-structured interview. The questionnaire for each of the experts has been included in Appendix I. The experts were selected across the globe (as mentioned in Chapter 3.1). These interviews helped in developing a framework that looks into including all elements of biophilia that would be beneficial in a healthcare setting.

5.1 EXPERT VIEWS ON BIOPHILIA

This is the most crucial process of the thesis, where efforts were made to understand how a biophilic application works in a real context. There are several restrictions in terms of the design guidelines when it comes to healthcare design. It was important to understand the impact of architecture on the mood of a person and the impact of their psychological health on their physical well-being. The contribution of professionals across different fields helped in understanding the challenges and positive impacts of biophilia. Also, KTPH hospital management in Singapore, was contacted to understand the result of their biophilic application on staff productivity and patient recovery. For this research, ten experts from different expertise areas agreed to participate in an online or in-person interview. Since the experts belong to different professions, it was important to design
questionnaires which were completely different to capture the right kind of information from each of them.

5.1.1 IMPRESSION OF BIOPHILIC DESIGN

The varied expertise of the experts helped in understanding the topic from different perspectives. Some of them offered a general opinion of biophilia, some gave an insight into using biophilia differently in healthcare and some pointed out the challenges with the concept. This helped in developing an overall understanding of the application of the concept specifically in healthcare spaces. They all had very distinct opinions. For instance, Expert 1, the principal architect of an architecture firm in Dunedin, defines biophilia as a strong human-nature connection. When asked how he would differentiate a biophilic design from a landscape design he pointed out that "they are very similar yet slightly different, in a landscape design one can use the direct natural features including a river, waterfall, and mountains whereas in a biophilic design it might not be possible to bring these features directly into an indoor space considering the maintenance and cost factor that comes along" (Expert 1, personal communication, Aug 28, 2020).

The literature informs that biophilic environments can psychologically impact a person (based on literature in Chapter 2), but it was essential to confirm this from psychiatrists who work closely with the patients. An associate professor of psychiatry in a university in New Zealand, Expert 2, was approached to understand the psychological impact of a design on the patients. According to Expert 2, “[Biophilia] is an interesting concept, being connected to nature is important, it is essential to consider natural lighting in the space. When outside a hospital environment a person recognises the difference between night and day, but in a hospital, people are exposed to the same lux (a unit to measure light levels) level of lighting throughout the day and night. Every person’s body follows a circadian rhythm. In response to the dark and light a person undergoes different physical and behavioural changes. The lighting of a space plays a considerable role in health, even an artificial circadian (a lighting pattern which affects the body’s sleep and wake cycle) lighting will help reduce the patient’s distress” (Expert 2, personal communication, Sep 1, 2020). When asked why he thinks it is
important to have a biophilic environment in healthcare, he mentioned that most buildings are high rise buildings today. In a high rise building where there is no scope for introducing outdoor space, even providing a small green space can impact the health positively. When asked, what are the other things he believes could impact the patient’s well-being in healthcare, he stated that introducing other factors like music therapy can also impact a patient’s mental health, "[Music] can be good therapy, personalised music helps shorten inpatient stay in hospital. Patients with memory issues respond well to music therapy" (Expert 2, personal communication, Sep 1, 2020). This music therapy can also be linked with the biophilic concept: introducing the sounds of nature can be therapeutic for the patient’s health. The sounds of nature including the recorded sounds of birds chirping, the sound of the waves and other sounds of nature, can be used as a part of the treatment process. When asked about the need to include a human-nature connection in the built space, he suggested that for some people their morale is boosted when their pets visit them, but this may not be ideal to maintain a germ-free (or) sterile environment in healthcare. According to Expert 2, the mental health and the physical health of the patients are interlinked, and the impact on their mental well-being could result in improved physical well-being. Biophilia according to him is the human connection to nature and natural organisms; one should include every living being including plants and animals.

Another clinical psychiatrist, from a cancer hospital, Expert 3 was interviewed with the same set of questions which were asked for Expert 2. According to Expert 3"[The] biophilic environment does not necessarily change the effect of the medical treatment, but it significantly changes the patient’s engagement in the treatment. When the anxiety, fatigue, and pain of the patients are well managed they are more likely to engage in the treatment process" (Expert 3, personal communication, Sep 18, 2020). In a psychological treatment facility, this is of much relevance, as most patients that visit the cancer hospital are patients of cancer treatment with high levels of stress and anxiety. They mentioned that “[In] this cancer hospital there is a waiting area with glass paintings of nature and sounds of birds are played in the background speakers. The sounds of birds produce a calming effect in patients. Due to technical issues, the speakers went off for a day and the patients started asking about that” (Expert 3, personal communication, Sep 18, 2020). When asked about introducing nature into the space, they stated that “It might be difficult
to comment about that on a psychological level, but the hospital premises has a natural
garden space inside, and this has not caused any negative impact on the patient health.
The only thing to be taken into consideration is including water in the space, the direct
exposure to water can lead to an outbreak of new disease, especially for patients with
compromised immunity. It is quite powerful to have a garden in the built space as the
patients find them very calming” (Expert 3, personal communication, Sep 18, 2020).

The usage of biophilia in design is considered significant in LBC and WELL certifications.
To understand the reason behind its inclusion, experts from these certifications were
interviewed. Expert 4 from LBC certification which is under the International Living Future
Institute (ILFI) was interviewed. When asked about the importance of including biophilia
as an important imperative in LBC, he mentioned that “[Health] is incredibly important
and not given much significance in architecture. It is important to be in a relationship with
the environment. To care about the natural world, one must experience it, connect people
to the natural system to make them understand it” (Expert 4, personal communication,
Sep 23, 2020). He added that “[It] is essential to have biophilia as a separate imperative
in LBC, as most of the services can go behind the door and be forgotten, but it essential
to celebrate nature and it has been included as an imperative for this purpose” (Expert 4,
personal communication, Sep 23, 2020). When asked how he would differentiate biophilia
from a landscape design he mentioned that “[We] don’t have to differentiate biophilia
from the landscape. We only have to be careful when introducing biophilic elements
inside and outside a building, it will be much easier to introduce biophilia in an outdoor
space compared to the indoors” (Expert 4, personal communication, Sep 23, 2020). He
stated that while designing a hospital space it is essential to include broad daylight and
more views of nature, and it is important to include these factors in nurse stations as well,
according to Expert 4. This is the most significant yet ignored design component in a
healthcare design.

Another expert, from ILFI, Expert 5, was interviewed. When asked about the difference
between biophilia and landscape design, they mentioned that “[Biophilic] design includes
direct contact with nature and natural elements, but it also goes beyond that. Even if you
emulate nature, the spatial, light, morphology and form have an indirect connection to
nature. The landscape architecture tries to include the natural environment, but the
biophilic architecture goes a step further and the built environment can mimic the natural environment even through non-natural elements” (Expert 5, personal communication, Sep 14, 2020).

Another building certification which includes biophilic design as a significant component is the WELL building certification. The WELL certification makes sure the wellness aspect of the design is satisfied; the preconditions defined in the study are dedicated to every single mechanism in the body. In this certification, the post-occupancy wellness evaluation is conducted after six months to one year of occupancy, with a series of survey questions that specifically target the well-being impact of the built environment. Expert 8, a expert in mental health was asked if they believe the environment can impact the well-being of a person, they mentioned that “[Yes], the environment can have an impact on psychology. Actually, in many ways, environment and psychology are inextricably connected. Studies suggest that there is a range of benefits that can come from increasing our contact with nature, including reduced levels of stress, depression, and anxiety and increased pain tolerance. Some studies suggest that biophilic design increases productivity in workplaces. It is important to consider that hospitals are also a workplace for doctors, nurses, and other staff. It is important to include them in the design, and a biophilic design can help increase the health benefits of the staff and patients alike” (Expert 8, personal communication, Sep 21, 2020).

The medical professionals, architects, and researchers of biophilia had different perspectives on using biophilia in healthcare. Some professional therapists use nature as a treatment method, where their patients experience nature to have improved mental health relieving their stress, depression and anxiety. To understand the importance of using a biophilic environment, Expert 6, an Eco therapist was interviewed. When asked if they believe biophilic architecture can impact well-being, they mentioned that ecotherapy is all about engaging the patients with the natural environment. The treatments are designed in such a way that they go for a walk outdoors or have prolonged exposure to natural environments like forests. According to Expert 6, this has helped in improving the mental well-being of the patients (Expert 6, personal communication, Sep 1, 2020).

Another expert from a similar background was interviewed, Expert 7 from a Therapy centre in Australia. He predominantly works on nature-related cures for improving
physical, psychological, and social well-being. When asked if he believes that nature can help in improving psychological and physical well-being, he mentioned that “[yes], absolutely there can be some positive benefits with nature. For a lot of people, they find going out on adventure trips including rafting reduces their stress, for some even going out to a park can also be regenerative. It is important to provide those gentle steps to reducing their stress” (Expert 7, personal communication, Sep 7, 2020).

5.1.2 CHALLENGES OF INTRODUCING BIOPHILIA IN HEALTHCARE

The discussion with the experts was not just insightful in terms of understanding the positive impacts of introducing the concept in healthcare, but some experts pointed to the possible challenges that might have to be taken into account. For instance, Expert 1 believes that it might be challenging to directly bring in natural elements like plants, soil and water inside a hospital space considering the level of sterilization that is required in the space. In these cases, he believes the sensory connection to nature can be quite impactful in connecting people to nature. This can be done by introducing sounds of birds, the sound of running water, and the fragrances including that of lavender that can remind people of nature can be used to establish this sensory connection.

It was important to understand if introducing biophilia affects the hygiene of the healthcare space, this helps to understand the challenges around introducing biophilia to an extent. When psychiatrist Expert 2 was consulted for the same, he mentioned that the sterility of space will not be necessarily affected by introducing treatment methods like animal-assisted therapy. When the cats or dogs come to visit the patients, they feel happy. This is an unconventional psychological approach to the problem, where bringing in pets would alter the sterility of spaces, but it could benefit in a psychological cure for the patients. However, he suggests that in healthcare spaces it is important to consider the sterility factor, especially because there are patients who visit the hospital with compromised immunity. Patients who are undergoing cancer treatment have compromised immunity and are easily prone to any kinds of infections, so it is important to design a sterile space. However, he suggests that natural light can be used in abundance
in spaces where there are concerns related to hygiene, as it would also positively impact their psychological well-being.

When approached with a similar question about sterility in healthcare spaces, Psychiatrist Expert 3 mentioned that introducing green spaces inside the hospital could improve the psychological health of the patients. It is important to maintain a sterile environment in hospitals, but in places where there is scope for introducing any biophilic elements that can be done to have a positive psychological response from the patients. According to Expert 3, it is also important to consider the use of natural lighting as an essential part of the design, as the circadian rhythm will be affected when a monotonous light is prevailing all through the day.

It was important to hear from Expert 8, a WELL expert about the challenges related to designing a hospital in a biophilic manner. Expert 8 mentioned that “[It] is important to think about the limitations of introducing biophilia in a hospital as well. Healthcare spaces have to adhere to strict protocols regarding cleanliness, sanitation, air quality/filtration, etc., especially cancer facilities or places where patients may have compromised immune systems; this is of much relevance” (Expert 8, personal communication, Sep 21, 2020). Based on interviews with the healthcare professionals, Expert 8 was asked about introducing water as an element inside the built space, to which they mentioned that “If you are thinking about introducing water as an element in the design such as fountains, waterfall, and water bodies, they can disturb the hygiene of the place and could lead to an outbreak of new diseases, such as legionella. In spaces, like hospitals, where there are more limitations concerning the design, it is important to get more creative with biophilic design strategies and ideas” (Expert 8, personal communication, Sep 21, 2020).

The air quality of the space is considered a crucial factor to allow for a clean built environment. It is useful to understand if introducing plants into the soil have an impact on the Air Quality Index (AQI) of space. To have a clear perspective on this Expert 5 was approached, they mentioned that potted plants do not have any significant role in purifying the air in an indoor space. However, to have a measurable impact on the air quality a large surface area (as big as at least three-quarters of the room’s wall area) should be covered with a living wall, this would create a significant effect on the air quality of the space. To increase the air quality of a space, one has to increase the input of fresh
air into the space by providing more natural ventilation, this might be a fitting idea for most spaces in a hospital design (Expert 5, personal communication, Sep 14, 2020).

When introducing biophilia, it is important to understand the impact of natural elements including air, water, light, and land. The elements including water, light, and air were discussed by different experts. The concept of introducing earthy connection was not mentioned by the other experts. In an interview with Expert 6, they mentioned the importance of material or colour-related connection to nature on the mood of the patients. They mentioned that using natural materials like wood and stones has a significant impact in changing the mood of the person during the treatment process, as these materials remind a person of nature. Also, when the colours of nature are introduced or the earthy texture or colour is introduced in a space, they help in having a calming effect on the patient (Expert 6, personal communication, Sep 1, 2020).

The interesting literature of the case study comparison of the KTPH in Singapore to the Changi hospital in Singapore (as discussed in Chapter 2), revealed that there are significant benefits of introducing nature to healthcare. A significant change was noted for factors including change in length of stay factor, where there was a reduction in length of stay despite an increase in the inpatient admissions. But it was important to verify from the experts if this positive trend toward using biophilic design in healthcare can be used as an argument to justify the importance of biophilia in healthcare. When asked, Expert 4 said that it might be beneficial to consider the other factors which might also be contributing to this positive trend, and this cannot be solely attributed to just the biophilic design (Expert 4, personal communication, Sep 23, 2020). Some factors including quality of medical staff, type of disease for which they were admitted, age group of the person, previous health conditions of the occupant, and many other factors could also contribute to the positive trend.

5.2 EXPERT VIEWS ON INCLUDING CULTURE IN BIOPHILIA

The idea of including culture in a biophilic design came after the ethics approval process. As part of the ethics approval process at the Otago Polytechnic, it was important to consult the KTO (as mentioned in Chapter 3). After this discussion with the KTO, literature
on the impact of including spiritual and cultural connections in space was explored. According to the literature, there is a need to introduce a spiritual connection in the healthcare space as this helps to build hope for the patients (Ripamonti et al., 2018) and the need for research on including a therapeutic cultural environment in healthcare is increasing (Marques et al., 2021).

When the experts were consulted on the importance of including culture in healthcare during the interview, they mentioned that it might be beneficial but it is important to ensure that it makes total sense and meaning in the space. The experts unanimously pointed to the fact that, in a multicultural city, it is important to make use of culture in such a way that it does not affect the sentiments of the people belonging to different cultural backgrounds. To understand the context specific to New Zealand it is important to understand the Māori culture, so a Māori cultural expert from New Zealand Expert 9 was approached.

The project aims at including culture as a component in the biophilic design of healthcare. When translating this idea into the design it is important to ensure the story connects the people to the space. Every culture is different and has strong beliefs and traditions which can relate to place. To understand the elements that connect Māori better to place, and make this a more inclusive design Expert 9 was consulted. He mentioned that “[Māori] associate themselves as part of the environment, they closely associate themselves to nature, birds and plants. According to Māori, their wellness comes from living with one as nature” (Expert 9, personal communication, Oct 26, 2020). In the fourteen patterns of biophilia, there was a mention of using this concept directly or indirectly, where the concept can be abstracted to remind us of nature. It was important to understand from Expert 9 if the abstract or direct translation of the cultural connection in a place connects the people better with the space.

He mentioned that Māori would prefer a more direct connection to nature with the help of views of mountains or sounds of the native birds. The mountains help them directly connect to the place, as they introduce themselves based on their mountain of origin. According to Expert 9, one of the heartiest connections the Māori have with space is through their Canoe journey; the Polynesian journey through which they reached New Zealand. He also mentioned the significance of the greenstone or jade to Māori. They
believe it brings good health when they are connected with jade. There are a lot of Māori symbols, according to Expert 9, which have a significance in healthcare, for instance the fern symbol or the Koru restores hope to people. He mentioned establishing a local connection to the space, even the representation of the Leith River might help establish a local connection to Dunedin. The existing hospital has been built on reclaimed sea land, so something that can remind people of the reclaimed sea area would also help in establishing this local connection. The visual representation of this in any form would give them a sense of pride and ownership of the land, making them feel more included in the space. It is important to understand that while introducing the local cultural context of the space, efforts have to be made to ensure that even people from a different cultural background feel included in the space. The relevance of including culture as a biophilic element or pattern has never been explored, so the framework in Chapter 5 will aim to include the findings from the interviews which are of relevance to this framework specific to healthcare design.

The discussions in this chapter tried to include a very diverse perspective and understanding of biophilia and its application in healthcare. In the next chapter, the challenges and opportunities that were mentioned in Chapter 4 has been addressed and resolved to an extent with the help of a framework.
Designing a healthcare space comes with a lot of challenges, including the infection and pest control (IPC) regulations which must be met while designing the space. From the literature it is evident that the concept of ‘Biophilia’ tries to introduce a closer human-nature connection (Chapter 2, Section 2.1) but it is important to consider the challenges in introducing a biophilic design in a healthcare environment. Biophilia has shown a lot of positive impact on the health of the patients in healthcare, so it is necessary to understand how it can be translated into designs. In an effort to have a better understanding of the design application of biophilia in healthcare, a framework has been developed which guides the introduction of the concept in the built space. The developed framework will also be critically reviewed in this chapter.

### 6.1 Design Framework

A framework is a visual structure that helps organise our ideas and information, and includes overarching goals for the project (Biophilic Design Guidebook, 2018). This can mean questioning the strategies and significant decisions made regarding the project. To create a framework for this design the ideas and information related to the project were listed down, this helped in organising the most valuable information related to the project.

It was important to understand the frameworks that already exist for applying the biophilic theories to a design. The widely accepted biophilic design application is the “Fourteen patterns of biophilic design” (chapter 2), formulated by a team of experts across various fields including architecture, interior design, landscape and psychology. The fourteen patterns help in a simplified application of the concept into a design problem. The patterns are made up of components that connect the users to nature. If we look at the patterns in more detail, most of them are interconnected or overlapping. The visual connection to nature includes views to green and blue landscapes, views to nature and wildlife in a direct or indirect form, where the indirect form could include VR devices or images of nature (as mentioned in chapter 2, section 2.3). Also, the presence of water, light, and connections to natural systems are given as three other different
patterns showing an overlap or interconnectedness within the patterns. The patterns are defined in a very generic manner and not specific to a built typology. The generic nature of it seems to restrict its application in healthcare, as this is a special built typology with several design challenges. Healthcare design has a lot of challenges, yet there is a constant need to have an environment which is not monotonous in healthcare spaces. The biophilic patterns including the ‘risk’ and ‘refuge’ pattern are more suitable for exhibition spaces, museums, theme parks, gardens and graveyard designs than any other design areas. In Chapter 2, there was mention of the lost hereditary connection to nature, this concept can reinstate the lost connection in a built environment. The ‘risk’ pattern of biophilia can be used to represent a fear factor in the space, it symbolises and creates an illusion of risk, which when introduced in adventure theme park helps in achieving great results; whereas in a healthcare space this is not of relevance. The whole idea of the thesis is to create a space which helps in improving the physical and mental well-being of the occupants of the healthcare space, so when the ‘risk’ element is introduced here the whole idea is disturbed.

The design of a healthcare building comes with a lot of challenges, so it is important to ensure that the environment inside the hospital is hygienic and suitable for the patients who have a compromised immune system. The literature studies have established a need for a creating a healing environment for the patient. The literature studies (as discussed in chapter 2) have verified that the biophilic environment is capable of enhancing the well-being aspect of a space, so it was important to understand how biophilia could be effectively introduced in a built clinical space. The existing biophilic framework helps translate the concept of biophilia in a design, but there are several gaps in the existing framework. Most of the patterns in the “fourteen pattern” overlap with one another and are very generic. The design application of these concepts has not been discussed in detail but an overview or idea of how this can be applied in a design is discussed in the book (fourteen patterns of biophilia). The framework still requires some additional layers of research which can help introduce elements that can help in improved the well-being of the occupant.

To design a biophilic healthcare space, it is important to ensure all the design aspects are taken into consideration and to develop a framework that helps to reduce the gaps in the
existing biophilic theories. The biophilic framework developed should consider the special considerations to be made in a healthcare design including maintaining a hygienic environment and should be reasonable to be applied into a design. To develop a framework for biophilic design which is specific to healthcare settings, the patterns were studied in detail.

The LBC and WELL certifications are other standards or certifications that use biophilia as a core component in their standards or theory. To develop the framework, the concepts of LBC, WELL and biophilic patterns were tabulated and compared to understand if there were any similarities in these concepts; the point of intersection are marked in green in Table 5.1.

<table>
<thead>
<tr>
<th>Living building challenge (LBC)</th>
<th>WELL Building Standards</th>
<th>Biophilic Patterns</th>
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<tbody>
<tr>
<td>Water</td>
<td>Water</td>
<td>Water</td>
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<tr>
<td>Materials</td>
<td>Materials</td>
<td>Material connection</td>
</tr>
<tr>
<td>Beauty</td>
<td>Nourishment</td>
<td>Visual connection to nature</td>
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<td>Energy</td>
<td>Light</td>
<td>Dynamic light</td>
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<tr>
<td>Place</td>
<td>Sound</td>
<td>Sensory Stimuli</td>
</tr>
<tr>
<td>Equity</td>
<td>Thermal Comfort</td>
<td>Thermal airflow</td>
</tr>
<tr>
<td>Health and happiness</td>
<td>Mind</td>
<td>Natural system</td>
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<tr>
<td></td>
<td>Air</td>
<td>Biomorphic</td>
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<td></td>
<td>Movement</td>
<td>Non-visual connection</td>
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<td></td>
<td>Community</td>
<td>Complexity and order</td>
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This intersection helped identify the elements that are mostly associated with a biophilic design, for instance the usage of air, light and water can be seen all the three models. Interestingly they are among the five natural elements of the nature, this helps in
establishing a closer human-nature connection. The concepts have been differently interpreted in each of the certifications, yet the intention of their usage was to provide an environment that helps in uplifting the well-being of the occupants.

The LBC and WELL certification focuses on the occupant’s well-being in the built space. They differ at a point where the LBC aims at improving the overall living quality of society and environment by reducing the dependence on non-natural non-renewable resources. Whereas a WELL certification helps in improving the health and well-being of the occupant by specifically targeting the occupant’s overall wellbeing. This is done by introducing specific design concepts that target either nervous system, the circulation in a body, or concepts that help improve the body’s functions. In both these certifications, a mention of biophilic design had been made, and the sub-components suggested a usage of biophilia in the indoors to improve the mental well-being of the component. This thesis aims at introducing an environment that improves the holistic well-being of the occupant. This has reiterated the need for comparing the biophilic patterns with these certifications.

It can be seen that some of the patterns are common to LBC, WELL and biophilic patterns.

As discussed in Chapter 2 the WELL and LBC certifications tries to introduce a healthy living environment for the occupant by having place-based connection, clean air, water component, material connection, natural light, sounds of nature, thermal comfort, and the beauty component. As seen in table 5.1, despite the similarities in these certifications, the concept of biophilia has been used differently in all these certifications and theories, but the ultimate aim of these certifications is to improve the well-being of the occupant of the space which is also the core of the thesis.

When designing a space, it is important to understand the surrounding environment of the space and intended usage of the built space, this is a factor which is directly influenced by the ‘place’ factor. The place based connection can be established by mapping the environmental, historical and cultural literature of the space which helps establish a social place based connection to the space (Hutson, 2011). Another important factor which influences the well-being aspect in a space is the ‘thermal comfort’ of the space, it is observed that in all of the three certifications thermal comfort was considered as an important factor. A fresh breath of air is good for the occupant’s well-being in a space. In the LBC certification this has been looked from an energy perspective which reduces the
reliance on the artificial ventilation sources. When introducing elements for thermal comfort, the geographical location of a space should be considered. In an area with hot and dry climate, the water component introduced in the space gives a cooling effect; whereas in a hot and humid climate the presence of water in the space makes it uncomfortable. The water element plays a crucial role in places with hot and dry climate, but in hot and humid areas it creates a discomfort for the occupant. In two expert interviews, it was mentioned that it is important to monitor the quality of air that is introduced through natural ventilation in the space as most of the time it may not be suitable for healthcare where most areas have to maintain a clean environment. It would be beneficial to filter the air through air purifiers to make sure it is clean and suitable for people with compromised immunity.

The ‘beauty’ or ‘visual connection to nature’ has been identified as common factor to LBC, WELL and patterns of biophilia. In WELL and LBC, the beautification of the place is introduced by decorating the space with live walls, potted plants, interior landscaping of the space by introducing ‘water’ elements including a fountain, waterwall and pond. These elements can satisfy the ‘visual connection to nature’ factor. The ‘material’ used in a space has a significant role in impacting the well-being of the occupant. Some materials including lead, asbestos, formaldehyde and chromated copper arsenate possess high health risks (Souza, 2022). Some materials are capable of improving the living quality of the space and help improve thermal comfort of the space, materials including rammed earth, stone walls and wood are also ‘natural materials’ that establish a material connection with nature. It is important to choose materials that can aesthetically enhance the quality of the space as well maintain an environment suitable for the occupants of a healthcare space. The ‘visual connection to nature’ can be achieved by introducing water, greens, light, earthy materials and landscapes in the space, which can be introduced in as direct or indirect with the help of windows and images of nature. According to Expert 2 a psychologist, introducing ‘natural light’ in a built space can have a huge impact on patient and staff health in a healthcare setup. In an interview, he mentioned that in a healthcare space the patients are generally unaware of the difference between day and night due to heavy medication and the monotonous light they are exposed to, so this affects their circadian rhythm. Patient well-being can be effectively improved by introducing sufficient natural light into the built space and this also reduces the energy demand of the building.
An initial biophilic design framework was developed by including place-based connections, material-based connections, air, thermal comfort, water, natural light and visual connection to nature as key design elements which can influence the health and well-being of the occupant in a built environment (refer Figure 8, above). These concepts have been short-listed based on the literature study, expert interviews and critical analysis of the existing design frameworks of biophilia. The Framework has been developed by considering the factors that influence the health and well-being of an occupant in a built space. The factors which are considered are comfort, place-based relationships, water, air, light, and material connection to nature. The comfort of the space is maintained by ensuring the occupant experiences both thermal and mental comfort inside the space.
The personal mental state in healthcare should be taken into account by introducing spaces that uplift mood, where people feel comfortable for the course of their treatment. Also, spatial planning could include spaces like therapeutic gardens, yoga or meditation spaces that will enrich the mental state of the occupant. It is equally important to provide a comforting environment for healthcare workers who have a lot of work pressure and stress (as mentioned in Chapter 1, Section 1.1). The thermal comfort of a space is also capable of influencing the mental comfort of the occupant. The place-based relationship plays a key role in connecting the person to the space; it is essential for both patients and staff to have a comforting environment in the healthcare space. The staff have to feel connected to the space to enjoy working in the environment despite their work pressure. For patients, especially the ones who have a longer stay, it is important to feel comfortable in the built environment. This connection can be established by introducing elements that remind the person of the historical, geographical, or cultural connection that they have with the place.

The place-based connection to a place can be established by introducing visual and sensory connection to the built space. The visual connection to nature can be achieved by introducing natural elements, images of nature, or a glass wall view to nature. The other methods of using VR devices in the space are more suitable for smaller clinical spaces, because the biophilic experience will not accessible to all people when it is fitted in a device. The sensory connection can be achieved with the help of sound, touch and feel. All these elements could help establish the lost hereditary connection to nature. The place-based connection helps in creating an emotional connection in a healthcare set-up. This is of importance to the medical staff as well as the patients. The next critical factor that influences the health of the person is the air quality. In a closed built environment, the quality of air should be constantly monitored; this is especially of relevance in healthcare where some patients have a compromised immunity. The air element in the framework takes care of the thermal comfort of the space and also the air quality factor, this ensures the place is germ-free and clean.

In the fourteen patterns of biophilia, the usage of water has been repeatedly recommended in many of the patterns including visual connection to nature, sensory connection to nature, presence of water and in the concept of including natural systems.
Also, in LBC and WELL the usage of water was highlighted repeatedly. In these certifications access to clean water and smart usage of water was emphasised. In an expert interview, an architect mentioned that visual or sensory connection to water has a calming or relaxing effect on the people using a space. The proposed framework tries to capture the importance of using the water in healthcare spaces, where the calming effect is much needed for the anxious patient and their attendants who are waiting for treatment. The usage of water in spaces including waiting areas and cafeterias, will have an impact on the occupants. In an expert interview, a psychiatrist (expert 3) mentioned that the open source of water is capable of bringing in infectious microbes to a space and so it is important to have an enclosed waterbody which is safe in healthcare environment.

In the expert interviews interestingly all the interviewees mentioned the importance of light in a built space like healthcare. Experts suggested that the circadian rhythm of the body is affected by light. A circadian rhythm of the body is a person’s wake and sleep cycle that gets adjusted to the 24-hour clock. A circadian rhythm gets affected by light. A person who is continuously used to a certain sleep and wake cycle based on light suffers when kept in a room which has been artificially lit. Especially in healthcare space, the usage of natural light has been limited, patients are often sedated with medicines and lose their natural circadian rhythm, so they become unaware of the time. Exposure to natural light in healthcare spaces helps in a speedy recovery for patients and for staff as it helps improve their mental well-being (as mentioned in expert interview with expert 2). According to an Eco therapist, another major factor that influences well-being is the usage of natural materials. Material connection to nature can be introduced in spaces where the usage of water, light or thermal comfort are restricted. The material connection also helps in establishing a visual connection to nature, and at times a thermal comfort can be achieved based on the type of material used in the space. For instance, rammed earth construction and stone walls are natural building materials which help in reducing the heat inside the built space. This material connection helps in connecting the people closer to nature, as the textures and materials makes them feel like they are closely connected to nature. In this framework, the material connection is proposed to be achieved by introducing sensory connection where you touch and feel the material, and a nature connection by introducing plants that remind people of the scent of nature. The framework aims at establishing the hereditary connection to nature, thereby influencing
the health and well-being aspect of the occupant of the space with the help of biophilia as a concept.

The framework gives us a basic outline of how the concept of biophilia can be applied to a design, but it is important to understand how the framework can be tailored for the design application specific to a healthcare space. Based on the literature studies, and expert interviews three main pillars which support a biophilic design for healthcare were identified. From analysis of the basic framework developed in Figure 8 and expert interviews it was evident that the physical health and psychological health of the patient and staff needs to be improved, so the simplified framework tries to identify specific elements which contribute to the well-being factor. In Figure 8, the comfort of the space, light and material connection to nature impact the physical health of the person. Similarly, the water, light and air components impact their psychological health. The place-based connection tried to establish a cultural and historical connection to the place. Interestingly, based on the interaction with the experts it was identified that cultural or spiritual connection of a person to the place also plays a role in improving the psychological and physical well-being of the person (Ripamonti et al., 2018). In this framework, the key target areas for the design would include ‘physical connection’ to nature which targets the physical well-being of the occupant, ‘psychological connection’ to nature which targets mental well-being and establishment of a ‘cultural connection’ to place which will help to improve the social well-being of the occupants in the healthcare setup. The six components of the initial framework were classified under three broader headings namely, the physical, psychological and cultural connection to nature. The literature review helped in identifying the physical and psychological connections to nature, discussing how it contributed to the well-being factor. Whereas, the cultural connection to nature has never been discussed in any of the biophilic frameworks and theories as far as we know.

In this framework, the cultural connection to a place or nature has been introduced as a new concept. This is an unexplored opportunity in biophilic design which is unique to this research. In this framework an effort has been made to understand how culture can directly or indirectly impact the well-being aspect in the built space. This especially is of relevance in healthcare, as some of the literature suggests that the spiritual connection
helps in the healing process (Ripamonti et al., 2018). When the experts were questioned on their understanding of introducing a cultural lens to the biophilic design, and how they believed it would impact the patient health, they agreed that cultural connection does have a significant impact on the mental well-being of the occupants. A number of previous research publications in the area of culture were reviewed to understand if there are any studies which link culture and health. For this study, the literature identified was specific to the context of New Zealand, as every place has their own unique cultural relevance.

To understand the cultural context in particular to New Zealand, the indigenous population who are native to the land were identified. The indigenous people of New Zealand are known as Māori, they have their own unique cultural beliefs and practices. In this research, a focus on the cultural context of the local population has been studied to understand how it can be translated into a biophilic healthcare design. The literature informed that Māori have suffered from the pressure of colonisation, globalisation and urbanisation (Marques et al., 2021; Panelli & Tipa, 2007; Reid et al., 2016). According to Panelli & Tipa, 2007, the significance of place in health research has increased. Māori identify themselves with maunga (mountains), awa (river) and their tupuna (ancestors) as this signifies their relation to the land and nature. In a population census study for the year 2011, it was revealed that Māori are 17.1% of the total New Zealand population (Maori Population Estimate 2020, 2020; Marques et al., 2021) emphasising a need to include their cultural aspect into the design. Māori have always associated themselves as close to nature, and the concept of biophilia also emphasises this connection to nature, which justifies the place of culture in the framework. According to the indigenous people of New Zealand, health is considered a treasure (as per the Treaty of Waitangi) and when a cultural connection in a healthcare space is achieved it would impact on the health and well-being of the patient (Hatton et al., 2017). The Māori health model (Figure 9) which was developed by the healthcare workers along with Mason Durie in 1982, it has a holistic approach to healthcare. The Māori health model (Hauora well-being model) states that the overall well-being of the person is dependent on their social, cultural, emotional and physical well-being aspects acting as the pillars of the health model (Roberts et al., 2015; Rochford et al., 2009).
Every place on earth has a different culture and tradition, in every culture the beliefs and customs are different. For instance, in Indian culture the concept of ‘vaastu shastra’ and in Chinese culture the concept of ‘feng shui’ has been widely popular and used in building designs. Both these concepts are based on scientific observations. It is believed that they bring harmony, happiness and prosperity into the life of these people (Mishra, 2021). The word ‘feng shui’ directly translates to ‘air water’, the concept application is based on the air and water elements, which it is believed bring harmony into the space. The ‘vaastu shastra’ on the other hand, is building in harmony with the five elements of nature including fire, sky, earth, wind and water. The application of this concept goes into greater depths, where the placement of the bedroom, bathroom and even cupboards can determine the prosperity level of the house (Kumar, 2016). These cultural traditions are followed still, considering the significance of these concepts. In various cultures, beliefs are linked in a direct or indirect form to nature, similar to the concept of biophilia. To achieve this connection to nature, culture could be used as a tool to introduce nature in the built space. People connect more easily with the cultural connection. For instance, during an interview with Ron Bull, a cultural expert from the Otago region, it was mentioned that the Pounamu stone (or green jade stone) stone has a significant relevance.
to Māori people and they believe that even touching the stone imparts some healing properties.

The proposed strategic framework for biophilic healthcare design consists of three core components which are the physical connection, psychological connection and cultural connection (in Figure 10). To effectively use this framework for a design problem, the core elements are further classified into smaller components that can be easily applied to the design. The physical, psychological and social well-being of a person are directly linked to the overall health of the person. The physical connection component of the framework targets the physical well-being aspect, by creating ways in which the patient can interact with nature. This nature interaction can be made by providing a view of nature, allowing the patient to have a walk along the therapeutic gardens, creating material connections, and biomimicking forms of nature. The concept of a therapeutic garden introduces plants which have medicinal properties in a garden area. When patients and staff are exposed to plants with medicinal properties, studies have shown an improved well-being among the patients and staff (Curtis et al., 2007). The physical connection can be achieved by introducing a material connection with the space by using materials including wood, stones, and earthy materials that remind people of nature. Introducing these components can help improve the physical well-being of the occupants.

The psychological connection component of the framework targets the mental well-being aspect of health, this can be achieved by introducing sensory connection to nature and establishing a place-based relation. The occupants of the hospital do not have similar health conditions, some patients have allergies to certain scents of nature, some have visual impairment where they cannot enjoy the view to nature, some patients have hearing impairment, and some have compromised immunity. It is important to introduce biophilia in a way that it can satisfy different patient groups with different requirements. A sensory connection can be established by providing views of beautiful gardens or scenic spaces (scent, touch and feel), sounds of nature (including sounds of birds, water and forest), different colours and using scents that remind us of nature.
Experts including an architect and an eco therapist suggested that the sounds of birds and water have a calming effect on both the patient and the staff working in the space, which contributes to enhanced mental well-being. When introducing real nature into the space, the change in seasons the hues and saturations of the surrounding environment keeps constantly changing. This helps in uplifting the mood of a person. When establishing a place-based relation to the space, the person is reminded of the past connections that she/he has with the space. For instance, the Dunedin hospital located in the Otago region of New Zealand is built on reclaimed land which was once a part of the sea area in the Otago region (as mentioned in an interview with Ron Bull). Introducing some elements which remind people of this connection makes it a place-based element. This gives a very localised connection to the space, where after the urbanisation some of the lost historic
connection to the place can be introduced by bringing sculptures of birds which were once native to the place, introducing the scents of rare plants which remind people of the place can be introduced. These decentralised reminders of the place can help in improving the mood or mental health of the person.

The cultural connection component of the framework targets the social well-being aspect of health. This can be achieved by introducing elements that remind a person of the cultural or traditional practices existing in that geographical area. This component tries to create an emotional connection for the occupants in the space through elements that remind them of their beliefs and practices. Māori have a very strong relation to the land, they do not believe in the ownership of the land, rather they are the kaitiakitanga or the guardians of the land (Tuakiritetangata & Ibarra-Lemay, 2021). Māori believe that they have lost the very strong connection that they have had with place for hundreds of years, so there is repeated mention of Mahinga Kai (traditional hunting and food gathering), spending family time along the bush or shorelines and remarks about the guardianship of the land among other things that have been disrupted by colonisation (Reid et al., 2016).

There are studies which have identified the role of social and environmental connections in improving the overall well-being of the person (Durie, 1998; Marques et al., 2021; Tuakiritetangata & Ibarra-Lemay, 2021).

Considering the fact that the culture of the Māori is a relatively new topic for someone who is not from this cultural background, it is important to explore this in depth to understand how their practices and rituals can be translated into a design, so the cultural expert Ron Bull was contacted to provide an insight in this topic. According to Ron Bull, most of the Māori can associate themselves with their ancestors’ canoe journey; the journey through which they reached New Zealand through the Polynesian journey route. There are a lot of Māori symbols which the people connect themselves to, each symbol has its own significance. The Royal albatross bird breeds in New Zealand at Taiaroa Head near Dunedin. People of this locality can easily relate when a symbol or figures of the bird is used in any given space. In New Zealand, with recent globalization, people from different cultures, races, religions, and ethnicities have settled over the last few decades. When introducing a culturally connective design solution in a space, it is important to respect the sentiments of people from diverse backgrounds, but it is impossible to include
all the cultural beliefs in one single design problem solution. When a cultural connection is introduced in a space, a place-based connection is introduced, and people of different cultures have a chance to learn about the local culture and tradition of a place. Introducing the cultural elements helps in enhancing the social well-being of the occupant in the space.

It is important to ensure that the physical, psychological and social well-being of the person is improved in a healthcare space to enhance his/her overall well-being. In a healthcare environment, the stress and tension levels are different across the different zones, which includes the treatment zone, diagnostic zone, operation theatres, waiting area and cafeterias. The anxiety levels of patients, their attendants and the medical staff are different across these zones. The proposed biophilic design framework in Figure 10 tries to address concerns that are specific to healthcare design. The existing environment in the Dunedin hospital is very simple, the building is more than 50 years old with the spaces being fitted to suit the requirements of today with upgraded medical equipment and instruments. Previous frameworks of the biophilic design have tried to include components which remind people of nature, but in this research a new layer of study to include the cultural context of the local area has been introduced. Based on studies, it is evident that culture tried to include nature as an integral part of the customs and practices, as most of the Māori healing practices include nature as an integral part of their therapy. It is important to consider the fact that healthcare space is a space meant for healing and it should be capable of uplifting the holistic well-being of the occupant. For some ailments like cancer, psychological well-being plays a major role in the treatment process. For some ailments like fracture, it is important for both the physical and mental-well-being to be uplifted for faster recovery.

This framework was developed by using the Māori health model (Figure 9) as the basis, where the physical, social and psychological well-being of a person was given utmost priority. There are various limitations with respect to this framework; every framework requires a refinement. This framework aims at introducing the physical and sensory connections of nature in a space, where live plants, bird and water elements are introduced as design components. This can pose a challenge in maintaining a sterile environment. The framework tries to introduce real nature into the space to create a
more dynamic environment with changing colours of leaves and flowers, but this does have a high risk of inviting infections and microbes. When introducing real plants in a space, people with pollen allergies or similar allergies can be affected. The environment created through this framework may be new and very fascinating for the patients as their period of stay is short, but after the staff are used to the space for a six-to-seven-month period it will be usual and not exciting anymore for the staff. It is essential to include elements which create a dynamic environment. This can be done by introducing wall punctures (like niches or wall cavities) which have a changing patterns and shadows based on light, where the intensity of the light keeps changing with the seasons hence there are often new patterns.

In this framework, culture is a new addition, so it has not been tested or verified to understand the kind of impact it might have on people from a non-Māori cultural background. There are various limitations imposed when designing for a special treatment care facility, for instance in a cancer hospital design it is important to construct a very sterile environment with at least one-metre-thick concrete wall for the radiotherapy room, as this treatment releases a lot of radiation which is not suitable for non-patients. It is important to ensure none of these criteria affect the general design proposal for any treatment care facility. According to literature the most stressful zones of the healthcare centre are the operation theatre and treatment zone (Abdelaal & Soebarto, 2019), but it might be close to impossible to introduce any of these biophilic proposals in an operation theatre as it would be rather distracting for the staff more than being helpful. Though the aim of this research is to focus on improving the overall well-being of both patient and medical staff health, most of the discussions were more patient centric. The framework is developed based on my learning from the literature and has not been clinically tested, although the literature reviewed included experimental studies. The expert interviews which highlighted the importance of biophilia in healthcare have been taken into consideration for developing this framework. The fourteen patterns of biophilia, 25 patterns of Kellert all have been considered while creating this framework, the overlaps have been identified and grouped with some additional research to create this framework. The cultural component was a treasured part of the framework when discussed with the experts but this has not been experimentally verified. Also, with globalisation in New Zealand, not everyone would feel connected to the cultural
component in the space. The psychological and physical component of this framework considers material connection to nature, and sensory connection to nature. In case of the sensory connection, experts including the eco therapist have mentioned that usage of the scent of lavender can impact a positive change on the mental health of patients, and the sounds of bird can have a calming effect on the patient, but this might not be comfortable or suitable for all the patients who occupy the space. This framework tries to take a different angle on how biophilic design can be introduced in a healthcare setting with the limitations it has with respect to the design. The framework has been simplified to help in a design application, and despite all the limitations with this framework, there are chances that this might be a more workable model when applied to a design problem and tested in the context of New Zealand. Though it might not be suitable for all the patients occupying the healthcare centre, some patient groups might benefit and experience a faster recovery in this method.

In this chapter, the discussion has been the developed framework which has taken into consideration the opinions of the experts from Chapter 4, and the learnings from literature review in Chapter 2. The next following chapter will look into the findings and analysis on the culture framework which has not been previously discussed in any of the earlier chapters.
7 FINDINGS AND DISCUSSION

In this research, the framework tries to introduce culture as a new element into biophilic design, as this has never been a part of biophilia before. It is important to understand if it is relevant to introduce culture in biophilia and how it would fit in a New Zealand-specific context. The discussion in this chapter tries to understand how core Māori values and beliefs can be introduced into design solutions. Remember that Māori culture is specific to this place and its values and beliefs are not necessarily shared throughout the globe.

7.1 DISCUSSION

The framework has been developed for biophilic design based on extensive literature reviews and stakeholder discussions with experts from different professional backgrounds. The developed framework tries to introduce a relatively new component that has been unexplored in biophilic design. The rationale behind including culture as part of the biophilic framework has been established in Chapter 5. It was revealed in literature reviews that in the earlier frameworks or patterns of biophilia which have been discussed, there are efforts to introduce nature into spaces, but cultural integration in biophilic design has often been overlooked. Some design concepts have tried to include society as part of the discussion, for instance, sustainable design, but none of it was specific to introducing the local cultural context of a space into a design. In this research, biophilic design has been introduced as a tool to positively influence the mental well-being of the patient in health, which according to the experts does have a significant impact on the physical well-being of the person. Psychological well-being can also be influenced by introducing an emotional connection to the space. Healthcare buildings can create an emotional connection to their space because, for many, life begins and ends at a hospital. The spiritual and cultural beliefs of a person may increase when they are in the healthcare space. It is important to provide an environment that includes a cultural connection in the built space. The culture and traditions of a place are different for people from different ethnic and cultural backgrounds.
It is important to understand the local cultural context when designing a space. For instance, in the context of New Zealand it is important to understand the culture of Māori (as discussed in Chapter 5). The appreciation of ‘place’ and ‘culture’ are critical to social conditions including health and well-being (Panelli & Tipa, 2007). The Māori in New Zealand has lived for more than 1000 years on the land and developed a lifestyle of their own, they are increasingly concerned with the integrity of their waterways as that is part of their cultural identity; the land they live on is part of their spirit as they value it as a soul and not material (Panelli & Tipa, 2007). The Māori kaumatua (elders) believe that spiritual connection to their ancestors can sometimes happen through listening to the sounds of the birds (Marques et al., 2021). This connection to the land, water, and nature can be established by introducing biophilic design components into healthcare spaces. Because Māori culture is intrinsically connected with nature, the closer connection to nature is what is culturally believed to enhance the well-being of the people.

The Māori of New Zealand consider health as a treasure, and believe that closer connection to their roots helps in maintaining improved well-being. The Māori have a health model (fig 12; Chapter 5), according to which the healing aims at four primary dimensions which include the Tinana (physical body), Wairua (spiritual well-being or life force and spirit), Whaua (social wellbeing or kinship and family bond), and Hinengaro (mental well-being or thoughts and feelings). It is believed that all these dimensions have to be kept stable to keep the ‘house’ upright, the lack of even one dimension can lead to an imbalance and poor health (Tuakiritetangata & Ibarra-Lemay, 2021).

Using the key component of this research, biophilia, and considering culture can help in improving the well-being of the occupant in a built space. The existing patterns of biophilia broadly classify its elements into nature of space, nature in space, and the nature analogues, all of which try to closely connect people with nature in direct or indirect ways as discussed in Chapter 2. The nature and culture component has a close connection, but the culture expert Ron Bull helped in discovering this in more detail.

It was important to understand what makes Māori feel more included in the space. According to R.Bull people connected very well to the Canoe journey or their Polynesian journey to discover New Zealand, a place that has been their home for over 1000 years. This ride on the water could symbolically represent how they survived the risky sea
journey or death to better health; this would motivate them to overcome their fear. The place-based connection can also be achieved through material connections. According to R.Bull limestones are unique to the South Island and this material connection can establish a very localised connection for the people of the southern region. The place-based connection can also be achieved by introducing local landscapes including trees and birds which are native to the space. R.Bull mentioned that the sound of the Tui could be more relatable to Māori.

In every culture or tradition, there are some myths and beliefs that people associate with when it comes to the health of a person. When asked about the beliefs of Māori concerning health, R.Bull mentioned the ‘pounamu’ or the Jade stone. Every person in the Māori community carries a ‘pounamu’ stone with them around their neck with different Māori symbols each of which has significance; the ‘pounamu’ stone is believed to bring good health. There are different symbols, each of which has a unique meaning, the ‘koru’ or the unfolding of fern symbol represents the beginning of life; the ‘Tiki’ symbol represents both life and death which can be problematic when used in a healthcare space; the ‘unaunahi’ a Māori fish scale pattern represents abundance and good health. These are a few symbols and patterns which are of relevance in healthcare design according to the expert. It was important to understand the relevance of using ‘Hauora’ or the Māori health model in a healthcare design and the impact it would create on the health of the locals. Ron Bull mentioned that the ‘Ha’ represents wind and ‘Uora’ represents wellness; using the movement of wind in the design could help in improving health. These are some of the cultural connections that can be easily relatable to the people of the Māori community. Some of these cultural connections could potentially help in improving the mental health of the people. It can be seen that the cultural connections are all linked with biophilic elements, where water, land, wind, stones, and reminders of wildlife including fish and birds can also be seen. Culture does have a direct or an indirect connection to nature, and when used in the right way can be a cultural symbol to people of a particular culture and for people from a different cultural background, it can just represent nature. In the research, the developed framework tries to include culture as a potential biophilic component. The framework was inspired by the Māori ‘Hauora’ health model which concentrates on the physical, psychological, social, and spiritual well-being of a person. The framework developed in Chapter 5 was based on layers of analysis, which
identified the factors influencing well-being in healthcare and for the convenience of the
design application it was divided into factors influencing physical, psychological, and
cultural (or social) well-being. The fourteen patterns of biophilia were modified into a
framework for this study. These patterns can be contextually modified to fit different built
typologies. For example, the usage of visual connection to nature can be creatively
modified to fit the needs of different building typologies. There should be some
consideration given to including culture as the fifteenth pattern of biophilia, where the
culture element can be variably used to fit different cultural contexts. In a biophilic design,
not all the fourteen patterns are used at once, only the patterns that can be used are
chosen uniquely for every design. Likewise, the culture can be used in designs where it is
of relevance, for instance, the spiritual or cultural connection is of relevance in a hospital
where different emotions are expressed in one single building. The hospital building
experiences lots of prayer for critical patients, lots of joy for recovery and birth, and tears
for the departing souls, this establishes a spiritual connection to the space. There is a need
to include culture as an integral part of the biophilic framework.

7.2 CULTURE AS A PART OF THE AUCKLAND DESIGN GUIDELINE

In the context of New Zealand, it was important to understand how culture has been
included as part of the design principles. This country has people from diverse cultural
backgrounds, and recently the Auckland City Council (ACC) has realised a need to
introduce Māori culture into the Auckland Design Manual (ADM). The ACC believes that
introducing local values and approaches into design would improve urban quality and
bring in more positive vibes. To include the ideologies of Māori as part of the design, their
core values were taken into consideration. The core Māori values that underpin the
foundation for Te Aranga Māori design principles are the Matauranga, Kotahitanga,
Wairuatanga, Whanaungatanga, Manaakitanga, Kaitiakitanga and Rangatiratanga. This
inclusion of values shows that New Zealand is moving towards a more inclusive design,
where the cultural aspect of the indigenous population is considered.
Each of the core Māori values has a meaning, ‘Matauranga’ means understanding the people and culture of Māori; ‘Kotahitanga’ means unity, cohesion, and collaboration; ‘Waituatanga’ refers to the spiritual connection between the humans and the environment; ‘Whanaungatanga’ provides a sense of belonging to the place with shared experience and working together; ‘Kaitiakitanga’ helps to maintain a reciprocal relationship with the environment; ‘Rangatiratanga’ helps exercise the right to authority in one’s own realm, and ‘Manaakitanga’ refers to the hospitality inherited from the Mana Whenua.

The seven core Māori values were compared to the biophilic framework proposed in Chapter 5 to understand if they have any points of intersection, the points of intersection would help to understand if they can be used as a part of the design application when used in a New Zealand specific context.

The framework proposed in Chapter 5 includes physical, psychological, and cultural elements as the core which targets the physical, mental and spiritual well-being of a person. The framework is further divided into sub-components to help in an easier
biophilic design application. Some of these core Māori values target the physical, psychological and cultural components of biophilia. The points of intersection between the framework and values have been identified and plotted in Figure 11. It can be seen that the core values can mostly be linked with the cultural aspect of the proposed framework, the core Māori values showcase the unity, respect for their traditions, their sense of belonging, and the spiritual connection they have with the place. Some of the values can impact the psychological aspect of the framework, some values including the Whanaungatanga, Rangatiratanga, and Wairuatanga have a cross-connection between the cultural and psychological aspects of the framework. The relationship with the natural environment is the only value that has a close connection to the physical aspect of the framework.

7.3 RECOMMENDATIONS

The cultural component can be a new addition to the biophilic design realm. Although this thesis has not tested the importance of cultural components in the healthcare setup this could be very important and beneficial in a healthcare setting. This opens up more opportunities for future research which can test the benefits of using culture appropriately in healthcare. Biophilia has always been linked to a closer nature connection and been associated with the greening of space, and the cultural element could help in establishing this nature connection but with a more emotional connection to place. Integrating Māori values will be of relevance when used in a New Zealand-specific context, but when this framework has to be applied to the context of a different country or region with a different local culture it will be completely inappropriate when used with Māori values. It is important to make sure the cultural component is varied to fit into a place-specific context where people of different cultures get to experience the local connection when biophilic design is introduced in a space. It is important to ensure that the cultural images used are appropriate and not offensive or culturally inappropriate for the end-user. Introducing the local cultural connection would help people from different cultural backgrounds to appreciate and become aware of the local culture of the place. Culture can be creatively used in design by introducing interactive
walls which are either manual or digital where the wall can represent the story of the local culture in a way that it can keep the patients seated in the waiting area distracted from thinking about their ailment. There should be a consideration of including culture as the fifteenth element in the patterns of biophilia.

It was interesting to learn from a psychiatrist that the colour green in the hospital was introduced in screens, walls, bedspreads and hospital gowns for the fact that it connects us to nature but with time this monotone has made the patients feel sick in the environment. Tablets were also coloured to make them interesting for the patients to consume according to him. He felt that colour tone inside hospital rooms does have a considerable impact on patient mood. He believes that when the psychology of the patient is impacted it does have an impact on their physical health and well-being. The colour green seemed to have a positive impact on patients a few decades back, but just recently its over usage has made it feel like a colour for sickness. In areas where potted plants cannot be used, there are artificial but realistic options made of cloth or plastics which require very low maintenance. These were suggested as alternatives by the medical practitioners and experts who felt there is a need to maintain a sterile environment. Clinically the psychiatrists have experienced patients recovering faster and feeling comfortable to express themselves when they were left in a green environment such as a park. The experts revealed that the experiences of nature have a significant impact on patient health and well-being. There is a concept called ‘Friendship Bench’ in Zimbabwe, where the counselling for psychiatric patients was given on a park bench, they were also given them life advice. This method has proven to significantly help patients open up better to these grandmas as it looks like an unconventional psychiatric clinic set up (Chibanda et al., 2016).

There are several elements of biophilic design which have been less explored. For instance, the expert interviews unanimously mentioned that introducing natural light has a huge impact on the health of the patient since both physical and mental well-being can be influenced by light. It might be challenging to introduce the natural light component in a healthcare design. Where the circulation pattern of the building should be considered, the light should be equally distributed to the waiting rooms, patient rooms, and staff work desks. It was mentioned in an expert interview that the nurse workstations
are often ignored when it comes to design. It is important to provide biophilic design with natural light in the nurse stations when designing healthcare. A biophilic design when used appropriately can be beneficial for even patients with impairments. A person with visual impairment will be able to experience the sounds of birds and fragrances of nature; a person with a hearing or speech impairment will be able to visually appreciate the nature and feel it and for patients with any other impairment the biophilic design will be a positive distraction as proven in the literature. When introducing biophilia in design the sterility levels of each space have to be considered, to reduce the risk of infections for the patients.

This chapter has tried to look at the aspects of the culture that has not been previously discussed anywhere, also insights and recommendations on how the future researches can be carried out in the biophilic realm with respect to the healthcare design has been discussed in Chapter 6. In Chapter 7, an overall summary of how the thesis has evolved with all the challenges and has attempted to resolve the key aspect of the research question has been discussed in detail.
The aim of this research was to understand the influence of biophilic design on the well-being of patients in hospitals or healthcare and to identify the contribution of biophilia in creating a healing environment for the patients and enhancing the well-being of the staff. As the mental health of a person is known to affect their physical health, the research tries to identify the impact of a biophilic environment on the mental health of people. The literature identified included biophilic applications in healthcare, the workplace, education institutions, and residences. Not all of these studies were discussed in the review of literature, it only included those case studies relevant to understanding the impact of biophilia on healthcare as this is the focus of the study.

To introduce biophilia in a design, it was important to understand ‘what is biophilia?’, different applications of biophilia, and to identify literature that had experimental studies on the impact of biophilia on the health of patients. To understand the ‘what’ of biophilia, a review of ‘how’ different people interpreted the concept was made. Several research articles including a study comparing the direct view to the nature and view of the brick wall, a study comparing the impact of VR-created biophilic environment and real biophilic environment, and another study that measured the impact of forest walk on the blood sugar levels were reviewed as part of the literature. Several other studies showed the impact of the direct or indirect application of the biophilic concept on the health of a patient. In this literature review, an effort was made to identify a specific patient group to understand, if biophilic design had an impact on the treatment process of that patient. The attempt was unsuccessful as the concept is not widely popular for healthcare designs, and only very few hospitals in the world are designed in a biophilic manner. Also, the available examples including Maggi’s cancer care has not shown any studies to prove the impact of biophilic environment on a specific patient group’s health. The literature also highlighted the stress and pressure the staff experience in healthcare. In a healthcare design, the design should focus on creating a better working environment for the staff and a healing environment for the patient. The experimental studies helped identify the impact through various factors including blood pressure change, skin conductance, heart rate, adrenaline, skin temperature, anxiety levels, pain medication dependence, and length of stay.
It was important to understand how the concept can be applied to a design. The design application varied depending on the budget of the project. This can range anywhere from creating a real biophilic environment with therapeutic gardens or living green walls or wall aquariums, to an artificial VR environment, and painting or wall panels that reflect images of nature. Each of these applications has its pros and cons. For instance, the VR environment can be changed every now and then, which makes it interesting for patients to appreciate the change. Similarly, it might not be possible to provide every patient who visits the space with a VR device, as it is not economically feasible. The other disadvantage of using a VR device is that it will not benefit the staff, and the well-being of the staff is part of the scope of this thesis.

The experimental studies from the literature were conducted on small patient groups and in these studies, the biophilic concept was either applied to a single room or a very small area. A case study of the biophilic hospital in Singapore (KTPH) with over 550-bed capacity was identified and carefully reviewed. To understand its impact, it was compared to a non-biophilic hospital of a similar scale for several factors. The results of the comparative case study showed that a biophilic environment does have a significant impact on the health of the patients in healthcare. Though the literature showed a positive trend toward creating biophilic healing spaces, it was important to verify from experts if the environment does have an impact on health and well-being.

The experts for interviews were chosen to cover the breadth of ideas and experience of biophilic design in health care settings. It was significant to have the opinions of experts across several fields to understand the design application of biophilia and verify if it impacts the well-being of the patients. Though the experts belonged to completely different fields, they unanimously agreed on the fact that a biophilic environment does have a significant impact on patient recovery. The analysis of the literature and interviews emphasized the need for creating hospitals with at least a little biophilic character in them to facilitate healing. The experts mentioned the importance of using light in a healthcare environment and mentioned that despite its importance it has not been explored in-depth as a concept in healthcare design.
An analysis of the literature and expert interviews were used to make a framework for biophilic design. The existing frameworks or usage of biophilia were considered. The LBC, WELL and the ‘fourteen patterns of biophilia’ were compared to understand importance of using biophilia in healthcare. This also helped identify the elements that are similar in these frameworks. This helped in narrowing down the elements that are important in a design to impact the health aspect of the occupant. There are a few ailments for which the patient has to stay longer in the hospital, so it is important to provide an environment that keeps the patient engaged in the treatment process with a positive mindset. An interesting discovery emerged from this investigation was that Culture has never been a part of the biophilic concept, but it could potentially be a biophilic element that facilitates well-being. The ‘shinrin yoku’ (forest bath) method from the literature review also gave an insight into how the cultural or traditional methods of healing could help in well-being. In this method, the traditional therapy aims to utilize nature as a treatment method; this example explains how culture and nature are closely linked and emphasizes the need to incorporate culture as part of biophilia.

The concept of introducing culture in a biophilic framework was a relatively new idea that has not been included thus far. The existing frameworks were developed to impact the physical, psychological, and social well-being of a person by introducing biophilic design components. This thesis explored the usage of culture in a biophilic design, by understanding the correlation between culture and biophilia. Culture is different across the globe of course, so, to put the culture into context to understand its application in a biophilic design the indigenous people of New Zealand, the ‘Māori’ were considered. The culture of Māori is directly linked with nature, their traditions, practices, and beliefs were and are linked to nature. While introducing the cultural context of a place in design, the story of the place and its culture can be portrayed through artworks, local building materials, or by biomimicking the things that remind people of the place. Similarly, when applied in a design the cultural elements will differ across different countries, it can be uniquely applied by introducing the culture of that place. This is a relatively new concept, and not much literature that links the importance of using culture as an element in the biophilic framework could be identified.
The proposed framework has some imperfections, and there is a huge scope to improve this in the future with additional research. Though, this might positively impact the psychology of the patients from indigenous background, and this might leave the people from different culture longing to feel included in the place. The proposed framework is an idea at this stage and has not been tested as yet in any real-time design to understand the individual impacts the components create on physical or psychological well-being. It is important to understand the user experience of any existing biophilic healthcare space to understand what people expect from the healthcare design to enhance this framework further. In expert interviews, when the experts were asked about their opinion of using culture in a biophilic framework that is specific to healthcare, they mentioned that this could help in improving the well-being of the occupants. The framework could be tested in the future to prove the relevance of introducing the culture as part of the biophilic framework.

Biophilia is a relatively new concept emerging globally, finding its application across various residential commercial, hospitality, and educational institutions designs. Future research could focus on using light efficiently in a design to facilitate healing. This research identified literature that has highlighted the benefits of introducing biophilia in healthcare. It is not possible to completely attribute the reason for the health benefits to biophilia, there could be several other contributing factors but biophilia is one of the contributing factors to improved well-being in the space. There are some setbacks to introducing biophilia in healthcare, introducing real plants and water bodies would not be suitable for patients with compromised immunity. Despite this, there are some plants that have a therapeutic impact on the patient’s health, and research indicated that the sound of water has a calming effect on the patient health. The water body can be introduced in a space creatively by introducing wall aquariums or floor aquariums which helps us to visually connect with the water element yet maintain a hygienic environment suitable for the patients. Several literature and expert interviews have reinstated the importance of introducing biophilia in healthcare. Therefore, it would be beneficial to have biophilic designs in the healthcare spaces that are built in the future, though there are some biophilic hospitals existing in the world today. The new concept, ‘culture’ which is introduced as part of the biophilic framework in this thesis needs to undergo trials to understand the positive effects of introducing cultural interventions in a healthcare space.
Questionnaire for biophilic experts

1. Do you believe that environment has an impact on the psychology of a person?
2. Do you think including a biophilic component would have an impact on the well-being?
3. What is your view on the concept of biophilia?
4. As an expert, how would you differentiate biophilia from landscape design?
5. One of the major concerns of the mind concepts in WELL building is to improve the mental well-being of a person, what are some physical changes in the environment you think could affect the psychology of a person positively?
6. I am fully aware that the WELL building focuses on post occupancy wellbeing of the occupant, what are some factors that are being considered to evaluate well-being while the post-occupancy Evaluation is conducted?
7. I am aware, that internal air quality is one of the imperatives of the certification. In a hospital environment where the sterility has to maintained, is it possible to have a perfect AQI?
8. How important is it to introduce lighting as an essential part of the well-being in a building?
9. What are some lighting considerations that can be adopted in a high-rise hospital building? I am aware of the light shelves and tube light, but are they sufficient to light up a high-rise building?
10. How relevant is the concept of biophilia in relation to a hospital design?
11. In a healthcare environment do you think the aesthetics of the space would add up to the healing nature of the space?
12. What are some challenges in building a biophilic environment in healthcare facilities?
13. What are some cost and maintenance issues that may occur in regards to a hospital design?
14. Do you think the impact of an artificially created biophilic environment and a natural exposure to the nature will have a difference in terms of patient recovery?
15. What are some considerations that should be adopted to make the biophilic environment sustain in a closed environment like hospitals? What are some alternative solutions which can be adopted in most sterilized zones such as ICU?
16. On a scale of 1-10 how would you rate the stress levels inside these spaces in a hospital:
17. Acute care setting (emergency, OT, ICU)
18. Treatment and recovery (Chemotherapy, Radiotherapy, Patient wards)
19. Diagnostic settings (X-ray, PET, CT, MRI)
20. Common facilities (waiting area, reception, cafeteria)
21. Outdoor spaces
22. What are some spaces in a hospital which require a biophilic element?
23. What are some mind concept considerations that will help in creating a better environment for the patients of cancer? What are design elements or space that will boost hope and confidence in a cancer patient?
24. Is it essential to look into the cultural part of a design? In case of New Zealand, the indigenous group ‘Māori’ associate them with healing stone, nature, boat sails and albatross. When a cultural consideration is made into a design will it make the population feel more included and help in faster recovery?
25. If biophilic environments can improve the health of the patients as suggested by the studies, why are there not much biophilic designs in hospitals according to you?
26. As an expert in biophilia, would you recommend a biophilic environment for your client in a health care design?

Questionnaire for healthcare experts

1. What are some psychological and emotional changes a patient experiences in a healthcare environment?
2. What kind of an environment could result in a better recovery of the patient?
3. As a healthcare professional do you think that the design of a healthcare environment can impact the psychological well-being of the patients? What are some ailments which physical health is linked to the psychological well-being?
4. Is there a need to design an environment which brings a closer human-nature connection?

5. What are some challenges in creating a biophilic environment in sterilized spaces like hospitals?

6. What are some factors that you can use to determine a positive change in the psychology of the patient?

7. From a healthcare professional point of view, what are some issues you face with the hospital designing in an existing healthcare design?

8. In a healthcare space, do the patient attendant and the medical professionals also experience equal or more stress as that of the patient undergoing the treatment itself? If yes, what are some factors you think could be improved in a hospital environment which would help in reducing the overall stress levels persisting?

9. What are some spaces inside a hospital which requires positive distraction, that could help in faster recovery? What are some ailments you believe would show a faster recovery on exposure to a natural environment?

10. Do you think an artificially created environment and an exposure to nature will have the same psychological impact on the well-being of a patient?

11. What are the spaces inside a hospital that have high level of stress to a lower stress level?
   a) Acute care setting (emergency, OT, ICU)
   b) Treatment and recovery (Chemotherapy, Radiotherapy, Patient wards)
   c) Diagnostic settings (X-ray, PET, CT, MRI)
   d) Common facilities (waiting area, reception, cafeteria)
   e) Outdoor spaces

12. What are the spaces inside a hospital that require high level of sterilization to a lower sterilization level?

13. What are some colours and fragrances that can induce some positive psychological response among the patients? (To psychiatrist)

14. How does the emotional need of a cancer patient differ from that of a patient admitted for general treatment?
15. Some studies suggest that 30% of the cancer cure is based on medical treatment and 70% of the cure is based on the emotional well-being. From a healthcare perspective, do you agree to this?

16. What are some spaces that can be included in a cancer centre which will keep the patients engaged and can uplift their moods?

17. Why do you think we do not have much biophilic designed healthcare spaces?

18. There is a method called horticulture therapy, where patients are made to practice horticulture in the garden area. Do you think such exercises can improve the physical strength of the patients similar to a physiotherapy?

19. Do you think it is essential to bring a cultural touch to the biophilic design when designing to a specific country? If yes, do you think this will have an additional impact on the psychological wellbeing of a patient?

20. Would you recommend biophilic design in healthcare spaces?
10 APPENDIX – II

KTPH MEDIA (Yishun Health)  
to me, KTPH MEDIA Careers  

Hi Keerthana,

Thank you for your interest in Khoo Teck Puat Hospital.

You may search for a suitable photo from our Facebook page but please avoid using the ones with our staff in it. Do credit all photos to ‘Yishun Health’.

Regards,
Pamela Chew
Assistant Manager, Corporate Communications
Yishun Health
Admiralty Medical Centre | Khoo Teck Puat Hospital | Yishun Community Hospital

Maria Gertell  
to me  

Dear Keerthana,

So happy that you’d like to use our project as an example in your master’s thesis. Please find images via this link: https://white.ponyte.com/fe4f550177

And also, please don’t use them in any other ways, as we don’t have the copyrights for that.

Here’s a lovely day and good luck with your work!

All the best,
Marie

Maria Gertell  
Head of Public Relations

Ingrid Claesson  
to me  

Hi Keerthana,

I’m sorry for not getting back to you sooner. It’s okay to use the image.

We appreciate if you put Chalmers as a source of the image.

Best regards from Sweden and good luck with your thesis!

Ingrid Claesson

----------------------------------------
CHALMERS

Education Team  
education@living-future.org via heljscout.net  
to me  

Hello Keerthana,

Thank you for reaching out. Yes you may use the image you cited. Please include: Copyright International Living Future Institute. For more information, visit living-future.org/I也许是

Best,
Anu

Rhea Bhargava (IWB Support)  
to me  

--- Please type your reply above this line ---

Your request has been updated.

Rhea Bhargava (IWB Support)  
May 3, 2023 2:27 PM EDT  

Hi Keerthana,

Thank you for reaching out to confirm with us!

You can certainly go ahead and use the PNG file as needed for your thesis. Please ensure the image isn’t used for distribution purposes, but other than that, you are good to go ahead with this.

Best,

Rhea
11 REFERENCES


Hutson, G. (2011). Remembering the Roots of Place Meanings for Place-Based Outdoor Education. Sense of Place, 7.


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