

PAPER • OPEN ACCESS

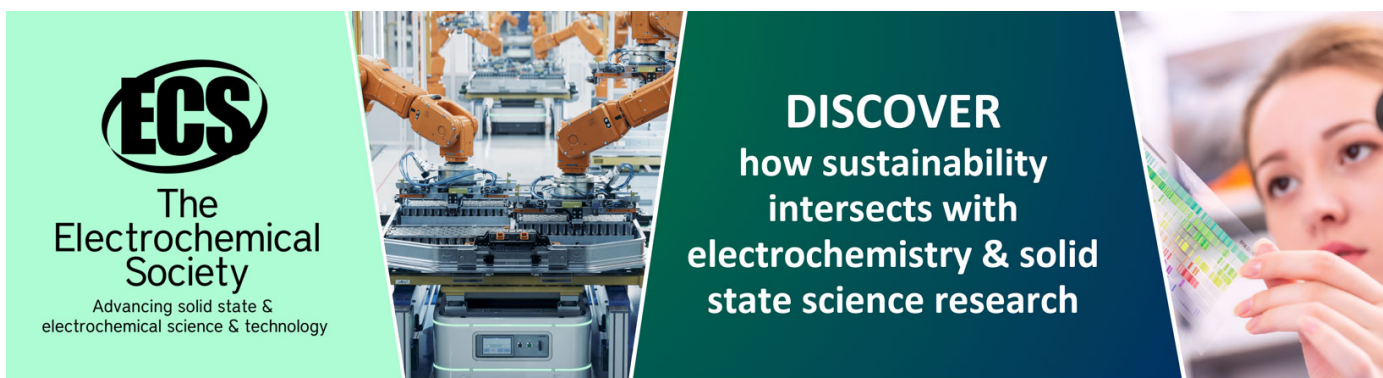
## The changing effects through biophilic design in increasing elderly memory capacity. Case study: Sasana Tresna Werdha Yayasan Karya Bakti Ria Pembangunan, Cibubur

To cite this article: R Felly and D Susanto 2020 *IOP Conf. Ser.: Earth Environ. Sci.* **452** 012110

View the [article online](#) for updates and enhancements.

### You may also like

- [Exploring Opportunities of Adopting Biophilic Cities Concept into Mixed-Use Development Project in Malaysia](#)  
K Z M Arof, S Ismail, N H Najib et al.
- [The implementation of biophilic design in co-working space design as a concept of healthy sustainable architecture](#)  
G Suharjanto, C Taufik, Y Mariana et al.
- [Assessing workers' productivity through biophilic design as a measure of sustainability in selected office buildings in Lagos state, Nigeria](#)  
E B Aduwo, O O Akinwale and P O Okpanachi



**ECS**  
The  
Electrochemical  
Society  
Advancing solid state &  
electrochemical science & technology

**DISCOVER**  
how sustainability  
intersects with  
electrochemistry & solid  
state science research

# The changing effects through biophilic design in increasing elderly memory capacity. Case study: Sasana Tresna Werdha Yayasan Karya Bakti Ria Pembangunan, Cibubur

R Felly<sup>1</sup> and D Susanto<sup>2</sup>

<sup>1</sup> Postgraduate Student of Sustainability Architecture, Universitas Indonesia, Jl. Kampus UI Kukusan, Depok 16424, Indonesia

<sup>2</sup> Lecturer, Universitas Indonesia, Jl. Kampus UI Kukusan, Depok 16424, Indonesia

\*Email: dalhar.susanto@ui.ac.id

**Abstract.** The degradation of cognitive function (memory) is one of the senile symptoms. The elders with age over 60 years old have a higher risk of having this disease. A design approach that can fulfill these needs is called biophilic design. The biophilic design gives a sustainable design strategy that considers the relationship between human and natural environment. The biophilic design aims to create a natural-based habitat by integrating nature with natural materials as well as natural shape into space. This research aimed to find how biophilic design could help to improve the elder's memory in Sasana Tresna Werdha. An Instrument used in this research was 43 biophilic design assessment instrument points, which were developed based on 14 biophilic design patterns to identify the presence of biophilic design quantitatively. To measure the elder's memory, this research used The Clinical Dementia Rating (CDR) table. This research conducted for 1.5 months. The biophilic design could affect the decrease in dementia level in elders with ages ranging from 60-85 years old that located in STW Ria Pembangunan, Cibubur. It will be a great implementation in any building function to improve the human's quality of life, in this case, is increasing human memory.

## 1. Introduction

Aging is a natural process that will be felt by every human being. In this process, the human will feel changes in their life [1]. Changes in aging, including changes in physiologic, psycho-social, and cognitive (memory) [2]. As human age increases, not only the body will age but also the brain. The brain will experience cell function degradation, which causes decreases in short-term memory cognitive function, concentrating capability, and slower in making a decision or acts [3].

A decrease in cognitive function (memory) is one of dementia or senile symptoms. Thus, if left uncured, the patient will face other problems such as decreases in understanding, linguistic, calculation, and behavior. These decreases will cause primary human need degradation such as forget to eat and drink, which give poor impacts on the elder's health [4].

According to the Republic Indonesia of Government Regulation number 43 of 2004, elders are people with the minimum age of 60 years old and older [5]. The elders have a higher risk to experience dementia. But, not all elders will suffer from dementia. Generally, elders start to suffer from dementia



Content from this work may be used under the terms of the [Creative Commons Attribution 3.0 licence](https://creativecommons.org/licenses/by/3.0/). Any further distribution of this work must maintain attribution to the author(s) and the title of the work, journal citation and DOI.

at the age of 60. Based on Survey Meter (Measurement, Training, and Research) in DI Yogyakarta, at the age of 60, 1 of 10 elders in DI Yogyakarta suffers from dementia. Then, at the age of 70, 2 of 10 elders experience it. When reaching 80 years old, the number increases to 4-5 elders, while at 90 years old, 7 of 10 elders will suffer from dementia [6].

According to the World Alzheimer's 2015 report, the dementia sufferers in Indonesia reach 556.000 people. In 2030, it is estimated to increase to 2.3 million people [7]. This increase is proportional to the elder's increasing number in Indonesia. In 2010, the elders in Indonesia reached 18.1 million people or 7.06% of Indonesia population and an increase occurred in 2014 with elders reaching 20.24 million people or 8.03% of Indonesia population [8].

This increase will give prosperity impacts if the elders are in fit, active, and productive conditions. It will give poor effects if the elders have health degradation problems like hearing problems, eyesight, motoric system (mobility) and cognitive (memory) functions degradations [9]. This problem will cause an increase in health service costs charged to the family. Moreover, it will increase the number of disables in Indonesia, which is potentially to become a country problem. Therefore, architecture as a place for people in doing every activity must capable of improving one's memory because based on previous research, the biophilic design could improve human health and well-being. Hence, the main purpose of this research is to find how the application of biophilic design could improve the elder's memory.

## **2. Dementia and Biophilic Design**

Dementia is a cognitive degradation which causes a loss in hard intellectual and memory function disturbing daily activities [10]. Dementia occurs due to brain cell damage where the nervous system cannot carry information into the brain, causing a progressive degradation in memory and skill, emotional problem, and changes in one's behavior [11].

Architecture is one of the platforms that support all human activities, it can be one of the approaches to solve this health issue. One of the approaches is the relation of architecture to the natural environment. Human has an inherent tendency to connect with nature called biophilia. This term was firstly introduced in 1964 by Erich Fromm, a German Psychologist. Then, in 1984, Edward Wilson, a biologist, popularized it. This term then was developed into many subjects, including architecture. In its development, there were researches and academics to correlate biophilia and architecture so that a new architecture concept came up which was later called biophilic design. Biophilic Design is an architecture design that considers human as a biological organism which focuses on achieving happiness and welfare through their mind and body system physically and mentally (Kellert, Heerwagen, & Mador, 2008). In the book "14 Patterns of Biophilic Design (Terrapin Bright Green)", it is stated that biophilic design can reduce stress, improving creativity and mind clearness, improving mental and well-being, accelerating the cure and improving one's cognitive function (memory) [12]. Based on this, it can be seen that the physical and psychological conditions of humans are related to their surroundings, i.e., natural environment. The aforementioned nature is divided into two types, i.e., living biotic components like animals and plants and non-living abiotic components like sun, water, wind, etc. Biophilic design has three basic categories, i.e. the presence of nature in space, nature analogy, space nature, which each has 14 different design application patterns. (Figure attached)

Table 1 14 Patterns of Biophilic Design

|          |                  |                     |                                           |
|----------|------------------|---------------------|-------------------------------------------|
| IOPHILIA | BIOPHILIC DESIGN | Nature in the space | 1. Visual connection with nature [P1]     |
|          |                  |                     | 2. Non-visual connection with nature [P2] |
|          |                  |                     | 3. Non-rhythmic sensory stimuli [P3]      |
|          |                  |                     | 4. Thermal & airflow variability [P4]     |
|          |                  |                     | 5. Presence of water [P5]                 |
|          |                  |                     | 6. Dynamic & diffuse light [P6]           |
|          |                  |                     | 7. Connection with natural systems [P7]   |
|          |                  | Natural analogues   | 8. Biomorphic forms & patterns [P8]       |
|          |                  |                     | 9. Material connection with nature [P9]   |
|          |                  |                     | 10. Complexity & order [P10]              |
|          |                  | Nature of the space | 11. Prospect [P11]                        |
|          |                  |                     | 12. Refuge [P12]                          |
|          |                  |                     | 13. Mystery [P13]                         |
|          |                  |                     | 14. Risk/peril [P14]                      |

### 3. Location and Methods

#### 3.1. Location

The research located in Sasana Tresna Werdha Yayasan Karya Bakti Ria Pembangunan, Cibubur. This Sasana Tresna Werdha (STW) was a complex building with a one-floor horizontal house type and three-floors vertical house type. Buildings within and out orientation had relatively many vegetations.

There was a vast garden outside the building, and a garden inside the building with various decorative and medicinal plants thus could increase biophilic design patterns, visual connection with nature [P1]. For air circulation, STW applied natural ventilation in every room, so that if looked in biophilic design patterns, it would improve thermal & airflow variability patterns [P4]. This could be seen by the number of openings in the form of windows with varied dimensions in each room. The presence of this opening also made human to feel a change outside the building like feeling the movement of clouds, wind blow or leaves friction sounds which would trigger inhabitant's sense of improving biophilic design pattern, Non-Rhythmic sense stimulation censor [P3]. Moreover, the elders also had a place to gaze outside, vastly improving the biophilic design prospect point, visual observation [P11].

The closing of the inner garden was a skylight; thus, the inner part of STW still got maximum natural lighting which might improve dynamic and assimilative light biophilic design patterns [P6]. There was a handrail in this corridor as a safety facility services for elders when walking which could improve risk/danger biophilic design patterns [P14].

In its biophilic design, this STW already had acceptable biophilic design presence since it gave a visual chance to inhabitant to gaze the presence of nature in its surroundings. Meanwhile, if seen from biophilic design patterns, other patterns like non-visual relation with nature [P2], water availability [P5], connection with nature system [P7], biomorphic forms and patterns [P8], relation between material and nature [P9], complexity and regularity [P10] and mistery [P13] inside room were lacked. Therefore, this STW was chosen as the research location to apply biophilic design intervention inside.

#### 3.2. Respondent

The population in this research was taken from STW Ria Pembangunan inhabitants with a total population of 64 people. Respondent was selected in this research based on:

- Sex category, i.e., male or female
- Age category, i.e., 60-85 years old

- Activity category, i.e., can do their activities by themselves, self-dependent and can be invited to socialize and communicate

A proper method in selecting respondents could give an actual condition of the population accurately. Therefore, in determining respondents, this research used Slovin formula, a formula that could calculate the minimum sample if the number of the total population is too many, which could represent the entire population. Thus it could be acquired:

$$n = \frac{N}{N(e)^2 + 1} \quad n = \frac{64}{64(0.2)^2 + 1} = \underline{18 \text{ respondents}} \quad (1)$$

Description:

n = Respondent/Sample Number

N = The number of population in STW Ria Pembangunan which is 64 people

e = Clearance percentage in research error, tolerable error in getting samples; e= 0.2 since the population is small (less than 1000)

From the above calculation, 18 people of male and female elders were chosen as respondents in this research. These 18 respondents were chosen based on respondent categories in this research.

### 3.3. Intervention Method

The first step in this research was evaluating the presence of biophilic design value in each existing elder's room using Index Value Assessment table of Biophilic Design. After obtaining the value, the intervention was done to increase the biophilic design value in each elders' room. This intervention was divided into three types. The purpose was to observe the development of memory in elders gradually based on applied biophilic design pattern. The three steps of interventions are:

- First intervention (Intervention 1), done by adding a shelf with leaf motive, Sansevieria Trifasciata Prain plants, and aromatherapy. This intervention was done to increase biophilic design value inside the room based on non-visual pattern with nature (P2), connection with nature system (P7), biomorphic form and pattern (P8) and mistery (P13), thus, increasing the total points in first intervention to 8 points;
- Second intervention (Intervention 1+2), done by adding decorative plastic plants to increase biophilic design value based on biomorphic form and pattern (P8), the connection between material and nature (P9), and complexity and regularity pattern (P10), so that improving the total points of second intervention to 8 points;
- Third intervention (Intervention 1+2+3), done by adding aquarium with fish inside. The purpose was to improve the biophilic design pattern based on the pattern of water presence (P5), hence, improving the total points of third intervention to 8 points.

By applying three intervention steps, the biophilic design value could increase up to 24%. (Table 3 attached)

Table 2 Three steps of intervention

| No.             | Biophilic Design Pattern          | Intervention                                             | Intervention steps                      | Intervention value |
|-----------------|-----------------------------------|----------------------------------------------------------|-----------------------------------------|--------------------|
| Nature in space |                                   |                                                          |                                         |                    |
| 1.              | Visual connection with nature     | Existing                                                 | Existing                                | -                  |
| 2.              | Non-visual connection with nature | Add aromatherapy and Sansevieria Trifasciata Prain plant | First Intervention (intervention 1)     | 4                  |
| 3.              | Non-rhythmic sensory stimuli      | Existing                                                 | Existing                                | -                  |
| 4.              | Thermal& Variability Airflow      | Existing                                                 | Existing                                | -                  |
| 5.              | Presence of water                 | Add aquarium and fish                                    | Third intervention (intervention 1+2+3) | 8                  |

|                     |                                 |                                                          |                                        |    |
|---------------------|---------------------------------|----------------------------------------------------------|----------------------------------------|----|
| 6.                  | Dynamic & diffuse light         | Existing                                                 | Existing                               | -  |
| 7.                  | Connection with natural system  | Add aromatherapy and Sansevieria Trifasciata Prain plant | First Intervention (intervention 1)    | 1  |
| Natural analogs     |                                 |                                                          |                                        |    |
| 8.                  | Biomorphic forms & patterns     | Add artificial plant                                     | Second intervention (intervention 1+2) | 5  |
|                     |                                 | Add leaf motif shelf                                     | First Intervention (intervention 1)    | 2  |
| 9.                  | Material connection with nature | Add artificial plant                                     | Second intervention (intervention 1+2) | 1  |
| 10.                 | Complexity & order              | Add artificial plant                                     | Second intervention (intervention 1+2) | 2  |
| Nature of the space |                                 |                                                          |                                        |    |
| 11.                 | Prospect                        | Existing                                                 | Existing                               | -  |
| 12.                 | Refuge                          | Existing                                                 | Existing                               | -  |
| 13.                 | Mystery                         | Add aromatherapy and Sansevieria Trifasciata Prain plant | First Intervention (intervention 1)    | 1  |
| 14                  | Risk/Peril                      | Existing                                                 | Existing                               | -  |
| Total               |                                 |                                                          |                                        | 24 |

### 3.4. Evaluation Method

Evaluation method in this research was done using three measuring tools, i.e.:

- Biophilic Design Value Assessment Table

This table consisted of an indicator to determine the value of biophilic design presence in a room. This table was popularized by Browning, Ryan & Clancy (2014) in a book entitled 14 Patterns of Biophilic Design [15].

- Clinical Dementia Rating (CDR)

This table was a measuring instrument used to determine the level of one's dementia. This CDR rating should be done based on direct observation by nurse or close relatives to know the development of the patient's condition accurately. There were six categories in this CDR instrument, i.e., memory, orientation, decision making, social activity, house activity and hobby, and self-maintenance. The rating scale in this table were 0 (normal without disturbance), 0.5 (questionable), 1 (light dementia), 2 (moderate dementia), and 3 (heavy dementia). The lower the value obtained from respondents, the lower the dementia level [16].

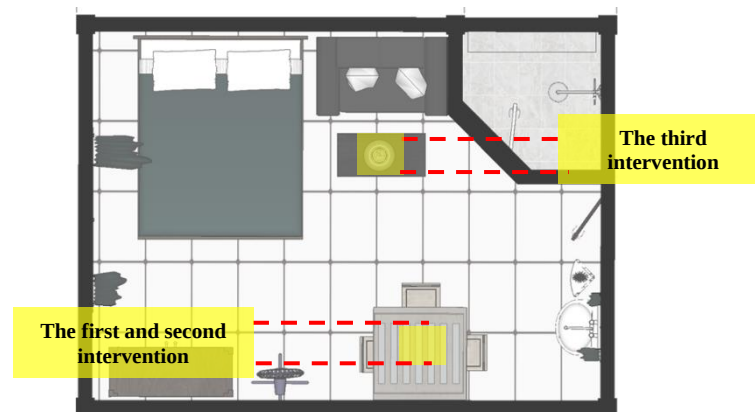
- Memory Card Games

This game was used to determine the respondent's short term memory by giving seven pieces of memory playing cards. The purpose was to recall the memory or to find out the capability to re-introduce the seen objects. Respondents were given 20 seconds to memorize the cards, then the cards would be flipped, and the respondents would be asked to memorize the spot of cards [17].

The rating evaluation using a biophilic design value assessment table was done before and after three steps of interventions applied. Meanwhile, for CDR and memory card games, the evaluation was done before the intervention, after first, second, and third interventions for 1.5 months.

## 4. Result and Discussion

Based on existing assessment result, it was obtained that were seven biophilic design patterns which had not received interventions. Thus, three intervention steps were done to complete the presence of biophilic design patterns in the elder's rooms.



**Figure 1** Room layout for three steps of intervention (Respondent 1 #R1)

The layout of respondent one #R1 room intervention was as follows. The location selected based on the view direction that was often gazed by the respondents. Shelf, pots of *Sansevieria Trifasciata* Prain plant, artificial plant and aromatherapy were placed near the entrance. Meanwhile, the aquarium was placed in the guest table. Before intervention was applied, the value of biophilic design presence in a room was 68 points. After three interventions, it could be seen that the biophilic design value increased in each respondent's room. After the first, second and third interventions, the biophilic design presence value obtained by respondent 1's room was 75, 84, and 92 points respectively. The same methods were applied to the other 17 respondents' rooms.

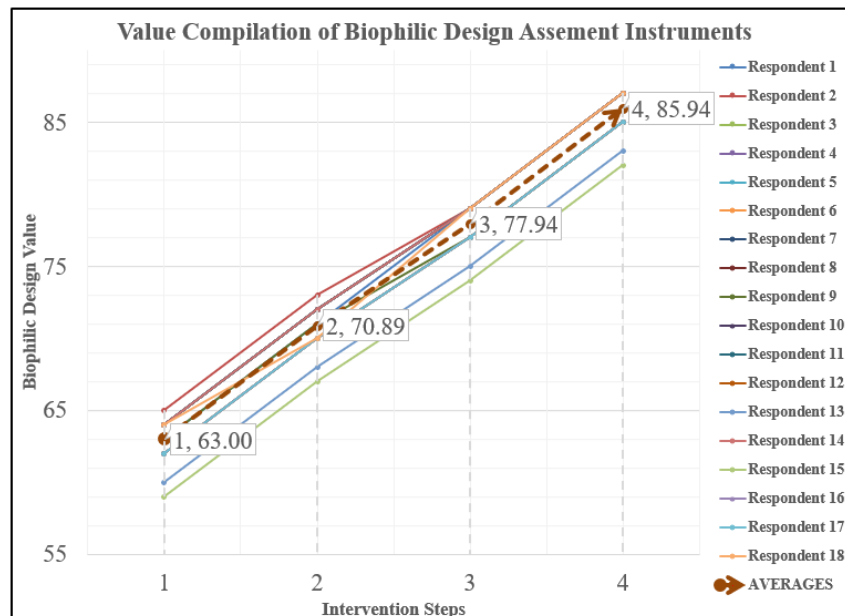
Thus, from the overall evaluation value, the result was obtained:

The biophilic design presence value increased in each intervention step. The increase for every intervention was 8, 7, and 8 points. Hence, intervention increases the biophilic design's presence value totally by 23%. (Graph attached)

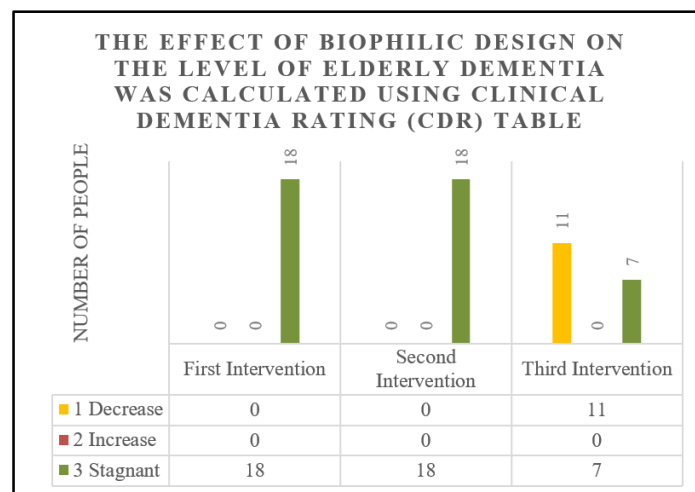
**Table 3** Table of the increase in the biophilic design of 18 respondents' rooms

| No. |                     | Increase in the total intervention (concept) | In number | In percent | Average Increase in the total intervention | Average Increase in the total intervention | Increase in percent (%) |
|-----|---------------------|----------------------------------------------|-----------|------------|--------------------------------------------|--------------------------------------------|-------------------------|
| 0   | Existing            | 0                                            | 24        | 24.00%     | 63                                         | 63%                                        |                         |
| 1   | First intervention  | 8                                            |           |            | 70.89                                      | 71%                                        | 8%                      |
| 2   | Second intervention | 8                                            |           |            | 77.95                                      | 78%                                        | 7%                      |
| 3   | Third intervention  | 8                                            |           |            | 85.84                                      | 86%                                        | 8%                      |

The increase of biophilic design value affected the elder's dementia level. Based on CDR value of 18 respondents, there were no increase and decrease in the first and second intervention step, remained unchanged. The CDR number changed in the third intervention step with the dementia level decrease by 20%. Thus, 61.11% of the elders were affected by dementia level decrease, but there were no elders found to experience an increase in dementia level. (Graph attached).



**Figure 2** Graph of increase in the biophilic design of 18 respondents' rooms



**Figure 3** Graph of dementia level decrease in 18 respondents based on intervention steps

This graph proved that the bigger the intervention applied, or, the higher the biophilic design value presented, the bigger the impact on one's dementia level decreases. It could be seen in the first and second steps, that the number had no impact on one's dementia. Meanwhile, in the third intervention, a decrease in the elder's dementia level occurred. In this case, this was a positive result.

Moreover, the application of biophilic design by applying the presence of nature actively became one of the factors in improving the elder's memory. The intervention type done was active, which meant that the respondents are actively involved in maintaining, watering, cleaning the aquarium in regular time duration. This was proportional to previous research. Ulrich (1984) researched the presence of nature that could accelerate wounds cure after surgery. The respondent in this research did direct contact to see and feel the plants and biophilic design elements directly. Moreover, Bhatt (2015) researched to find the effect of the biophilic design on the health and welfare of elders. Almost similar to Ulrich's research, the respondents in this research were directly connected with nature by adding natural elements



in the nursing home's design so that direct interaction with nature occurred. Feandri (2016) also researched to determine how far the biophilic design patterns could be applied in housing. The red line of this researches was by actively involved with maintaining natural elements; the elders could experience mental welfare increase compared to the method which presented nature passively.

## 5. Conclusion

The increase of biophilic design value can affect the decrease of dementia level in elders with the age range of 60-85 years old who lived in STW Ria Pembangunan, Cibubur. Therefore, the application of biophilic design in housing, or, the other buildings are highly recommended as a preventive method to reduce the dementia level in Indonesia.

However, there is another thing that should be considered related to biophilic design, i.e., how much quantity of nature can be applied to buildings. Based on previous researches, presenting nature into a building only affects some factors in human life such as: accelerating the wound healing after surgery, increasing well-being, and improving health. But, the research on the appropriate quantity of nature presented into a building has never been conducted. Moreover, further research is required to determine, which is the best among all 14 biophilic design patterns that are highly impactful on the elder's memory factor.

## Acknowledgment

Financial support from Directorate of Research and Community Engagement (Direktorat Riset dan Pengabdian Masyarakat) Universitas Indonesia in PITTA B scheme grants year of 2019 [grant number NKB-0714/UN2.R3.1/HKP.05.00/2019], is gratefully acknowledged.

## References

- [1] Mubarak, W., Nurul, C., & Bambang 2010, Ilmu Keperawatan Komunitas: Konsep dan Aplikasi. Vol. 2.
- [2] Potter, P. & perry, A. 2005, *Buku Ajar Fundamental Keperawatan: Konsep, Proses, dan Praktik. Vol. 1 (4th Edition)* (Yasmin Asih, dkk, Translator).
- [3] Sitanggang, S. 2002, Pikun? Ingat kata lupa.
- [4] Sarwono, P. 2010, Pelayanan Kesehatan Mental dan Neonatal.
- [5] Undang-Undang Republik Indonesia no. 13, 1998.
- [6] Suriastini, N. W., Turana, Y., Witoelar, F., Suprptilah, B., Wicaksono, T. Y., Dwi, E. 2016, Survey meter: Angka Prevalensi Demensia: Perlu Perhatian Kita Semua.
- [7] Alzheimer's Disease International, 2016, Annual Report 2015-2016.
- [8] Kementerian Kesehatan Republik Indonesia, 2017, Data dan Informasi: Profil Kesehatan Indonesia 2017.
- [9] Badan Pusat Statistik, 2015, Statisik Penduduk Lanjut Usia.
- [10] Nugroho, W. 2008, Keperawatan Gerontik & Geriatrik edisi 5.
- [11] Pieter, Zan, H., Janiwarti, B., Saragih, M. 2011, Pengantar Psikopatologi untuk Keperawatan.
- [12] Browning, W., Ryan, C., & Clancy, J. 2014, *14 Patterns of Biophilic Design*. New York: Terrapin Bright Green Inc.