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THE DESIGN INNOVATION WITH A BIOPHILIC APPROACH TO SUPPORT THE TEMPORARY CONVERSION OF STUDENT DORMITORY AS A COVID-19 ISOLATION SHELTER

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ABSTRACT

The increasing number of Corona Virus Disease (COVID-19) cases in Bandung, Indonesia, in July 2021 resulted in a higher hospital bed occupancy rate. The conversion of two student dormitory buildings into isolation shelters is expected to accommodate COVID-19 patients who do not have rooms in the hospital. This requires specific planning and innovation, particularly for materials. This study has two objectives: first, to evaluate how long coronaviruses can remain active on different material surfaces. The data collection strategy was carried out through Systematic Review. The second research objective was to design a COVID-19 isolation room that uses materials that facilitate the healing process. Field surveys and traditional literature reviews were conducted for this purpose. This study found that the virus did not survive long on the surfaces of cotton and cardboard. Thus, the room design uses these materials and is considered a biophilic design. This study is expected to provide insights for academics and researchers in interior design and architecture regarding the knowledge of furniture materials that prevent viruses from surviving longer. In addition, it is expected to inspire interior designers to design rooms that can help the healing process using a biophilic approach.

1. INTRODUCTION

The increasing number of COVID-19 cases in Bandung-West Java, Indonesia, in July 2021 resulted in a higher hospital bed occupancy rate. Therefore, the Government of West Java has scheduled the conversion of some building facilities into isolation facilities and emergency quarantine. To determine the bed occupancy rate, Telkom University contributes to providing its campus dormitory as a place of isolation (CNN Indonesia, 2021). The dormitories were selected based on the suitability of the facilities and supporting infrastructure that facilitates quarantine procedures. The conversion of two student dormitory buildings with a capacity of 260 bedrooms is expected to accommodate COVID-19 patients in Bandung and the surrounding areas who do not get rooms in the hospital.

The Ministry of Social Affairs of the Republic of Indonesia has prepared guidelines for preparing community-based facilities for quarantine and isolation related to COVID-19 (Ministry of Social Affairs, RI, 2020). The guideline states that isolation facilities are for patients who are sick or tested positive for COVID-19, as well as for patients who do not exhibit symptoms, with the aim of reducing the risk of transmission. The facilities in this dormitory are specifically for asymptomatic and mildly symptomatic COVID-19 patients because patients with other criteria are provided with other facilities.

Planning an appropriate isolation room to help the healing of COVID-19 patients is very influential; how space can maintain the behaviour, physical health, and psychological health of COVID-19 patients when in isolation is very important to note. Currently, the condition of the student dormitory has not met these needs both in terms of space creation and furniture design. The solution is to create a good space atmosphere to maintain psychological health and the application of material surfaces that do not preserve viruses for long and are easy to maintain so that hygiene is maintained. This is expected to accelerate the recovery of COVID-19 patients. The quality of the materials reflects the idea of the room and adds

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depth to the healing environment (Goenka, 2018). By reviewing several different material surfaces and testing the persistence of the Coronaviruses on the surface, it is expected to reveal what materials are most suitable to be applied to isolation rooms both in terms of health and easy maintenance. Appropriate material planning is considered the most applicable design solution because it is a temporary emergency covid isolation shelter that does not change the building structure.

The biophilic design approach promotes the connection between humans and nature and explores the various positive effects produced (Browning & Ryan, 2020). Biophilic design focuses on how a space can stimulate the physical and psychological restoration of its inhabitants. Biophilic design has been shown to relieve stress, increase creativity and clarity of thought, improve our overall well-being, and speed up the healing process (Browning et al., 2014). Differences in the material surface can persist the coronavirus with different durations from 5 minutes to 5 days (Fiorillo et al., 2020). The use of biophilic design in the application of the materials is also expected to strengthen the healing environment in isolation rooms. The conversion of student dormitory rooms to isolation rooms requires more specific planning and innovation, especially the designing of space and materials selection. Therefore, further analysis is needed about the proper materials to accommodate these needs. Therefore, the problems identified are:

1. What is the resistance of Coronaviruses on different material surfaces?

2. How is the application and material treatment applied to an isolation room that can speed recovery?

In research conducted by Susilo et al. (2020) in Singapore, viral infections were found in all rooms and toilets of COVID-19 patients. Previous research conducted by Fiorillo et al. (2020) discusses the persistence of viruses on different surfaces of materials and the effectiveness of disinfectants as anti-microorganism materials set by Suman et al. (2020). This research will focus on the application of materials that have been tested relatively not to persist viruses for a long time, and that is easy maintenance. This method is expected to be more suitable for planning isolation rooms as a healing place.

The aims of the research are to evaluate how long the COVID-19 virus can remain active on different surfaces of the material; as well as to design an isolation room that applies materials/ finishing with a biophilic design to speed up recovery.

3.1 Coronavirus Persistence on Surface

COVID-19 or Corona Virus Disease has been reported to have infected humans since 18 December 2019 in Wuhan, Hubei Province, China. This virus is caused by a virus named Severe Acute Respiratory Syndrome Coronavirus-2 (SARS-CoV-2) (Susilo et al., 2020). This virus has spread worldwide, and in December 2021, there was over 274 million total case globally (worldometers, 2021). Therefore, it has attracted much attention from researchers in various disciplines. According to World Health Organization (2020), this virus can be transmitted through close physical contact and respiratory droplet-contaminated surfaces. Furthermore, World Health Organization (WHO) points out that these surfaces, particularly those in contact with patients who have COVID-19, must be thoroughly cleaned and disinfected to prevent future transmission. Likewise, this suggestion extends to other locations for isolation of COVID-19-positive persons with mild and moderate disease, such as residences and non-traditional facilities. Many studies have investigated the survivability of coronavirus on different surfaces.

He et al. (2021) imply that high temperatures (by increasing the rate of evaporation) and low humidity may reduce virus viability on surfaces. Moreover, the influences of relative humidity, temperature, and droplet size on the stability of SARS-CoV-2 on nonporous surfaces were examined by Biryukov et al. (2019). Their findings indicate that SARS-CoV-2 decays more rapidly with increasing humidity or temperature, but that droplet volume and surface type had no significant effect on the rate of decay.

Liu et al. (2021)laboratory test results, smear sample information, and quarantine room information. Genome sequencing and phylogenetic analysis were conducted. We analyzed the factors associated with environmental contamination. Result: Among 39 COVID-19 cases, 10 were asymptomatic and 37 were imported from aboard. We collected 271 swab samples from environmental surfaces related to observational patients. Eighteen swab samples from seven patients were positive. The highest contamination rates occurred on cups (100% found the wetness of the sampling site was linked to the duration of environmental surface contamination. The stability of SARS-CoV-2 and SARS-CoV-1 in aerosols and on various surfaces has been evaluated by (van Doremalen et al., 2020). They reveal that both SARS-CoV-1 and SARS-CoV-2 have similar stability under their experimental circumstances tested. Corpet (2021) reveals that SARS-CoV-2 is inactivated in 7 days on plastic and 3 hours on paper. Another study found that copper exhibits antiviral properties—so much so that the virus seems degraded or transformed when it encounters copper surfaces (Fiorillo et al., 2020).

The Coronavirus surface persistence has been investigated using systematic review by many studies (Fiorillo et al., 2020; Kampf et al., 2020; Marzoli et al., 2021; Zaid et al., 2020). The review of 4 studies by Fiorillo et al. (2020) reveals that different human coronaviruses can survive on inanimate surfaces for up to 9 days before being effectively inactivated within 1 minute by surface disinfection procedures. Their findings are similar to the analysis of 22 studies by Kampf et al. (2020). The review of 18 investigations by Marzoli et al. (2021) revealed that the longest SARS-CoV-2 survival time under laboratory circumstances at room temperature had been proved to be 28 days on glass, steel, and both polymer and paper banknotes. Whereas Zaid et al. (2020) found it is possible for human coronaviruses to stay infectious on objects or fomites for up to nine days.

3.2 Biophilic Design

Biophilic design is a fast-emerging field that is set to play a critical role in creating a kind of modern, liveable city (Downton et al., 2017). The goal of biophilic design is to solve such flaws in modern building and landscape design by setting up a new way for people to enjoy nature in the modern built environment. The biophilic design intends to make the modern built environment a good place for people to live as a living thing that improves their health, fitness, and well-being (Kellert & Calabrese, 2015). There are three experiences of biophilic design such as the direct experiences of nature, the indirect experience of nature, and the experience of space and place. According to them, the indirect experience of nature refers to contact with representations of natural elements, the transformation of natural elements from stranding conditions, or exposure to processes and patterns of the natural environment. One of the factors that can support the indirect application of natural experience is natural materials. Natural materials can be very interesting because they show how organic matter changes over time as it adapts to the stresses and challenges of living. It's common for materials that come from nature to be changed in a way that makes people feel good about how they look and how they feel. Most artificial materials can't do that. Wood, stone, cotton, leather, and wools are some of the most common natural building and decorative materials. They are used in a wide range of products and furnishings for both exterior and interior. Besides natural material, the indirect experience of nature consists of images of nature, natural colors, simulating natural light and air, naturalistic shapes and forms, biomimicry, and so on (Kellert & Calabrese, 2015). The prior study (Yuniati et al., 2018) discovered that each natural element in the interior had a unique effect on how mood, motivation, and attitude responses were triggered.

Browning et al. (2014) list "14 Patterns of Biophilic Design" that explore the connections between nature, human biology, and the built environment's design. These 14 patterns are suitable for use in a variety of interior and external environments. Furthermore, Browning & Ryan (2020) update 15 patterns of biophilic design. For nature in the space, the patterns are visual connection with nature, non-visual connection with nature, non-rhythmic sensory stimuli, thermal and airflow variability, presence of water, dynamic and diffuse light, same as connection with natural systems. For natural analogs, the patterns consist of biomorphic forms and patterns, material connection with nature, as well as complexity and order. For the nature of the space, the patterns are prospect, refuge, mystery, risk/ peril, and awe. Natural materials and elements that, with minimal intervention, reflect the local ecosystem or geology and contribute to the creation of a distinct sense of place (Browning & Ryan, 2020). Understanding the advantages of interacting with the environment is essential for sustaining and improving human well-being in a growing urban society (Keniger et al., 2013)been limited to a single discipline, or covered the benefits delivered from a particular type of interaction. Here we construct novel typologies of the settings, interactions and potential benefits of people-nature experiences, and use these to organise an assessment of the benefits of interacting with nature. We discover that evidence for the benefits of interacting with nature is geographically biased towards high latitudes and Western societies, potentially contributing to a focus on certain types of settings and benefits. Social scientists have been the most active researchers in this field. Contributions from ecologists are few in number, perhaps hindering the identification of key ecological features of the natural environment that deliver human benefits. Although many types of benefits have been studied, benefits to physical health, cognitive performance and psychological well-being have received much more attention than the social or spiritual benefits of interacting with nature, despite the potential for important consequences arising from the latter. The evidence for most benefits is correlational, and although there are several experimental studies, little as yet is known about the mechanisms that are important for delivering these benefits. For example, we do not know which characteristics of natural settings (e.g., biodiversity, level of disturbance, proximity, accessibility.

3.3 Isolation Room

According to the Centers for Disease Control and Prevention (CDC, 2020), quarantine prevents anyone who has been in close contact with those that have COVID-19 away from others, whereas isolation keeps those who are sick or tested positive for COVID-19 but does not exhibit symptoms away from others. Based on previous experience, both in Indonesia and in other countries, the provision of shelter, especially for quarantine or isolation purposes, is highly recommended to be done independently and not using public facilities. This is because being in an independent facility can ensure the implementation of existing health protocols, especially regarding COVID-19, such as keeping a distance from others and implementing a regular clean, and healthy lifestyle (Kementerian Sosial RI, 2020). In shared/collective/public shelter facilities, these things become very difficult to do. Therefore, the use of private residences or official residences is highly recommended for quarantine or isolation purposes. Lodging places, such as hotels and motels, education and training centers, social rehabilitation centers, and hajj dormitories are the next choice. The use of other public facilities such as village halls and sports facilities can be used if the option of self-quarantine and/or self-isolation cannot be carried out. There are also no lodging facilities that can be used. The use of schools and Islamic boarding schools is not recommended and can only be used as a last resort. Because in general, school buildings are not designed to be used as residences. The use of places of worship is also a consideration in providing shelter. However, it is also necessary to pay attention to the inclusiveness aspect by considering access for potential shelter users who have different religions and/or beliefs. The guidelines for preparing shelter facilities for community-based quarantine and isolation related to COVID-19 have been provided by the Ministry of Social Republic of Indonesia (Kementerian Sosial RI, 2020). There are several isolation technical criteria in community-based public facilities. According to the guideline, it is highly recommended to

treat confirmed patients in single occupancy rooms with separate doors and ventilation systems to avoid mixing of air between rooms. Positive confirmed patients should not be joined together with suspected or probable cases (Kementerian Sosial RI, 2020). Table 1 describe the guideline in preparing shelter facilities for community-based isolation related to COVID-19.

Table 1: *Guidelines for isolation patients room design*

Items	Guidelines
Bed	• The distance between the beds is approximately 2 meters. • Separate rooms for men and women. • Beds are separated by curtains or partitions for privacy and to prevent the spread of disease.
A terrace or Open Space Access	• There should be an open space with enough sunlight to sunbathe for health, exercise, provide aspects of freshness and avoid stress by still taking infection prevention measures. • There are information boards to place educational materials, communication, and information, including numbers that can be contacted. • Residents need an area of 4 m2/ person to keep their distance.
Availability of Clean Water	• There is a good provision of clean water distribution and in accordance with applicable standards • Clean water facilities are disinfected at least twice a day.
Handwashing Facilities with Soap	• Only used for people in quarantine/ isolation. • At least one facility for one occupant. • Provide dry tissue instead of dryer wipes. • Provide closed trash bins for tissue waste and other waste, which are equipped with waste management procedures. • Make a distance guard signage for residents in line. • Provide hand sanitizer. • Clean at least twice a day using a disinfectant.
Toilet	• There is a minimum of one toilet available for every 20 patients separated between men, women, children, and health workers. • Toilets are cleaned with disinfectant at least twice a day. • Provide hand sanitizer. • Make a distance guard signage for residents in line.
Lighting	• Have adequate lighting and power sources.
Entertainment Access	• Provide access to entertainment such as television, books, and the internet.
Worship Facilities	• Distance of at least 2 meters with other residents when worshiping. • Use own worship equipment and do not share the equipment.
Accessibility	• The room needs to be adjusted if there are patients with physical, sensory, mental, and intellectual disabilities. • A healthy companion is needed who has no symptoms and is not in a high-risk group (elderly, pregnant women, comorbid) and understands the impact and risks of COVID-19. • Mobility aids are available and cleaned as often as possible with disinfectants. • Accessibility is tailored to the needs of residents whose location is near the treatment site.
Ventilation	• There are enough windows that can be opened with good and smooth air flow (60 liters/ second/ patient). • Separate ventilation between isolation rooms.

Summarised from Kementerian Sosial RI (2020).

2. METHOD

This research aims to seek the resistance of coronavirus on different material surfaces. The method used a Systematic Literature Review (SLR) as a data collection method adopting The Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) (Page et al., 2021). This secondary data collection strategy is one useful way to obtain data (Baum, 2021). Scientific articles related to research topics were reviewed, including articles about the characteristics of Coronaviruses and the resistance of Coronaviruses in materials. The study was conducted in three electronic databases (PubMed, Scopus, and ScienceDirect).

For study selection, the search was conducted in the English literature database with keywords on TITLE-ABS-KEY (SAR-Cov-19) OR TITLE-ABS-KEY (COVID-19) AND TITLE-ABS-KEY (persistence) AND TITLE-ABS-KEY (surface). Data searching was done on 13 September 2021. Following data collection, the data were selected manually using the online software rayyan.ai (Ouzzani et al., 2016)and no single method fulfills the principal requirements of speed with accuracy. Automation of systematic reviews is driven by a necessity to expedite the availability of current best evidence for policy and clinical decision-making. We developed Rayyan (http://rayyan.qcri.org to delete duplication and to screen the included & excluded papers (Figure 1).

Figure 1*: Rayyan.ai interface*

After that, the data were filtered with several inclusion and exclusion criteria. The criteria for excluded articles were articles that do not contain sufficient information and are not related to the topic, were written in a language other than English, systematic papers, not full research articles, and did not have access to the full text. According to the inclusion and exclusion criteria, the full texts of the publications were read to ensure that each study was eligible for inclusion. The review was conducted by the first author.

After the data were collected and checked for relevance and evaluated, the findings regarding the required information were then compiled in tabular form using NVivo12 and exported into .xls format for analysis using Google Sheets. The table contains information such as the type of interior material, virus persistence (time in hours or days), temperature (if any), and sources (author and year of publication). After the table was compiled, then the data was synthesized manually. This data was used to develop material concepts and design the dormitory rooms for COVID-19 isolation.

The object of this study is a student dormitory room in one private university in Bandung. For the suburban area of Bandung, the Telkom University Dormitory has very adequate facilities and infrastructure in terms of the number of beds and an environment that allows the isolation process. Field observations were carried out in dormitory rooms as a case study by making documentation (photos) of dormitory facilities, specially building interiors. The field observation also aims to record the objects or facilities in the building, including the materials and finishes that were available during the research. Following the SLR and field observation, the design of the dormitory room as an isolation place was conducted to answer how the application and treatment of material applied to the isolation room can speed recovery?

3. RESULTS AND DISCUSSION

3.1 Findings from the Systematic Literature Review (SLR)

During the first search, 296 articles were obtained. Of the 296 articles included in the first search, 139 duplications were found. After deletion of duplication, 185 article titles were obtained. After that, the data were filtered with several inclusion and exclusion criteria. The flow diagram of article sampling to be the object of study was adopted from a prior study (Fiorillo et al., 2020; Page et al., 2021), as illustrated in Figure 2.

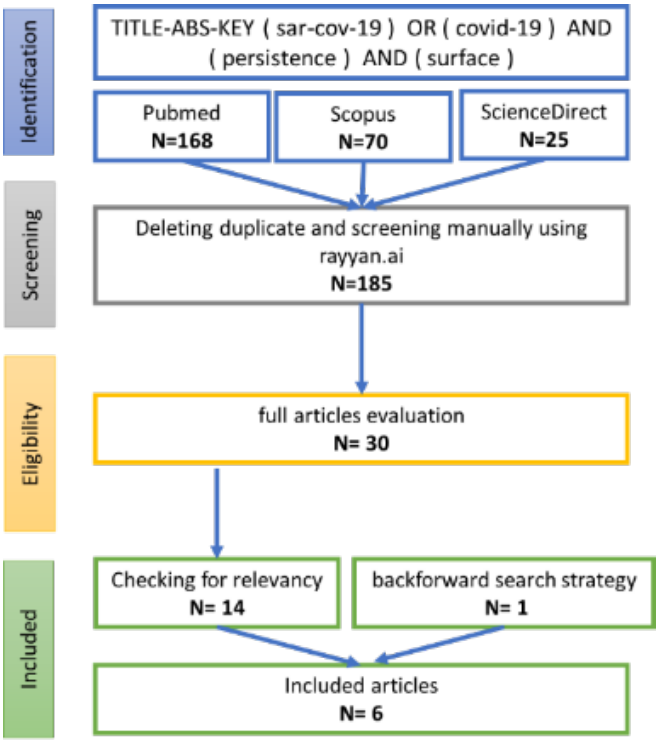

***Figure 2**: Flow diagram of study selection*

Source: adapted from Fiorillo** et al. **(2020)

Following an in-depth study in each included articles, the findings of those investigations were summarised in Table 2. Coronaviruses have a different lifespan on different material surfaces, and Table 2 provides an overview of that persistence.

***Table 2**: Persistence of COVID-19 on different material surfaces*

Material		Persistence (duration hours/ days)	Sources (N:6)
Porous	cardboard	no viable SARS-CoV-2 was measured after 24 h	(van Doremalen et al., 2020)
	100% cotton	human coronaviruses can remain infectious on cotton for 24 h	(Owen et al., 2021)
	100% cotton	The recovery of SARS-CoV-2 on porous material (cotton cloth) was reduced with no infectious virus recovered past day 14 post-inoculation.	Riddell et al., 2020
	100% cotton	At 20 °C, 5.5 days	Riddell et al., 2020
	100% cotton	At 30 °C, the infectious virus was recoverable for three days	Riddell et al., 2020
	100% cotton	At 40 °C, Infectious SARS-CoV-2 was not recovered past 24 h	Riddell et al., 2020
	cotton t-shirt	Times for 99.9% reduction 84 h	(Paton et al., 2021)
	polyester sports shirt	Times for 90% reduction 2.5 h	Paton et al., 2021
	99.3% polyester	human coronaviruses can remain infectious on polyester for 72 h	Owen et al., 2021
	65%/35% polyester-cotton blend (polycotton)	human coronaviruses can remain infectious on polycotton for six h	Owen et al. 2021
	vinyl	At 20 °C, 6.3 days	Riddell et al., 2020
	vinyl	At 30 °C, the infectious virus was recoverable for three days	Riddell et al., 2020
Nonporous material	copper	no viable SARS-CoV-2 was measured after four h	van Doremalen et al., 2020
	polymer notes (banknotes made from a synthetic polymer)	At 20 °C, the infectious virus was still detectable after 28 days	Riddell et al., 2020
	polymer notes	At 30 °C, the infectious virus was recoverable for seven days	Riddell et al., 2020
	banknote	Times for 99.9% reduction 74.86 h	Paton et al., 2021
	bank notes	The calculated decay rate is the fastest, with a 99.9% reduction in recovery within 75h.	Paton et al., 2021
	paper note	infectious virus was detected for 21 days	Riddell et al., 2020
	Glass	SARS-CoV-2 survival with half-lives 6.9 h	(Bonil et al., 2021)
	Glass	At 20 °C, the infectious virus was still detectable after 28 days	Riddell et al., 2020
	Glass	At 30 °C, the infectious virus was recoverable for seven days	Riddell et al., 2020
	Glass	the half-life of 4.2 h; infectivity was detectable until 96–120 h	Gidari et al. 2020
	photo-activated coated glass	SARS-CoV-2 survival with half-lives 4.1 h	Bonil et al., 2021
	stainless steel	SARS-CoV-2 survival with half-lives 3.5 h	Bonil et al., 2021
	stainless steel	At 20 °C, the infectious virus was still detectable for 28 days (SARS-CoV-2 is extremely stable on stainless steel surfaces at room temperature (> 28 days at 20 °C/50%RH))	Riddell et al., 2020
	stainless steel	At 30 °C, the infectious virus was recoverable for seven days	Riddell et al., 2020
	stainless steel	At 40 °C, Infectious SARS-CoV-2 was not recovered past 48 h	Riddell et al., 2020
	stainless steel	the virus half-life was 4.4 h; virus infectivity was detected no longer than 48–72 h	Gidari et al. 2020
	Stainless steel	Times for 99.9% reduction 113.66 h	Paton et al., 2021
	Stainless steel	the virus titer was greatly reduced after 48 h; the estimated median half-life of SARS-CoV-2 was approximately 5.6 hours	van Doremalen et al., 2020
	aluminum	SARS-CoV-2 survival with half-lives 2.3 h	Bonil et al. 2021
	Plastic	SARS-CoV-2 half-life was 5.3 h, and the infectivity persisted until 120 h.	Gidari et al. 2020
	Plastic	the virus titer was greatly reduced after 72 h; the estimated median half-life of SARS-CoV-2 was approximately 6.8 hours	van Doremalen et al., 2020

Virus half-life can be interpreted as the time taken to achieve a 50% reduction in titer (Riddell et al., 2020). They investigated that virus recovery was drastically decreased at 40 °C, compared to both 20 °C and 30 °C experiments (Riddell et al., 2020). They also found the persistence of SARS-COV-2 on vinyl and glass (such as for touch screens and screen protector materials) might become a potential source of transmission and recommend that touchscreen devices should be disinfected regularly.

In particular, plastic will be the most resistant to Ultraviolet-C (UV-C) disinfection, followed by stainless steel and glass, the latter of which demonstrates adherence to treatment (Gidari et al., 2021). They suggest that disinfecting indoor built environments with UV-C irradiation could be an effective and rapid method.

A prior study points out that SARS-CoV-2 or coronavirus has a variable survival period on various surfaces and may persist at varying temperatures and humidity levels (He et al., 2021). They further explain that high temperatures (by increasing the rate of evaporation) and low humidity can limit the production of residues, reducing the virus's survival on surfaces. Our SLR findings (as seen in Table 2) are the persistence of COVID-19 on cardboard followed by 100% cotton as porous surfaces become the fastest among others, while aluminum and plastic are the longest that preserve the virus. Our findings are consistent with Corpet (2021), which reveals that compared to paper, SARS-CoV-2 lives longer on plastic. Therefore, compared to plastic, he concludes that the virus is much faster inactivated on paper. It can be listed that the stability of the virus from short to long is as follows: copper, tissue, paper, wood, cotton, banknote, cardboard, pig skin, stainless steel, glass, plastic, and polypropylene (Corpet, 2021).

Another study explains the higher adhesion to copper could be one of the contributors to the shorter persistence of coronavirus on copper (Xie et al.,2020)"ISSN":"19448252","PMID":"33337873","abstract":"The SARS-CoV-2 virus that causes the COVID-19 epidemic can be transmitted via respiratory droplet-contaminated surfaces or fomites, which urgently requires a fundamental understanding of intermolecular interactions of the coronavirus with various surfaces. The corona-like component of the outer surface of the SARS-CoV-2 virion, named spike protein, is a key target for the adsorption and persistence of SARS-CoV-2 on various surfaces. However, a lack of knowledge in intermolecular interactions between spike protein and different substrate surfaces has resulted in ineffective preventive measures and inaccurate information. Herein, we quantified the surface interaction and adhesion energy of SARS-CoV-2 spike protein with a series of inanimate surfaces via atomic force microscopy under a simulated respiratory droplet environment. Among four target surfaces, polystyrene was found to exhibit the strongest adhesion, followed by stainless steel (SS. They found that the adhesion of spike proteins is (i) very weak on hydrophilic inorganics (e.g., glass) due to the lack of substantial hydrogen bond formation, (ii) relatively high on metal surfaces (such as copper and stainless steel) due to strong coordination interactions, and (iii) very strong on hydrophobic polymers (e.g., plastics), which are associated with hydrophobic interactions (Xie et al., 2020)"ISSN":"19448252","PMID":"33337873","abstract":"The SARS-CoV-2 virus that causes the COVID-19 epidemic can be transmitted via respiratory droplet-contaminated surfaces or fomites, which urgently requires a fundamental understanding of intermolecular interactions of the coronavirus with various surfaces. The corona-like component of the outer surface of the SARS-CoV-2 virion, named spike protein, is a key target for the adsorption and persistence of SARS-CoV-2 on various surfaces. However, a lack of knowledge in intermolecular interactions between spike protein and different substrate surfaces has resulted in ineffective preventive measures and inaccurate information. Herein, we quantified the surface interaction and adhesion energy of SARS-CoV-2 spike protein with a series of inanimate surfaces via atomic force microscopy under a simulated respiratory droplet environment. Among four target surfaces, polystyrene was found to exhibit the strongest adhesion, followed by stainless steel (SS.

Thus, the survival of COVID-19 on the surface of items manufactured of or covered with such material (paper, cardboard, cotton) would be expected to be lowered. The explanation is that the increased use of water-absorbent objects could thus inhibit COVID-19's fomite dissemination (Corpet, 2021). Further explained that nonporous surfaces will be better at maintaining the survival of the coronavirus because it does not remove moisture from the adsorbed virus. (Corpet, 2021). At room temperature (> 28 days at 20 °C/50%RH), SARS-CoV-2 is very stable on stainless steel surfaces (Riddell et al., 2020).

3.2 Existing condition

This study uses Telkom University's dormitory building as a case study and both buildings have a typical layout plan. Environmental surfaces in student dormitory room settings include furniture and other fixed items inside and outside the bedroom, such as bed, desk, chair, wardrobe, light switches, walls, and toilet (Figure 3). One unit of the dormitory room as a case study is intended for 4 occupants. Inside there are two bunk beds, four study desks, four wardrobes, one towel hanger, one water dispenser, one trash bin, and one bathroom. In the bathroom, there is only a squat toilet and shower without a sink or hand basin. There are two windows in every unit. The existing artificial lighting in dormitory rooms uses two bulbs as general lighting in the bedroom and one bulb in the bathroom.

***Figure 3**: Interior of the student dormitory room*

3.3 Design concept

Before starting to develop the design concept, first brainstorm using mind mapping techniques. Figure 4 below shows a mind map as the basis for drafting the design concept.

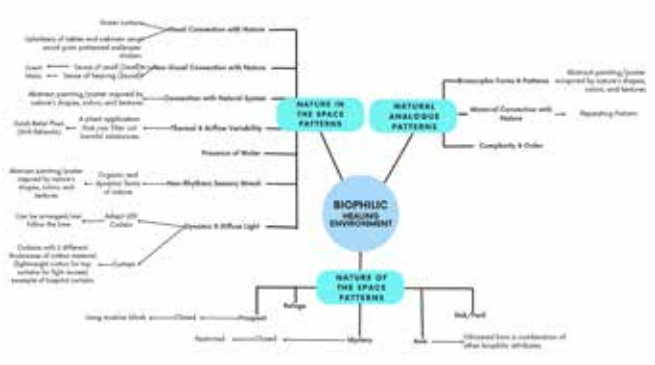

***Figure 4**: Mind mapping*

The mind mapping described in Figure 4 above breaks down the 15 patterns of biophilic design referred to Browning & Ryan (2020). Based on the mind mapping, the design of the dormitory room for this isolation COVID-19 patient uses a biophilic design approach. Biophilic is a design approach that seeks to unite humans with the natural environment which will form various positive impacts on humans. Therefore, the theme of this dorm room design is "Biophilic Design - connecting with nature". The shape concept uses organic and dynamic forms from nature. Figure 5 depicts the design concept.

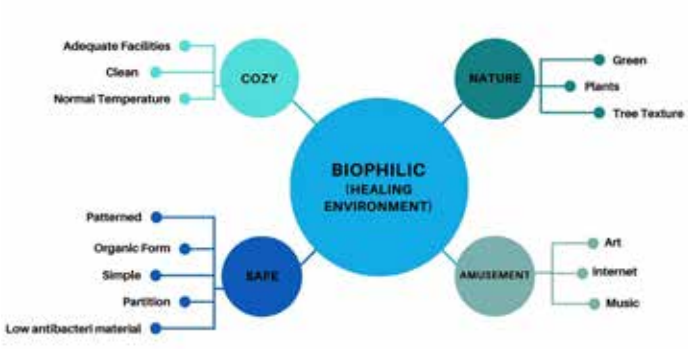

***Figure 5**: Design Concept*

The implementation of the biophilic-design relationship and patterns converted to the implementation of design can be checked in Table 9.

3.4 Material and Texture

Material limitations to be used for isolation patient rooms refer to Table 2 Virus Resistance on Material Surfaces. Table 2 lists the surfaces which have a short to a long time in retaining viruses based on SLR from six previous recent studies. The following Table 3 describes the material treatment to be used in the isolation room, divided into three categories: permanent, semi-permanent, and non-permanent.

***Table 3:** Treatment Material*

Permanent	*Semi-Permanent*	*Non-Permanent*
The Wall The walls of the bed area, study table area, and portable sink area will be coated with cardboard so that the virus does not stick to the wall.	**The bed** The top of the bed is given a coating in the form of waterproof cotton cloth and given signage "don't touch".	**Bedding cover** Bed linen uses waterproof cotton material patterned with green plants
The door (Handle) Treatment material for door handles that handle will be coated with cotton waterproof	**Table** On the study table coated in cream-colored waterproof cotton cloth	**Partition** use curtains and paper rolls. Curtains use waterproof cotton material patterned *vines,* and for curtain railings, use paper roll material
Switches and sockets It can be covered with materials made of acrylic/silicone 	**The chair** The chair is lined with waterproof cotton cloth with cream color 	**The trash bin** For the trash bin using stainless steel material  **Hand sanitizer and tissue Dispenser** 

3.5 Wall Treatment

Wall treatment applied to the design of the isolation patient room is coated with cardboard. Presenting natural elements in interior design is an attempt to create indirect interactions between humans and nature, including looks and texture (Hatmojo Danurdoro et al., 2013; Keniger et al., 2013). The cardboard selected is a dynamic and organic patterned cardboard. The wall that will be covered with cardboard is a wall in a high-traffic area, such as in the bed area, study table area, and portable sink area. Figure 6 shows the pattern of the cardboard module to be applied to the walls in the isolation room.

Figure 6: *Cardboard Modular Pola Phenomenon by Annie Georgeson*

3.6 Room Divider Treatment

For isolation room design, there needs to be a barrier or partition to prevent the spread of viruses/ diseases. In accordance with the standardization that has been explained in Table 1 that the isolation room space among beds can be limited with curtains or partitions. Treatment of space dividers using curtains urgently needs to pay attention to several aspects, including shape, material, and structure.

The shape of the curtain applied to this design is inspired by the work of Shigeru Ban. Shigeru Ban made this room divider for flood victim shelters in Japan to offer privacy for flood victims. The partition measures 2m x 2m, as shown in Figure 7.

Figure 7: *Temporary Shelter System by Shigeru Ban*
Source: ArchDaily

The material used to make curtains/ room dividers for isolation rooms is using paper rolls with a diameter of 13 cm for curtain supports and paper rolls with a diameter of 8 cm for curtain railings (Figure 8). As for the curtain material, waterproof cotton with a vine pattern is used. The bottom of the curtain support/ partition is coated with PVC pipe as a plinth to prevent the paper roll from getting wet when the floor is mopped.

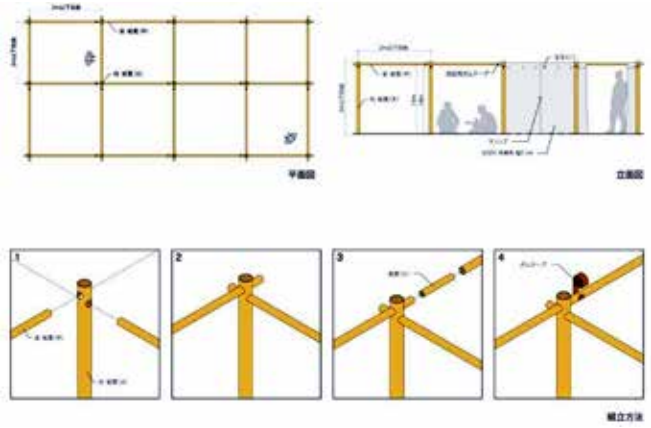

Figure 8: *Partition structure*

3.7 Color Treatment

For color treatment applied to the isolation room design uses earth-tone colors from the characteristics of soil, rocks, and plants (Figure 9). The room is dominated by green color. Green color can help to speed healing (Goenka, 2018; Swasty, 2017). From the philosophical side, green is widely described as fortitude in undergoing suffering, strong desire, and a picture of the hardness of the heart. Naturally, this color becomes a symbol of fertility and harmony of life. In terms of color psychology, this color describes a person who symbolizes the existence of a strong desire, fortitude in dealing with life problems, having a hard personality, and a symbol of power.

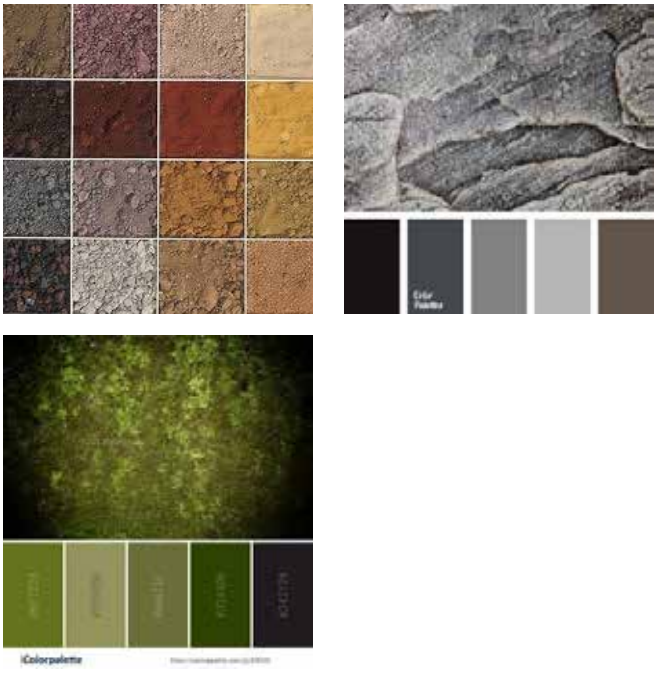

Figure 9: *Colour Concept (soil, rocks, and plants color palette)*
Source: abudhabblog and iColorpalette

3.8 Furniture Treatment

Furniture applied to the room should be easy to get and quickly processed because the design for this isolation room is an emergency. Table 4 lists the furniture treatment to apply in the isolation room.

Table 4: *Furniture treatment*

Furniture	Image
Bed The fabric used to cover the top mattress is a waterproof cotton *vines* pattern and is marked "*Don't touch it*".	
Desk table The table is covered with waterproof cream cotton **Wardrobe** The Handle is covered with waterproof cotton	
Room divider The room divider uses curtains and railings to make it easier for users when opening or closing curtains.	 
Hand basin use a portable hand basin with step-on	
Trash bins Useful to accommodate garbage from patients, such as used masks, toilet paper, and others. The type of trash bin used is a trampling trash bin with a cover. This room needs three trash bins. Two bins, each placed next to the bed and the rest placed next to the sink.	

3.9 Decoration Treatment

Table 5 describes the décor treatment used in the isolation room.

Table 5: *Decoration treatment*

Decoration	Image
• vegetation elements Providing vegetation elements in the room is a strategy to bring natural experiences directly to the built environment. The requirements for selecting indoor plants refer to Yuniati et al. (2018) as follows: 1. Indoor plants that can grow in a room with a low light intensity of 25-75 fc (foot-candles). 2. Indoor plants must be free from allergens, spores, pollution, and able to live in spaces controlled by humans. 3. Easy to maintain, easy to find in Indonesia, and has an attractive appearance, Dutch betel (*Epipremnum Aureum*) is chosen because it has the most attractive appearance and can use water as a biophilic approach. This plant also can neutralize air and filter toxins (anti-pollutants) such as benzene, xylene, trichloroethylene, and formaldehyde. In this study also use vegetation pattern curtain to improve mood Yuniati et al. (2018). This curtain besides functioning as a room divider but also as a decorative element. for color treatment uses earth-tone colors from the characteristics of soil, rocks, and plants; Especially, green color can help to speed healing (Goenka, 2018; Swasty, 2017) Paintings can be put in the room, which can indirectly provide emotional and intellectual satisfaction and indirect experience with nature. Based on Kaplan's restoration theory, viewing pictures of nature can improve cognitive functioning, mood and working memory (Berman et al., 2012).The image can be realized by photos, paintings, and murals. Expressions of representations of natural elements must be repetitive, thematic, and abundant. The dynamic patterns also can be found on the pattern of card board. Painting or picture of mundane nature and, specially awesome nature can improve mood (Joye & Bolderdijk, 2015).	   

3.10 Lighting Treatment

Natural lighting

The building is located on Jalan Radio Palasari Road No.3, Citeureup, Dayeuhkolot, Bandung, West Java 40257. The entrance faces south. In the morning, sunlight will enter from the window/ opening located in the east direction; in the afternoon, the light will enter the window/ opening located in the west (see figure 10).

Figure 10: *Analysis of wind direction (top); analysis of sunlight (bottom)*

The existing dormitory building faces east (see Figure 11). Doors and windows face north and south. In each room, there are two windows and one entrance to the room unit measuring 140 x 70 cm with hung windows type (there is one fixed window and one hung top type window that can be opened).

Figure 11: *Analysis of existing building and opening*

The problem that arises is not much sunlight that can enter the room, as the window is in the front of the bathroom, so it does not fully reach the bed area, resulting in the room becoming dark and slightly damp. As a solution, the window should be opened during the day, so the sunlight enters and illuminates the room. In addition, materials that can reflect light can be used (e.g., application of glass walls, wall paint with bright colors, floor materials with bright colors, and smooth surfaces so that they can reflect light effectively in the room).

Artificial Lighting

The existing artificial lighting in dormitory rooms uses bulbs that are still inadequate. There are two alternative solutions that can be done: first, to add two armature lights with the same lux, so the total lights in the room are four light spots. Alternatively, which remains using two light spots, but the lamp is replaced with a higher lux so that the light created can be sufficient for the room.

3.11 Air Circulation Treatment

The openings in each room unit in the dormitory building are two windows. One window is inside the bathroom and another window is close to the bathroom door. The window measures 140 x 70cm. Table 6 describes the treatment of air conditioning in the isolation room.

Table 6*: Air circulation treatment*

Air Circulation/ Conditioning	Description
Natural	Leave the window open during the day
Artificial	1. HEPA Air Purifier Put the High-Efficiency Particulate Air (HEPA) air purifier in the room. Several studies have shown that air purifiers can prevent exposure to COVID-19 indoors (Lindsley et al., 2021; Tobisch et al., 2021; Zhao et al., 2020). It was found that the ability of air purifiers with HEPA filters can reduce the risk of exposure to COVID-19 in a closed room reach 65% without wearing a face mask. Even this effectiveness can increase up to 90% when combined with the use of masks. (Lindsley et al., 2021). 2. Reed Diffuser Provide aroma treatment with a reed diffuser so that the room becomes fragrant and fresh. In addition, reed diffusers are also relatively safer for breathing because there is no smoke or steam. Reed diffuser does not need electricity, batteries, or fire, so it is more environmentally friendly. Lavender scent is recommend to use because has been found to have relaxation and sedative effects, reducing anxiety levels in dental patients and promoting a sense of calmness (Amores et al., 2018).

3.12 Acoustic Treatment

To determine the acoustic treatment, existing acoustic and noise sources analysis are required. The source of noise is usually the noise of the factory surrounding the building, the sound of motorbikes passing the building, and the noise of people (mainly experienced by the residents whose rooms are next to the lobby). The acoustic treatment can be done by using Bluetooth speakers with natural sounds and can be arranged by the users (Alvarsson et al., 2010).

3.13 Entertainment Treatment

Entertainment treatments offered in this design are outlined in Table 7 below.

***Table 7**: Entertainment treatment*

entertainment	description
Internet	Provide internet facilities so that the patients do not feel bored
Book	Provide books in the room so that patients can do activities by reading books
Speaker	Provide a speaker in the patient's room to play the strains of nature sound music, especially water sound (Browning & Ryan, 2020).
Dynamic and organic forms	Apply the dynamic and organic shapes not only to serve as a pattern but also to be entertainment for patients.

3.14 Aroma Treatment

The aroma treatment can be done by providing the room with a reed diffuser so that the room becomes fragrant and fresh. The aroma of the reed diffuser for the patient's room is the scent of lavender. Lavender has long been thought to offer a wide range of therapeutic and curative effects. There is substantial evidence that lavender oil may be a useful therapy for a variety of neurological problems (Koulivand et al., 2013). The lavender essential oil has a long traditional history of calming effects, which has lately been backed up by clinical efficacy trials (Malcolm & Tallian, 2017).

3.15 Disinfection Treatment

Table 8 describes the treatment of disinfection in isolation rooms. The frequency shows the minimum period of disinfection.

***Table 8:** Disinfection treatment*

Interior Element	Furniture type	Furniture	Material	Frequency
Permanent	Existing Furniture	Toilet	Ceramic	2 days
	Emergency Furniture	Wall cover	Cardboard	-
		Switch cover	Plastic	2 days
		Electric outlet	Plastic	2 days
		Shower	Stainless steel	2 days
		Door handle	cotton	2 days
Semi-Permanent	Existing Furniture	Bed	Material: Hollow metal Finishing: glossy metal paint	2 days
		Wardrobe	PVC (Polyvinyl chloride) Interior Film	2 days
		Desk cover	cotton	-
		Chair cover	cotton	-
		Mineral water dispenser	Plastic	2 days
	Emergency Furniture	-	-	-
Non-permanent	Existing Furniture	Ember	Plastic	2 days
		Towel hanger	Metal	2 days
	Emergency Furniture	Portable hand basin	Stainless steel	2 days
		Plant pot	glass	2 days
		Speaker Bluetooth	Stainless steel	2 days
		Painting frame	Plastic	2 days
		Bed sheet	cotton	Change after the patient's discharge
		Room divider	Structure: Cardboard, PVC pipe curtain: cotton	2 days (PVC pipe)
		Hand sanitizer dispenser	Plastic	2 days
		Tissue Dispenser	Plastic	2 days
		Wall clock	Plastic	2 days
		Wardrobe knob cover	cotton	-

3.16 Space Blocking

Zoning and blocking in each isolation room can be categorized based on three types of patients (asymptomatic, mild symptoms, and moderate symptoms). Since each room is occupied by two patients, hence the use of wayfinding on the room path is needed to communicate to the Patient A occupants about Patient B the entry and exit points so that it does not cause confusion and social distancing can be applied properly in the built environment. Figure 12 illustrates the pathways between patients. Figure 13 shows the 3-dimensional visualization from many perspectives of the interior. The design is based on the biophilic approach, and the selection of material is based on the Systematic Review of related scholarly publications. The material/ finishes applied are not permanent; consider the isolation room is temporary and can be reconverted to a student dormitory room in the future.

***Figure 12:** Occupants' flow in the room*

Figure 13: *three-dimensional visualization*

4. CONCLUSION

Research on biophilic material approaches to support the shifting of student dormitories as COVID-19 isolation facilities aim to achieve the result of the application of materials and to finish in isolation rooms. Based on the systematic review, porous surfaces such as cotton fabrics and cardboard do not persist viruses for too long compared to nonporous surfaces such as stainless steel and plastic. In other words, the persistence of SARS-COV-2 on porous surfaces does not last long even if the surface is not cleaned (disinfected). According to previous research, this is possible because the porous surface makes SARS-COV-2 dry and causes the virus to inactivate or not be infectious.

The research is expected to be useful or have implications academically and practically. The academic implications are expected to add insight for academics and researchers in interior design and architecture, especially regarding the knowledge of furniture materials, including finishing and maintenance. The practical implications are expected to be used as a guide for manufacturing or producing materials and finishes that do not store viruses, as well as the inspiration for designing isolation rooms that can help the healing process.

The data collected in this study used secondary data through SLR. For further research, clinical testing can be conducted on some of the materials covered in this study (cotton, cardboard, vinyl, stainless steel, polymer paper, glass, plastic) to find whether the results are the same and can be generalized or not. In addition, this study created a visualization of interior design using a biophilic approach. Furthermore, the wall treatment in this study used modular cardboard with the existing design. It is interesting to be able to create a new modular design so that it can be registered the intellectual property rights.

In addition, further research will be interesting to understand patient behavior associated with the design of COVID-19 isolation rooms using such biophilic approaches. The patients tend to easily feel saturated when in the isolation room. Limited social interaction and activities that can be done in the isolation room can be the cause. The study of the activities of residents in the isolation room can help with more specific planning of space and furniture design in isolation rooms. By observing the touch point of COVID-19 patients on certain fittings and furniture, it can be known what material surfaces have the potential to store the virus and how the patient behavior is associated with furniture in COVID-19 isolation rooms. Future research will also be interesting to focus on analyzing occupant activities in the isolation room and determining touch points so that the application of the material becomes more appropriate and specific. This method is expected to be more suitable for planning an isolation room as a place of healing.

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Biophilic-Design Conversion

Table 9 Biophilic-Design Conversion

Biophilic Patterns (Browning, W. D., & Ryan, C. O. ,2020)					**Standardization (Kementrian Sosial RI, 2020)**	**Existing Telkom Dormitory Room**	**Literature Review**	**Implementation**
Application / Interaction	**Nature Design Relationship**	**Definition Nature Design Relationship**	**Biophilic Patterns**	**Definition Each Pattern**				
I. Nature in the Space Patterns	Direct experiences of nature within the built environment	Nature in the Space refers to the presence of natural elements within a specific environment. This includes plant life, water, animals, as well as the sensations of breezes, sounds, and scents.	1. Visual connection with nature	A view to an element of nature, living systems and natural processes.	Windows that can be opened for healthy air flow (60 liters/ seconds/ patient)	Have 2 windows	a view to a natural processes, in this case daily light cycle, can improve mood (Browning et. al, 2020)	Having 2 windows to look at surrounding.
			2.Non-Visual Connection with Nature	Auditory, haptic, olfactory or other stimuli that engender a deliberate and positive reference to nature, living systems and/or natural processes.	Windows that can be opened for healthy air flow (60 liters/ seconds/ patient)	Air flow from opening windows	Lavender scent has been found to have relaxation and sedative effects, reducing anxiety levels in dental patients and promoting a sense of calmness (Kritsidima et al., 2010; Mancini et al., 2021; Amores et al., 2018).	Providing air purifier facilities apart from natural ventilation, and the use of reed aroma therapy, especially lavender scent.
					-	Noise from industrial complex, vehichles, other neighbours.	Nature sound helps increasing mood, escpesially water sound (Browning et. al, 2020)	Provide a speaker in the patient's room to play the strains of nature sound music.
			3.Non-Rhythmic Sensory Stimuli	Stochastic and ephemeral connection with nature that may be analysed statistically but may not be predicted precisely.	-	-	-	-
			4. Thermal & Airflow Variability	Changes in air temperature, relative humidity, airflow and/ or surface temperatures that mimic natural environments.	Windows that can be opened for healthy air flow (60 liters/ seconds/ patient)	Air flow from opening windows	Dutch betel (Epipremnum Aureum) is chosen because it has the most attractive appearance and can use water as a biophilic approach (Yuniati et al. , 2018).	Using natural ventilation, adjusting air cleanliness with an air purifier and using decorative elements in the form of natural plants
			5.Presence of Water	Condition that enhances the experience of a place through seeing, hearing or touching water.	-	Noise from industrial complex, vehichles, other neighbours.	The existence concept of water increases concentration and memory recovery caused by complex visual stimuli and fluctuating naturally; and increased perception and psychological and physiological responsiveness when many senses are stimulated simultaneously (Alvarsson, 2010). Nature sound helps increasing mood, escpesially water sound (Browning et. al, 2020)	The water sound can be play on speakers in the patient's room as entertainment.
			6.Dynamic & Diffuse Light	varying intensities and colour of light and shadow that change over time to create conditions similar to those that occur in nature.	Windows that can be opened for healthy air flow (60 liters/ seconds/ patient)	Have 2 windows	a view to a natural processes, in this case daily light cycle, can improve mood (Browning et. al, 2020)	Natural light can be access by opening curtains and windows
					Have adequate lighting and power sources.	Exsisting lightings are inadequate.	-	First option, to add two armature lights with the same lux, so the total lights in the room are four light spots. Alternatively, which remains using two light spots, but the lamp is replaced with a higher lux so that the light created can be sufficient for the room.
			7.Connection with Natural Systems	Awareness of natural processes, especially seasonal and temporal changes characteristic of healthy ecosystems.	Windows that can be opened for healthy air flow (60 liters/ seconds/ patient)	Have 2 windows	a view to a natural processes, in this case daily light cycle, can improve mood (Browning et. al, 2020)	Having 2 windows to look at surrounding.

Biophilic Patterns (Browning, W. D., & Ryan, C. O. ,2020)					Standardization (Kementrian Sosial RI, 2020)	Existing Telkom Dormitory Room	Literature Review	Implementation
Application / Interaction	**Nature Design Relationship**	**Definition Nature Design Relationship**	**Biophilic Patterns**	**Definition Each Pattern**				
II. Natural Analogues Patterns	Indirect or representational experiences of nature in the built environment	Natural analogues refer to the incorporation of non-living elements in the built environment that evoke the essence of nature. These elements can include objects, materials, colors, shapes, sequences, and patterns that are inspired by nature and are manifested in various forms such as artwork, ornamentation, furniture, décor, and textiles. The goal is to create a connection with nature through these analogues, even though they may not be exact replicas of their natural counterparts. The most impactful natural analogue experiences are achieved by providing a wealth of information and sensory richness in an organized and sometimes evolving manner .	8.Biomorphic Forms & Patterns	Symbolic references to contoured, patterned, textured or numerical arrangements that persist in nature.	-	-	Wood patterns are consider as natural pattern in Biophilic.	Using wood grain patterns and textures on shelf.
					Space circulation minimum of 2 meters and using curtains between beds for privacy and disease-spreading avoidance	Have 4 bunk beds	Presenting natural elements in interior design is an attempt to create indirect interactions between humans and nature (Danurdoro, 2013; Keniger dkk., 2013), including vegetation pattern curtains (Yuniati et al., 2018). For color treatment uses earth-tone colors from the characteristics of soil, rocks, and plants; Especially, green color can help to speed healing (Goenka, 2018; Swasty, 2017)	Using vegetation patterns curtain, Dutch Betel and dominated by green color, to match real plant on this study, for curtain bed divider.
					-	-	Based on Kaplan's restoration theory, viewing pictures of nature can improve cognitive functioning, mood and working memory (Berman et al. 2008). Painting or picture of mundane nature and, specially awesome nature can improve mood (Joye & Bolderdijk, 2015).	Paintings can be put in the room, which can indirectly provide emotional and intellectual satisfaction and indirect experience with nature. The image, escpesially awesome nature, can be realized by photos, paintings, and murals. Expressions of representations of natural elements must be repetitive, thematic, and abundant. The dynamic patterns also can be found on the pattern of card board.
					-	-	Mimicry of nature shape such as leaves, shells, can be consider as biophilic patterns and increasing mood (Browning & Ryan, ,2020).	The dynamic patterns can be found on the card board.
			9.Material Connection with Nature	Materials and elements from nature that, through minimal processing, reflect the local ecology or geology and create a distinct sense of place.	Windows that can be opened for healthy air flow (60 liters/ seconds/ patient)	Have 4 bunk beds	Presenting natural elements in interior design is an attempt to create indirect interactions between humans and nature (Danurdoro, 2013; Keniger dkk., 2013), including vegetation pattern curtains (Yuniati et al., 2018). For color treatment uses earth-tone colors from the characteristics of soil, rocks, and plants; Especially, green color can help to speed healing (Goenka, 2018; Swasty, 2017)	Using vegetation patterns curtain, Dutch Betel and dominated by green color, to match real plant on this study, for curtain bed divider.
			10.Complexity & Order	Rich sensory information that adheres to spatial hierarchies similar to those encountered in nature.	-	-	-	-

Biophilic Patterns (Browning, W. D., & Ryan, C. O. ,2020)					Standardization (Kementrian Sosial RI, 2020)	Existing Telkom Dormitory Room	Literature Review	Implementation
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III. Nature of the Space Patterns	Four–dimensional characteristics of common spatial experiences in nature	Nature of the Space refers to the arrangement and design of physical spaces that evoke a sense of connection to the natural world.	11.Prospect	An unimpeded view over a distance for surveillance and decision making.	Windows that can be opened for healthy air flow (60 liters/ seconds/ patient)	Have 2 windows	a view to a natural processes, in this case daily light cycle, can improve mood (Browning et. al, 2020)	Having 2 windows to look at surrounding.
			12.Refuge	A place for withdrawal, from environmental conditions or the main flow of activity, in which the individual is protected from	-	-	-	-
			13.Mystery	The promise of more information, achieved through partially obscured views or other sensory devices that entice the individual to venture deeper into the physical environment.	Windows that can be opened for healthy air flow (60 liters/ seconds/ patient)	Have 2 windows	a view to a natural processes, in this case daily light cycle, can improve mood (Browning et. al, 2020)	Having 2 windows to look at surrounding.
			14.Risk/Peril	An identifiable threat coupled with a reliable safeguard.	-	-	-	-
			15. Awe	Stimuli including other biophilic patterns that defy an existing frame of reference and lead to a change in perception.	-	-	Obtained from a combination other biophilic attributes (Browning et all, 2020)	Awe biophilic pattern can be achieved by applying others biophilic patterns that mentioned before: 1. Visual connection with nature,2. Non-Visual Connection with Nature, 3.Non-Rhythmic Sensory Stimuli, 4. Thermal & Airflow Variability,5. Presence of Water 6.Dynamic & Diffuse Light, 7.Connection with Natural Systems, 8.Biomorphic Forms & Patterns, 9.Material Connection with Nature, 11.Prospect, 13.Mystery, 15. Awe