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Optimizing Open Green Space on Urban Campuses Through the Case of UI Salemba Campus: A Step Towards Improved Green Metric Ranking

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ABSTRACT

Universities are trying to make their campuses sustainable. One of the tools used to evaluate the level of campus sustainability is UI Green Metric World University Rank (UIGMWUR), which focuses on sustainable efforts implemented by universities. It has become clear, however, that it is difficult for urban campuses to obtain a good ranking under the UIGMWUR framework due to the limited amount of open green space in dense city areas. Therefore, one possible strategy involves optimizing the existing open green space. This research was conducted to determine some possible solutions through the use of observation and a Likert scale questionnaire. The initial result showed that the building coverage area exceeds the government standard, and that most of the people on campus have a negative perception of the open green space that currently exists. The community prefers green space that offers privacy, with big canopy trees and natural elements. The study combined these preferences with a biophilic design pattern to generate a design proposal. It was concluded that there is a need to optimize the open green space in urban campuses based on four strategies: building vertical gardens, renovating the existing open green spaces, optimizing the buildings, and constructing vertical parking facilities.

Keywords: sustainable urban campus, open green space, biophilic design, green metric

INTRODUCTION

Cities are growing rapidly due to several factors such as increasing urbanization and improvements in transportation infrastructure (Forero et al., 2021) driven by population growth that increases the density cities and lowers their carrying capacity (Borck & Schrauth, 2021; Jiang et al., 2021). This means there is an increasing need to build sustainable cities (Giusti et al., 2020; Thomson & Newman, 2021) as indicated in goal number 11 of the United Nation in Sustainable Development Goals (SDGs), known as Sustainable Cities and Communities.

Most large cities are home to one or more universities, and these urban campuses are integral and important elements of each city. A campus is defined as a place where the higher education process takes place, and this means it is home to a lot of activities and involves several stakeholders (Andreucci et al., 2021; Anis et al., 2018; Ferreira et al., 2021; Novosadová & Knaap, 2021) As a higher education institution, a university is required to play an important role in achieving a sustainable environment, especially its own environment (Anis et al., 2018). Of course, these days, many universities are building new campuses in peri-urban areas with enormous tracts of land due to land crises in the cities. The construction of the new campuses in peri-urban areas increases the possibilities for ensuring sustainability. This is quite different from campuses in urban areas where there are a lot of activities and people, despite the fact that some of their main activities may have already been moved to the new campuses in these peri-urban areas. Unfortunately, however, at urban campuses, universities usually build new infrastructure or facilities in empty spaces between existing buildings, leading to ever-increasing building density, which leads to negative impacts as open green space is diminished, thereby separating the people who use the campus from nature's elements (Mallen et al., 2020).

Nature is not the only factor of sustainability on campus, but it is a very important one. Several studies have proven the need for people to interact intensely with nature to obtain an acceptable quality life, especially those living in urban areas with a lot of built environments (Parris, 2016; Russo & Cirella, 2018). Studies have also found that people who are separated from nature are usually less productive, experience greater fatigue, depression, and stress, and have other negative effects (Kayıhan, 2018; Sen & Guchhait, 2021). This is why an urban campus needs to have enough natural elements to help ensure the well being of the students, lecturers, employees, and other stakeholders that spend most of their time on the premises.

Several tools have been developed to evaluate campus sustainability. One such tool is the Universitas Indonesia Green Metric Ranking (UIGMWUR), launched in 2010 by Universitas Indonesia to promote sustainable campus programs and encourage universities to implement efforts aimed at enhancing campus sustainability. This program ranks the sustainable achievement of each participant from all around the world, and one of its aims is to contribute to the greening of the campus as a step to achieve sustainability (Guideline UI Green Metric World University Ranking, 2022). However, one obvious issue is that an urban campus usually has limited area that is available for conversion into open green space. Therefore, the objective of this research is to determine some alternatives for solving this problem.

The study aims to answer three research questions:

1) Can an urban campus build more open green space?

2) Can the existing open green space be optimized to provide a more positive impact on the campus?

3) Can the optimization of green areas lead to a better ranking under the UIGMWUR framework?

Answering these important questions is central to this reasearh, and the discussion includes some design alternatives for optimization.

The Salemba campus of the Universitas Indonesia (UI) in Jakarta was used for this case study. While new campus areas have been established in Depok, West Java which is one of the peri-urban in Jakarta, the Salemba campus is the historical birthplace of the university. It is important to note that the Depok campus was established and built in accordance with a good master plan that incorporates sustainability,

unlike the older Salemba campus, which is still being used for several activities, and is continues to be occupied by a large number of people.

Figure 1 shows that the campus is located on a busy road, Jl. Salemba Raya, and is located near a national hospital and surrounded by a lot of business activities such as office buildings and an electronic market, making it a dense and highly polluted area -- a condition that is getting worse due to the construction of new on-campus facilities.

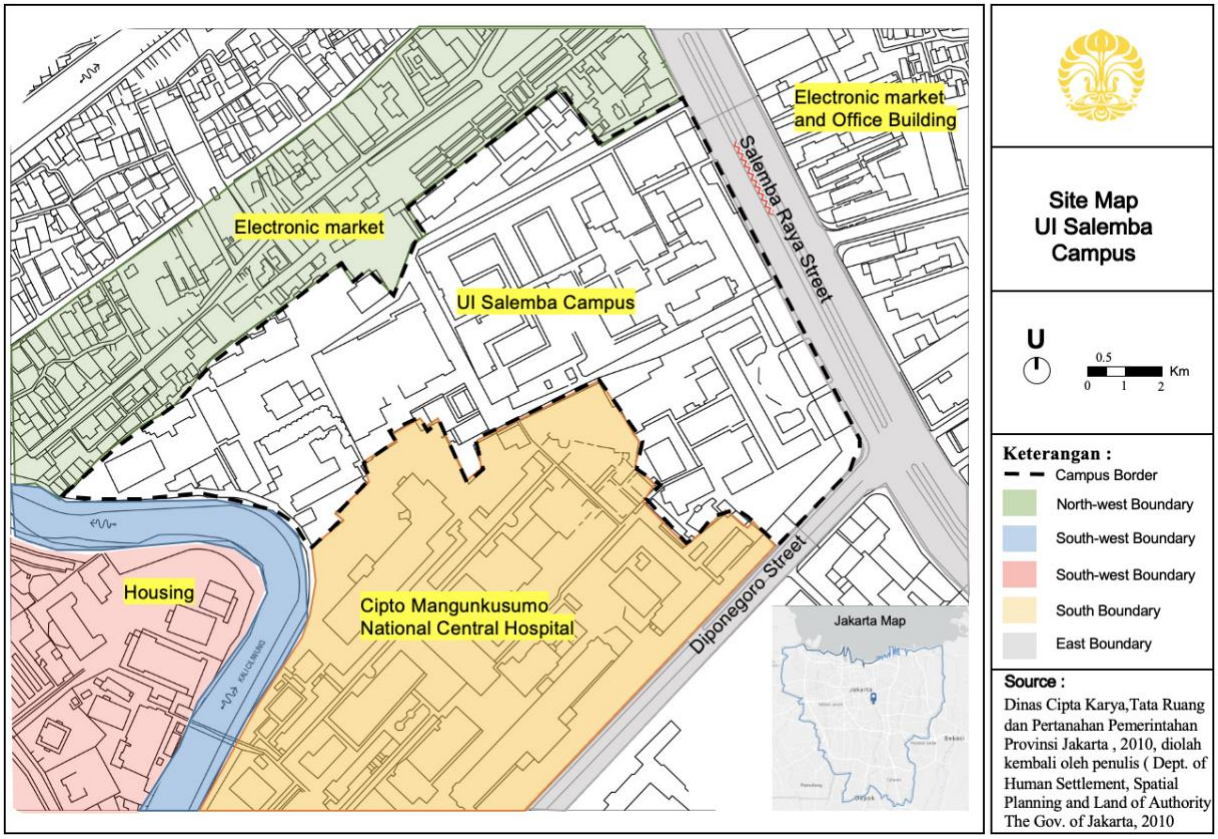
There is no single “ideal” solution to developing open green space on urban campuses. The only option is to undertake a suitable and applicable effort to optimize the existing open green spaces and to increase the volume of open green space, creating an interaction between the campus community and nature, and achieving a better ranking under the UIGMWUR framework.

Fortunately, UI Salemba has some areas of open green space which can be optimized. They are the focus of this research.

There are several green design approaches which include green building and biophilic design methods. It is important to note that green building is popular among building designers and architects because the indicators are clear and standards are based on the regulation of the Green Building Council worldwide, with the focus being to achieve net zero energy in accord with the Paris Agreement. The indicators of Green Building are highly focused on energy usage, without due consideration for people’s physical and mental health aspects such as comfort and happiness (Anis et al., 2019; Fachrudin, 2020). Meanwhile, the COVID-19 pandemic has reminded the world that health and well-being are

Figure 1

Location of UI Salemba Campus



Note. The total area of this site is 9.35 Hectares. Adapted from *Dinas cipta karya, tata ruang dan pertanahan pemerintahan provinsi Jakarta* [Department of Human Settlement, Spatial Planning and Land of Authority, The Government of Jakarta] , by The Government of Jakarta, 2010. Copyright 2010 by The Government of Jakarta.

very important, and that buildings or built environments should not only focus on being green, but also being healthy. Biophilic design is an approach formulated based on biophilia theory, with its focus on attempting to reconnect people to nature by improving their interaction with it (Arof et al., 2020; Makram & Ouf, 2019). In this approach, energy saving is achieved along with ehancement of people's mental health (Feng et al., 2021; Liprini & Coetzee, 2017). This method has become more popular among architects and building designers since the publication of 14 biophilic design patterns (Browning et al., 2014). Architecture should support and strengthen the connection between nature and people (Kayıhan, 2018); therefore, biophilic design, which focuses on connecting nature with people, is utilized in this research due to its positive impacts.

Most previous studies on sustainable urban campuses have discussed the comprehensive achievement of SDGs (Longoria et al., 2021), green campus (Atici et al., 2019), the importance of building open green spaces (Olugu et al., 2019), and the role of open green space in reducing surrounding air temperature (Feng et al., 2021). Another study observed to be closely related to the focus of this research discusses the role of campus parks in optimizing students' concentration and reducing mental fatigue (Liprini & Coetzee, 2017). Some others have emphasized the improvement of open green space to ensure sustainability through the application of a biophilic design approach. This is important because a sustainable open green space is one of the factors in achieving a sustainable campus (Hady, 2021).

METHODOLOGY

This research used a quantitative-qualitative method. The quantitative aspect involved the development of a questionnaire to determine the perceptions and preferences of the campus' society toward open green space on the campus. The data obtained were analyzed using descriptive analyses. Meanwhile, a qualitative aspect was used to retrieve clearer data from respondents and information from Direktorat Operasi dan Pemeliharaan Fasilitas UI (Directorate of Operation and Maintenance Facility UI), all of which was subsequently analyzed along with the questionnaire results.

The output of this research is expected to be used in designing a guideline based on a biophilic design approach for proposing designs of open green spaces on campuses. It is also important to note that the economic aspects were also analyzed by calculating the renovation costs.

Table 1

The Population at UI Salemba Campus (Average Between 2015-2019)

No	Population	Total	
1	Students	9,261	people
2	Lecturers	4,266	people
3	Employees	3,167	people
	Total	**16,694**	**people**

Note. Adapted from *Pangkalan Data Pendidikan Tinggi Kementerian Pendidikan dan Kebudayaan* [Higher Education Data Center], by The Ministry of Culture and Education Republic of Indonesia, 2022, https://pddikti.kemdikbud.go.id. Copyright 2022 by The Ministry of Culture and Education Republic of Indonesia; Direktorat SDM UI [UI Human Resources Department], by Human Resources Department, 2022. Copyright 2022 by Human Resources Department, University of Indonesia.

Population and Sample

Population

The required sample for this research was determined to be 70 respondents, using Isaac and Michael's formula with a 10**%** error rate **(**Sugiyono, 2016**)**, as follows**.**

$$S = \frac{\lambda^2.N.P.Q}{d^2(N-1)+\lambda^2.P.Q} \quad (1)$$

Where, S= Sample

l^2 = chi-square

d= error rate

P = Q probability

N = Population

Where the degree of freedom is 1, d is 10%, the chi-square value is 2.706, P and Q are 0.5, and N is 16,694. The calculation is as follows:

$$S = \frac{2.706\ x\ 16694\ x\ 0.5\ x\ 0.5}{0.1^2(16694-1)+2.706\ x\ 0.5\ x\ 0.5} \quad (2)$$

S = 67.4 (approximately 70 respondents)

The sampling technique used is stratified random sampling because the population consists of different strata: students, lecturers, and employees. The samples are not classified by faculty, but they are classified by clusters because a building may comprise a number of faculties.

There are four clusters based on the attachment to the open green space. Each cluster consists of one or several faculties.

a. Cluster A: Medical Faculty

b. Cluster B: School of Environmental Study, Rectorate Building

c. Cluster C: School of Environmental Study, School of Global Strategic Study, Faculty of Law, Faculty of Engineering/ Engineering institute

d. Cluster D: Faculty of Economy and Business, Medical Faculty

Figure 2

Sampling Cluster

Note. Clusters are divided based on the distance to the open green space. Adapted from *Direktorat Operasi dan Pemeliharaan Fasilitas UI* [Directorate of Operation and Maintenance Facility UI], by University of Indonesia, 2006. Copyright 2006 by University of Indonesia.

Research Variables

This research used three variables: (1) the physical condition of open green space, (2) perceptions of campus' society about open green space in UI Salemba campus, and (3) preferences of campus' society toward open green space in UI Salemba campus.

Perception and preference can affect the design (Russo & Cirella, 2018), so both are considered to be variables of this research. The indicators derive from the pattern of biophilic design, the approach that will be used in the research.

The physical condition of the open green space was determined by using the biophilic design patterns as indicators. Meanwhile, the data about perceptions and preferences were collected through an online questionnaire distributed to all faculties, with answers provided using Likert score 1-4 in which Scale 1 = strongly disagrees (SD), Scale 2 = disagrees (D), scale 3 = agrees (A), and scale 4 = strongly agrees (SA). The stakeholders in the campus society such as the students, lecturers, and employees comprised the respondents. Moreover, most campus activities at the time of data collection were being conducted online due to the Covid 19 pandemic; for this reason, all respondents were required to have participated in offline campus activities for at least one year at some point prior to the survey. The questionnaire was distributed through the administrative officer of each faculty to avoid redundancy.

The qualitative aspect was conducted through observation that was focused on the activities and physical condition of the existing open green space, and the initial results of the questionnaire were analyzed descriptively to determine the people's preferences and also to formulate design guidelines to serve as a reference for the proposed renovation of the open green space using biophilic design.

The site map presented in Figure 3 shows the density of the campus area. Only the six open green spaces observed to be dominant were used in this research.

Table 2

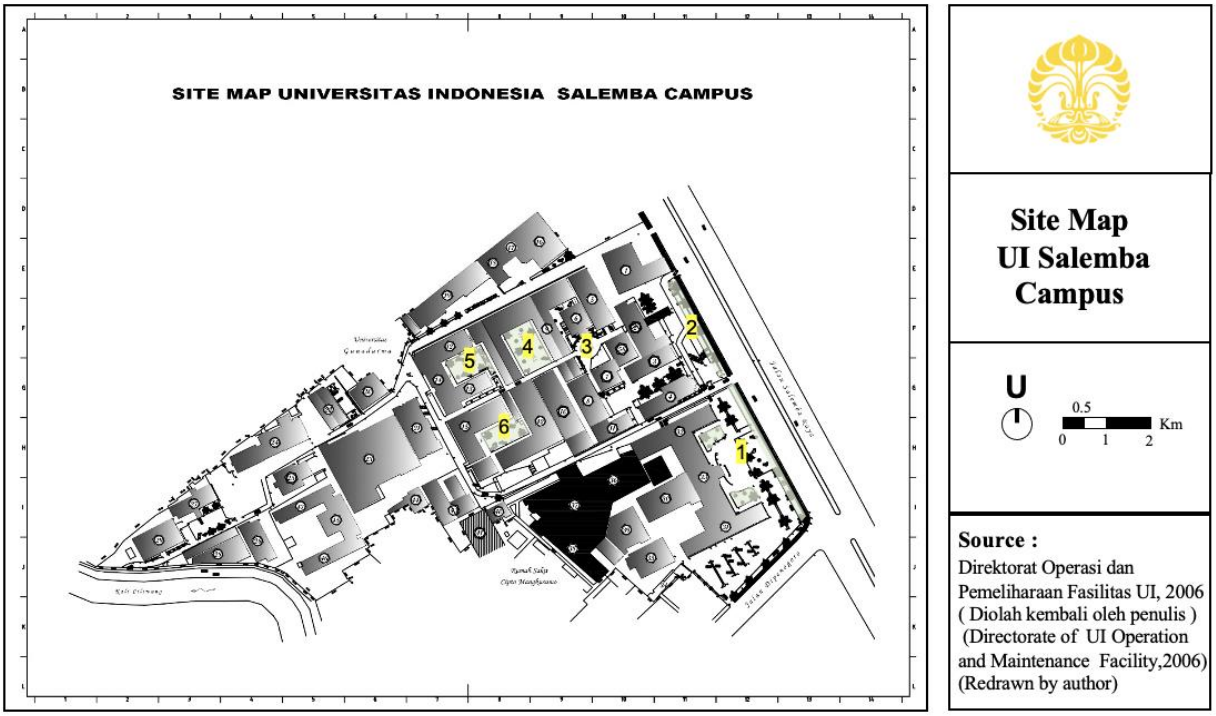
Variables and Indicators

Variable	Indicator
PERCEPTION	Social interaction facilities
	Satisfaction
	Cognitive ability
	Well-being
	Exterior quality
PREFERENCE	Private space
	Nature elements
	Natural material
	Pedestrian element

Note. This table demonstrates variables and indicators.

Figure 3

Site Map of UI Salemba Campus



Note. The map shows the building layout and the open green space of UI Salemba Campus. The open green spaces are numbered from one to six. Adapted from *Direktorat operasi dan pemeliharaan fasilitas UI* [Directorate of Operation and Maintenance Facility UI] , by University of Indonesia, 2006. Copyright 2006 by University of Indonesia.

Internal research about the site plan was carried out in 2010, and shows that the Building Coverage Ratio (BCR) of this site is 55% ,while the rule from the Urban Planning Department of The Government of Jakarta states that the maximum allowed BCR is 45% (UI Campus Environment Planning Team, 2010).

UI GREEN METRIC WORLD UNIVERSITY RANKINGS

Universitas Indonesia (UI) launched a program named UI Green Metric University Rankings in 2010 to measure the sustainable effort of universities around the world. The number of users had increased to 956 universities from 80 countries by 2021 (Guideline UI Green Metric World University Ranking, 2022). This program uses six criteria for scoring: setting and infrastructure, energy and climate change, waste, water, transportation, education and research. The focus of this research is only on the Setting and Infrastructure criterion, which is very difficult to meet in an urban campus with a limited area. The criterion also has some sub-criteria that require optimization of the existing open green space.

Improving this criterion can also bring a multiplier impact to other aspects such as energy, climate change, and water. Improving the ratio of open space, the area of planted vegetation, and the water absorption area will reduce the micro temperature, increase the area of permeable surface, and restore water absorption.

Table 3

Sub Criteria of Setting and Infrastructure

	Sub Criteria of Setting and Infrastructure
1	The ratio of open space area to the total area
2	The total area of the campus which is covered in forest vegetation
3	The total area of campus covered in planted vegetation
4	The total area of campus for water absorption besides the forest and planted vegetation
5	The total open space area divided by the total campus population
6	Percentage of university budget allocated for sustainability efforts
7	Percentage of building operation and maintenance activities during the Covid-19 pandemic
8	Campus facilities for the disabled, for special needs, and for maternity care
9	Security and safety facilities
10	Health infrastructure facilities to ensure the well-being of students, academics, and administrative staff
11	Conservation: plant, animal, and wildlife, genetic resources for food and agriculture secured in either medium or long-term conservation facilities

Note. This table summarizes the sub-criteria for the setting and infrastructure criteria. Adapted from *Guideline for UI Green Metric World University Rankings 2022: Collective Actions for Transforming Sustainable Universities in the Post-Pandemic Time,* by University of Indonesia, 2022 (https://greenmetric.ui.ac.id/publications/guidelines/2022/english). Copyright 2022 by University of Indonesia.

BIOPHILIC DESIGN

Biophilia theory states that a human being has an inner need to feel comfortable when connecting with nature or nature-like elements (Wilson, 1984). The theory has been developed and applied effectively to design processes through the concept of Biophilic Design (Browning et al., 2014). According to Browning, fourteen patterns of natural elements can be applied to the design process to ensure intensive interaction between people and nature to improve their quality of life. Moreover, the bonding between people and nature is based on a basic condition in which people tend to love the connection with life and its processes, which are important factors for physical and mental growth (Kellert et al., 2008).

Biophilia theory explains why people's minds are usually calm when they see waves splashing at the seashore, hear water flowing, smell flower scents, or feel a soft breeze (Browning et al., 2014). This understanding has been developed and applied in several sectors such as urban planning and architecture (Cabanek et al., 2020; Ghaziani et al., 2021; Justice, 2021; Koat & Zari, 2019; Novosadová & Knaap, 2021). The theory gives rise to the notion that people need to interact with the elements of nature to keep healthy, happy, and productive as well as to have a better interpretation of life (Jiang et al., 2020; Parris, 2016; Russo & Cirella, 2018). The fourteen biophilic design patterns formulated by Browning, Ryan, and Clancy can be grouped into the following three categories:

1) Nature in the space: addresses the direct, physical and ephemeral presence of nature in a space or place; the presence of natural elements such as plants, animals, water, breezes, and warm sunshine is important in this group.

2) Natural analogues: addresses organic, non-living and indirect evocations of nature; the presence of nature is symbolized by the analog patterns that can stimulate people's five senses.

3) Nature of the space: deliberate and engaging spatial configurations commingled with patterns of Natural Patterns in the Space and Natural Analog Patterns .

It is unnecessary to put all of the patterns into the design during the formulation process because each situation and condition requires a specific pattern. Moreover, there is a need to consider the quantity and frequency of each pattern carefully because some people have biophobia, which involves fear of nature elements (Patuano, 2020). These people do not always feel comfortable and secure when they are too close to a big volume of these elements because, in their opinion, nature has a lot of threats such as insect bites or dangerous animals (Patuano, 2020).

INITIAL RESULT

The initial results of the observations made and responses to questionnaires were analyzed to compose a set of guidelines for the proposed design.

Physical Condition

This research analyzes the existing condition with respect to the Setting and Infrastructure criterion of UIGMWUR.

The physical condition of the six parks analyzed in this research can be seen in the pictures that comprise Figure 4.

The parks looked empty, with few activities taking place during the observation periods. Most of the facilities, including benches, planter boxess, water fountains, and pedestrian walkways as well as plants, are not in good condition. Parks 1 and 2 were observed to be well maintained, but there is little sign of interaction between people and nature at these locations. Pedestrians simply passed by, and only a few had a conversation in the corridor. A similar trend of people passing was observed at Park 3. Park 4, located in front of the Faculty of Economy and Business, is quite well maintained, strategically located next to the main pedestrian, and equipped with a lot of benches. At the time of the observation, several people were sitting individually and in groups at the park interacting and engaging in some work. Park 5 is not located on the main pedestrian access; only a few people were observed passing by the corridor, and nobody was inside the park. It seems the users of Park 5 are people from the surrounding buildings. Park 6 is a restricted area located behind the Parasitology Building and is quite well maintained, but there are no facilities such as benches or water features. It was observed to be used only by the people from the building complex.

The elements that comply with the biophilic design pattern in all the parks were also assessed and the findings are indicated in Table 5, with those already applied marked with (v), while those that have not been applied are marked with (x).

Table 4

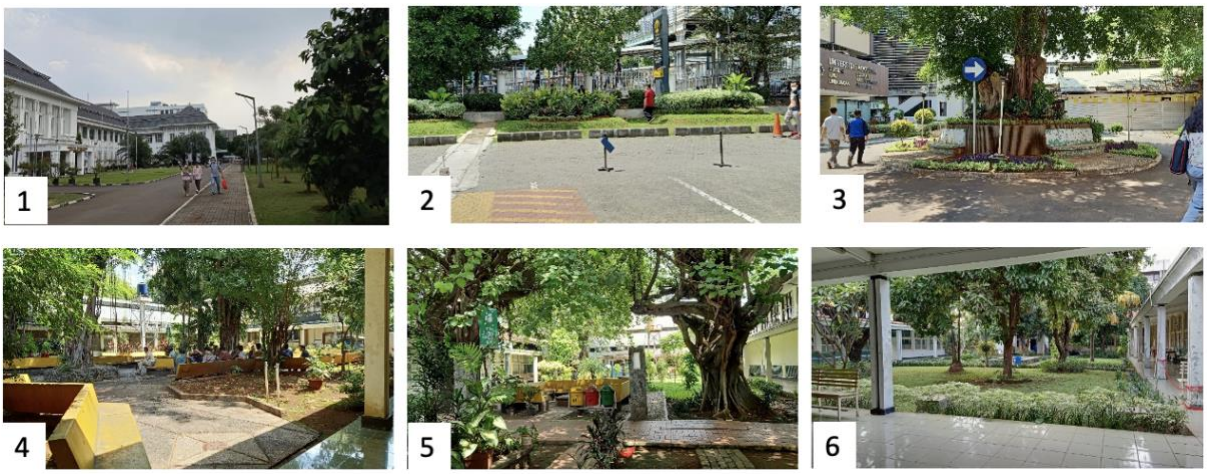
Existing Condition With Respect to the Setting and Infrastructure Criterion

	Sub Criteria of Setting and Infrastructure	
	Criteria	Existing Condition
1	The ratio of open space area to the total area	Open space: total space = 45%
2	Total area on campus which is covered in forest vegetation	Not available
3	Total area on campus covered in planted vegetation	5310.5 sqm
4	Total area on campus for water absorption besides the forest and planted vegetation	Not available
5	The total open space area divided by the total campus population	0.32 sqm/person
6	Percentage of university budget for sustainability efforts	Data not available
7	Percentage of operation and maintenance activities of the building during the Covid-19 pandemic	Data not available
8	Campus facilities for the disabled, those with special needs, and/or maternity care	Only at some buildings: elevator and ramp
9	Security and safety facilities	Available in some buildings (boom gate, security post, CCTV, access door)
10	Health infrastructure facilities for the well-being of students, academics, and administrative staff	Health clinic (Makara Satelite Clinic)
11	Conservation: plant, animals, and wildlife; genetic resources for food and agriculture secured in either medium or long-term conservation facilities	Not available

Note. The area is measured through the site CAD drawing. Adapted from *Direktorat operasi dan pemeliharaan fasilitas UI* [Directorate of Operation and Maintenance Facility UI] , by University of Indonesia, 2006. Copyright 2006 by University of Indonesia.

Figure 4

Existing Conditions of Open Green Space



Note. The open green space from number 1 (Park 1) is in front of the Medical Faculty; Park 2 is in front of the Rectorate building; Park 3 is at the junction of the main pedestrian walkways; Park 4 is in front of the Business and Economy Faculty; Park 5 is in front of the Magister Program of Business and Economy Faculty; Park 6 is inside the Parasitology building complex.

Table 5

Applied Biophilic Pattern

Nature in the space	**Park 1**	**Park 2**	**Park 3**	**Park 4**	**Park 5**	**Park 6**
Visual connection with nature	v	v	v	v	v	v
Non-visual connection with nature	v	v	v	v	v	v
Non-rhythmic sensory stimuli	v	v	v	v	v	v
Thermal and airflow reliability	v	v	v	v	v	v
Presence of water	x	x	x	x	x	x
Dynamic and diffuse light	v	v	v	v	v	v
Connection with natural systems	x	x	x	x	x	x
Natural analogues						
Biomorphic forms and patterns	x	x	x	x	x	x
Material connection with nature	x	x	x	x	x	x
Complexity and order	x	x	x	x	x	x
Nature of the space						
Prospect	x	x	x	x	x	x
Refugee	x	v	x	x	x	x
Mystery	x	x	x	x	x	x
Risk/peril	x	x	x	x	x	x

Note. The Application of Biophilic Design Pattern in Park 1– Park 6. Adapted from *14 Patterns of Biophilic Design: Improving Health & Well-Being in the Built Environment*, by W. Browning, C. Ryan, & J. Clancy, 2014, Terrapin Bright Green (https://doi.org/10.1016/j.yebeh.2008.04.024). Copyright 2022 by Browning, William, Catherine Ryan, & Joseph Clancy.

Profile of Respondents

A total of 75 responses were received, but questionnaires from 5 respondents were removed due to being incomplete, thereby leaving 70 for subsequent analysis. It was discovered that 53% were women, while 47% were men; 34% were employees; 13% were lecturers, and 53% were students. All the respondents came from the buildings around the parks and from a variety of faculties.

Ideally, the number of respondents from each faculty should be distributed proportionately, but the limited access to respondents during the pandemic situation made it impractical to achieve these ideal proportions. The respondents have been grouped by different periods of activities, as indicated in Figure 5.

The period of activities was classified into five groups that range from one year to more than five years. It was discovered that most of the respondents had been engaged in the studied activities for four to five years or more, and that they are predominately employees and lecturers. Meanwhile, the students were categorized in the one-, two-, and three-year groups because postgraduate students are required to complete their studies in two to three years.

Table 6

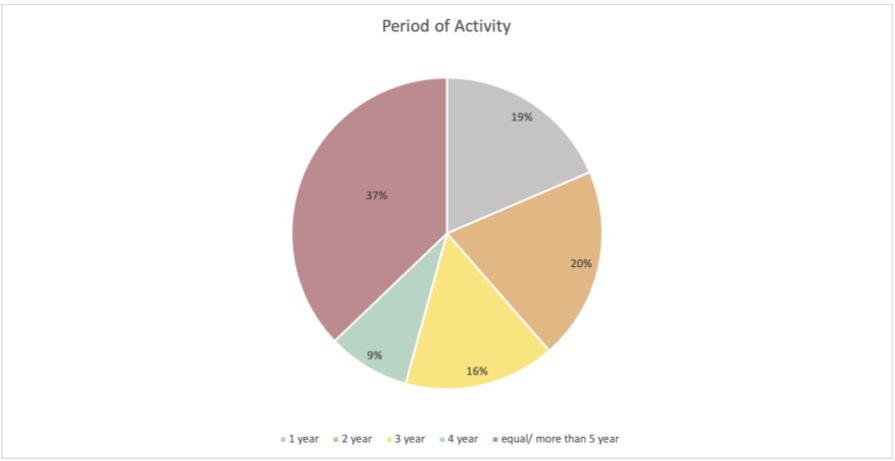
Affiliation of Respondents

Faculty and Affiliation	Respondents
School of Environmental Studies	26
School of Global Strategic Studies	4
Faculty of Dentistry	3
Faculty of Engineering/ Engineering Institute	14
Applied Psychology Institute	1
Medical Faculty	7
Faculty of Business and Economics	9
Faculty of Law	3
Rectorate	3
Total	70

Note. The table shows the number of respondents from each faculty. The questionnaire was sent to an administration officer from each faculty and then distributed to the faculty members.

Figure 5

Period of Activity



The Results of the Questionnaire

Table 8 shows the global results from the questionnaire.

Table 8 shows that 54% of the respondents feel less comfortable or not comfortable when engaged in social interaction activities at the park. The primary reason was found to be because the park looks dirty, dark, and not well maintained, while some respondents stated that the bench is too exposed to people passing by. Overall, 64% of respondents were not satisfied with the park. It is important to note that the parks provide positive effects on cognitive ability and well-being even when people are less satisfied or not satisfied. This was confirmed by the fact that 64% of respondents said that the parks improved working or study spirit, and 63% said they reduced the stress level caused by work or study load. Moreover, 88% believed the poor exterior condition is due to the high building density.

The respondents expressed a need for more comfortable parks on campus as indicated by the desire of 97% to sit on a bench located in a proper place without any disturbance from pedestrians or vehicles. It was also discovered that 91% want big canopy trees that produce shade, and 93% want shade for pedestrians. Moreover, the findings showed that 90% like natural materials such as stone or wood for the finishing material.

The research also analyzes the responses of respondents from different occupations as they are stratified. This analysis is done to identify whether there are any influences from occupation toward the perceptions and preferences.

Based on the responses, the staff expressed two different perceptions. First, 63% of them were satisfied with the campus park design, and 58% felt comfortable when engaged in social interaction activities at the park. This was confirmed by the fact that 71% said that the exterior space is crowded. However, 79% responded that the park reduced the stress level caused by work or study load. These preferences align with the global responses. 87% of respondents expressed a desire for pedestrians paths with big canopy trees, natural finishing material (96%), big canopy trees for shading (88%), and semi-private areas for sitting (71%).

Figure 6

General Perceptions and Preferences Toward Existing Open Green Space

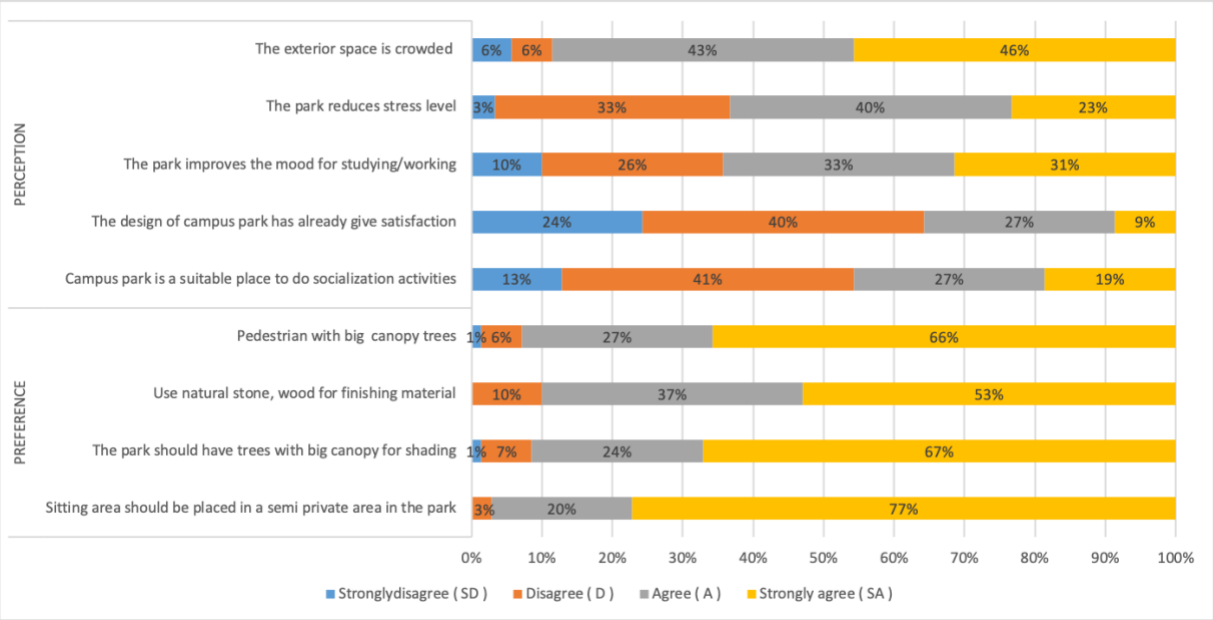
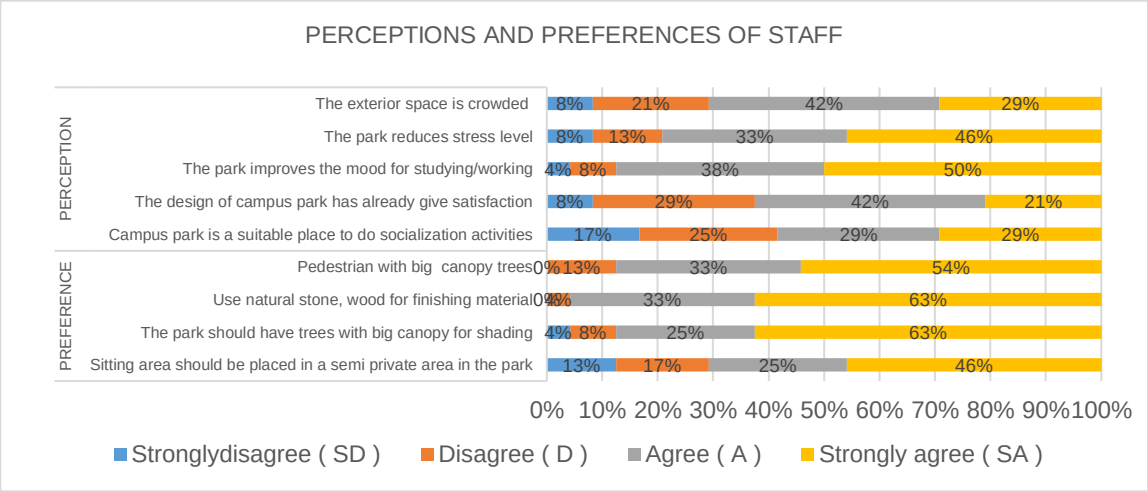


Figure 7

Perceptions and Preferences of Staff



The perceptions of lecturers were different from the general responses: 55% responded that the campus park is a suitable place to do socialization activities; 78% confirmed that the exterior space is crowded; 77% confirmed that the park reduces stress level due to the work or study load, and improves the spirit for studying or working (88%). The lecturers liked pedestrian paths with big canopy trees (100%), natural finishing material (89%), big canopy trees for shading (89%), and semi-private sitting areas (100%).

The perception and preferences of students are in line with the general result. 65% confirmed that they were not satisfied with the design of the campus park. The responses of 65% of students confirmed that were not comfortable when engaged in social interaction activities at the park. 54% agreed that the exterior space is crowded, and 78% confirmed that the park can reduce the stress level and improve the mood for studying (89%). Their preferences were for pedestrian paths with big canopy trees (92%), natural finishing material (86%), big canopy trees for shading (95%), and semi-private sitting areas (94%).

There is also a need to increase the quantity of open green space and ensure that designs comply with the needs and activity patterns of the users. Therefore, it is very important to collect and analyze the perceptions and preferences of the users, and design guidelines based on the three aspects of sustainability, which are nature, the social aspect, and economy.

Table 5 shows that all the parks have fulfilled one biophilic design pattern, which is “Nature in The Space” but there is a need for some improvements to satisfy the others, that is, Natural Analogues and Nature of The Space. As can be seen from Table 8, 64% of respondents stated that they do not feel satisfied with the park design. Increased consideration of Natural Analogues and Nature of the Space is needed to achieve enhancement of the open green spaces on campus.

Figure 10 describes some alternative design guidelines to improve the quality of the parks based on the preferences of the users and biophilic design patterns. Integration of these guidelines in green space design is expected to ensure the users interact more intensely with nature and obtain more positive impact from the open green space for their physical and mental health.

Figure 8

Perceptions and Preferences of Lecturers

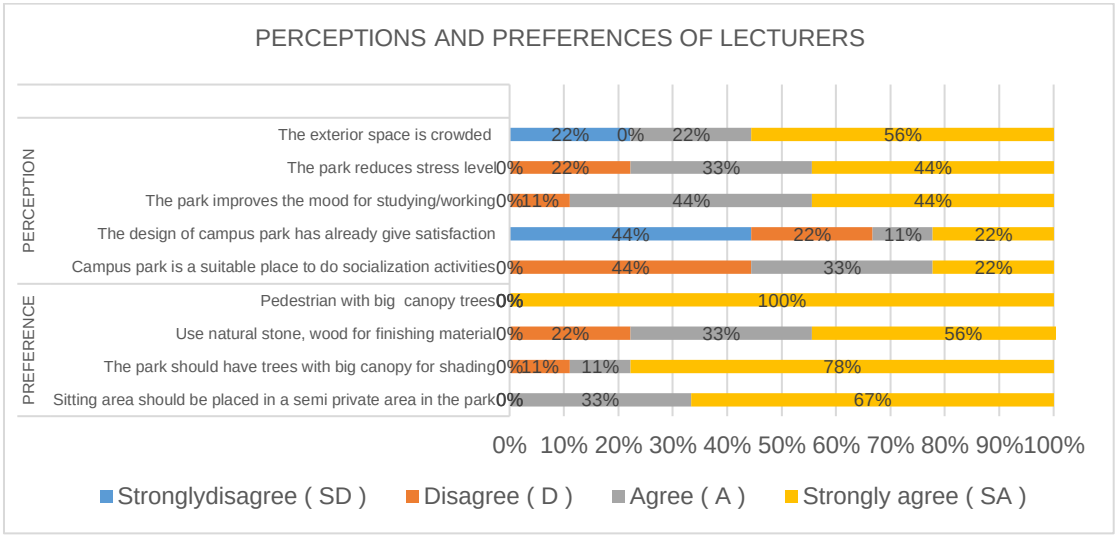


Figure 9

Perceptions and Preferences of Students

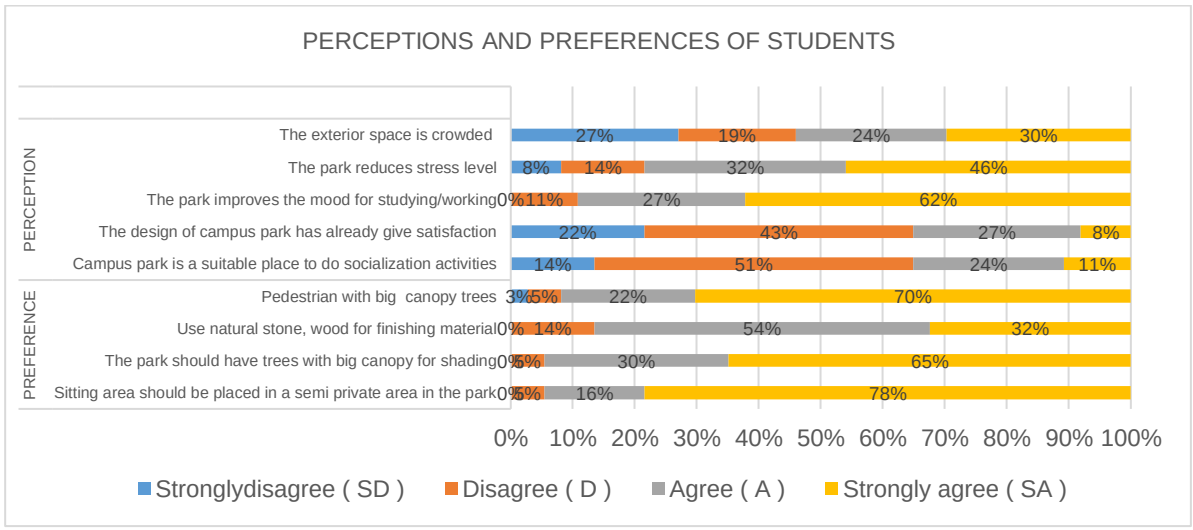
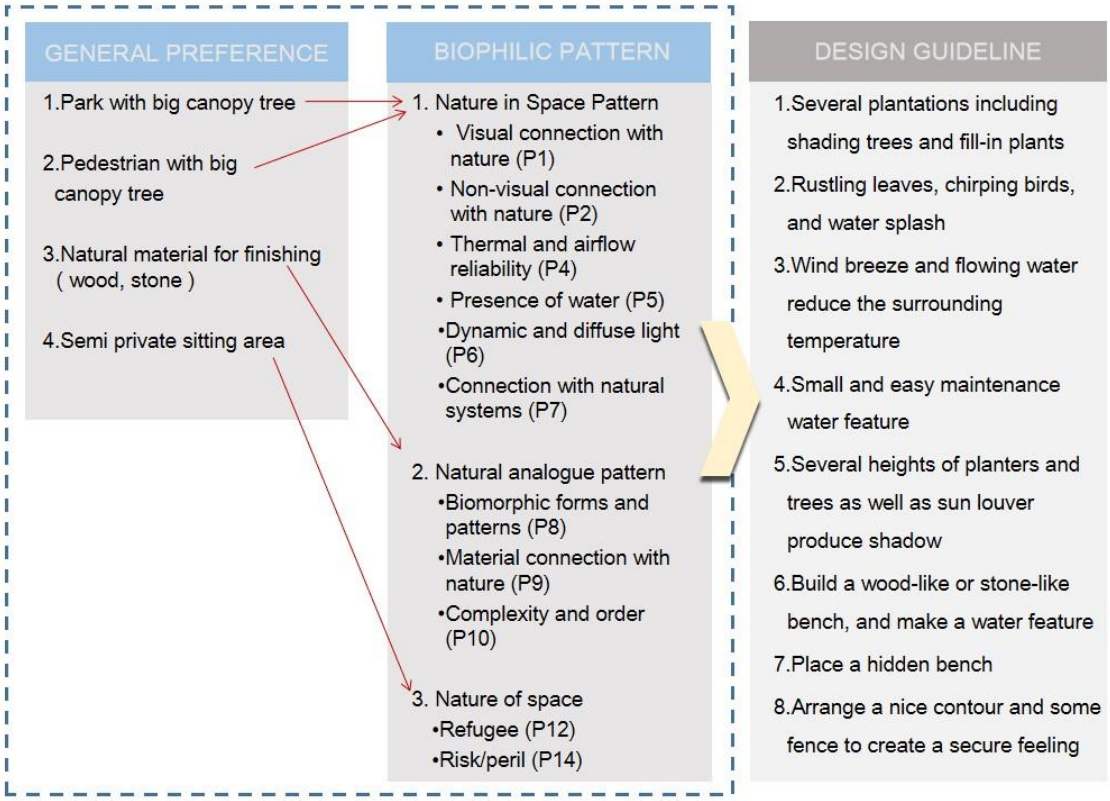


Figure 10

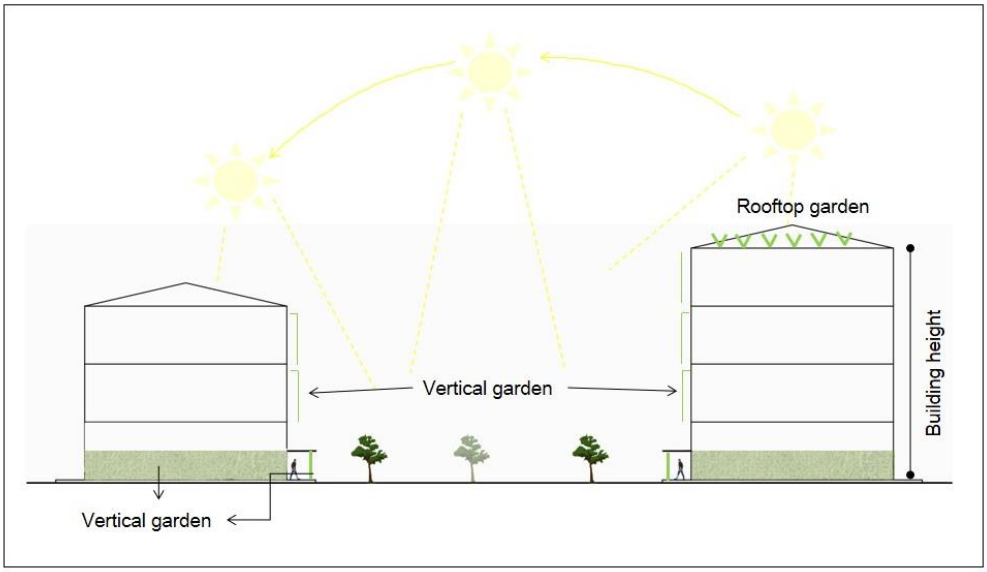
Design Guidelines



Note. The design guidelines were produced by combining the preferences of the resondents and biophilic design patterns. Adapted from *14 Patterns of Biophilic Design: Improving Health & Well-Being in the Built Environment*, by W. Browning, C. Ryan, & J. Clancy, 2014, Terrapin Bright Green (https://doi.org/10.1016/j.yebeh.2008.04.024). Copyright 2022 by Browning, William, Catherine Ryan, & Joseph Clancy.

Figure 11

Schematic Concept



Proposed Solution

The observation process and design guidelines give rise to four suggestions for optimizing open green space on urban campuses, as follows:

a. Build vertical gardens

b. Renovate existing open green spaces

c. Optimize building spaces

d. Build vertical parking structures

Deep consideration should be given to the choice of plants as a number of factors can influence appropriateness, especially with respect to shrubs and other fill-in plants: (1) sun path, (2) building height, and (3) shadow from buildings or big canopy trees.

Build Vertical Garden

The wall of the buildings, including the columns, can be used for vertical gardens to expand the green area. Moreover, some new buildings with appropriate rooftops can also be utilized for installation of greenery.

Renovate Existing Open Green Spaces

The proposed renovation of the existing open green spaces based on the design guidelines that include the preferences and biophilic design patterns is described in detail in this section (see table 7).

It is possible to improve Park 1 by adding some big trees, shrubs, and other decorative plants to make the park more attractive. The people entering or exiting the building are already visually connected with nature (P1, P2, and P3). Moreover, the big trees can provide better thermal comfort, though they need to be placed carefully to avoid covering the heritage building façade (P4 and P6). A contour needs to be added along the park, next to the public road, to cover it from the hustle and bustle of passing traffic, and to provide a more secure feeling (P14). The plaza also needs to be well-maintained to ensure its usage as a place to interact with nature.

Park 2 has similar characteristics to Park 1. Therefore, there is a similar need for the existing big trees to be maintained because they give shade, provide the sound of rustling leaves, and reduce the surrounding temperature (P1, P2, P4). There is also the need to add contours along the park, next to the public bus shelter, to sheild it from the busy road (P14). Moreover, some benches and pedestrian seats should be installed for users who like to sit on the wall; wood-like material should be used for the benches and stones for the pedestrian seat (P8, P9).

Park 3 is located at the junction of two main pedestrian walkways, and this is considered to be an ideal meeting point or place to sit. The benches around the big planter box located at the center of the junction needs to be moved to the side of each building to ensure more privacy for the users (P12). The existing big canopy tree in the planter box at the center of the park already create sufficient shade to provide thermal comfort for the users (P1, P2, P4, P6). The curved bench can also be replaced by a small pond with a water feature to produce the sound of splashing water (P1, P2, P3, P4, P5, P8, P10), while the ground needs to undergo landscaping to mimic a natural contoured pattern (P14). The bench also needs to be refurbished using appropriate finishing materials (P8). Furthermore, the walls of the surrounding buildings can be used to accommodate vertical gardens in order to reduce the hardness of the concrete wall and increase the amount of green area (P1, P10).

Park 4 is a big open green space with a lot of benches, but is not in good condition. It is the liveliest of all the parks on campus, and a great deal of user interaction was observed here. The proposal for this park is to redesign the layout of the bench, the plants, and the pedestrian walkway. Furthermore, the existing big canopy tree needs to be better maintained (P1, P2, P3), and the body of water needs to be enlarged (P4, P5). Additionally, plants should be updated with flower shrubs to attract butterflies and other insects (P1, P2, P3), the finishing material of the bench should be changed to a wood-like material (P8), the ground should be cobblestoned (P8, P9), and the park cleaned.

Park 5 is separated from Park 4 by a building and is smaller even though they have a similar design. The location of Park 5 is more hidden from the main pedestrian walkway, which is why

it is perceived not to be as lively as Park 4. Moreover, the users are limited to people from the surrounding buildings. The design concept is essentially the same as Park 4.

Park 6 is an interior courtyard that is hidden from pedestrians, with the only access being through the Pathology building. This makes it an exclusive park for the users of this building. Therefore, it is proposed that several benches designed with nature-like materials be added near the corridor (P8, P9, P12), and the rest of the park be made green (P1, P2, P3) with a water feature (P4, P5), different kinds of plants (P1, P2, P3, P6), and additional contouring (P14) because it is not accessible to a lot of people. The wall, including the columns, can be used for the addition of vertical gardens.

Optimize Building Space

The density of the campus area can be reduced by replacing semi-permanent buildings (which are mostly supporting buildings) with open green space.

Figure 12 shows that the lobby space can be optimized by shifting the photocopy booth into the space, allowing for the existing photocopy kiosk to be demolished and the area used for open green space.

Parking Buildings

Parking space has become a big problem due to the continuous increase in the number of private vehicles driven to campus. This has led to the conversion of open green spaces to parking areas with the surface covered with asphalt. The most obvious solution to this problem is to construct a car park building.

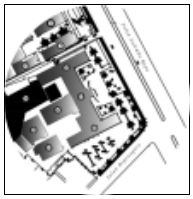
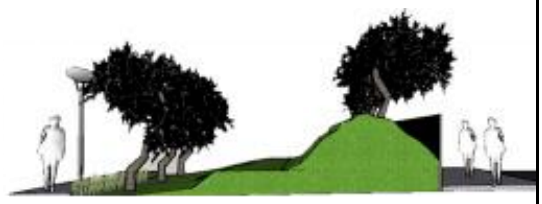
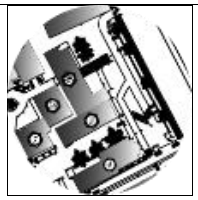
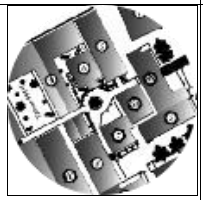
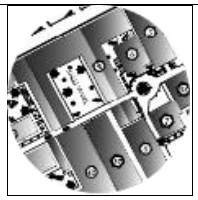
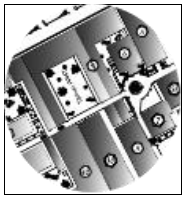
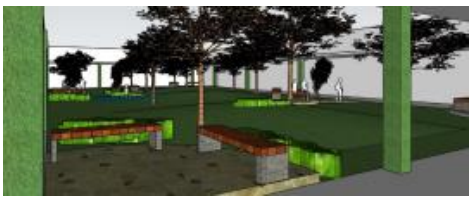
A car park building has a lot of advantages, which include its ability to reduce the area required to accommodate onsite parking, and the application of the structure frame as a vertical garden.

Moreover, sustainability has three pillars which include the environment, the social aspect, and the economy. It is observed from the lens of the environmental aspect that these recommendations can improve the quality of the environment by making it greener, lowering the micro temperature, and ensuring biological diversity. The campus' society can benefit from the thermal comfort, nice green view to reduce stress, and the opportunities to interact with nature.

It is important to note that these recommendations do not require special building materials or treatments, which means that construction costs will not be unreasonable.

Table 7

Proposed Design

No.	Key Plan	Current Situation	Proposed Design
1			
2			
3			
4			
5			
6			

Note. The proposed designs for the renovation of the existing open green spaces. Picture 1*:* the proposed design for Park 1. Figures 2, 3, 4, 5, and 6 for Parks 2, 3, 5, 4, 5, and 6, respectively.

Figure 12

Building Optimization

Note. The lobby in Picture 1 can be optimized by relocating the photocopy booth in Picture 2 to the lobby.

Figure 13

Parking Building

Note. One parking building has already been built inside the campus area, but it is not sufficient.

Table 8 shows the scope of work of the proposed design and the unit price. The components are the same whether the design does or does not apply biophilic principles.

The initial result shows that the proposed solution does not significantly improve the score of UIGMWUR - Site and Infrastructure Criteria. Table 9 details the impact on the score.

The total area on campus covered in planted vegetation increased by 574 m^2 *(* 11*%)*, so the total open space area divided by the total campus population increased from 0.32 m^2/ person to 0.35 m^2 / person. The score is not high, but campus users will have access to nicer parks where they will have a chance for enhanced interaction with nature.

Table 8

Unit Price for Open Green Space Work

NO	ACTIVITY	VOLUME	UNIT	PRICE (Rp)
1	Land clearing	1	ls	1,000,000
2	Landfilling	1	m2	42,000
3	Hardscape work :			
	Bench (0,6 m x 1,2 m x 0,5 m)	1	unit	1,035,468
	Water feature (4m x 2,5m x 0,6m)	1	unit	9,400,000
	Plaza and pedestrian	1	m2	390,000
4	Softscape			
	Big tree (h: 4-5 m)	1	unit	4,000,000
	Shrub (h: 0,3 cm)	1	unit	4,500
	Shrub (h: 0,7 cm)	1	unit	6,750
	Grass	1	m2	60,000

Table 9

Impact of Proposed Design

	Sub Criteria of Setting and Infrastructure	
	Criteria	Proposed Condition
1	The ratio of open space area to the total area	Open space: total space = 45%
2	Total area on campus which is covered in forest vegetation	Not available
3	Total area on campus covered in planted vegetation	5884.5 sqm
4	Total area on campus for water absorption besides the forest and planted vegetation	Not available
5	The total open space area divided by the total campus population	0.35 sqm/person
6	Percentage of university budget for sustainability efforts	Data not available
7	Percentage of operation and maintenance activities of the building during the Covid-19 pandemic	Data not available

Table 9 (Conitinued)

	Sub Criteria of Setting and Infrastructure	
	Criteria	Proposed Condition
8	Campus facilities for disabled, special needs, and or maternity care	Only at some buildings: elevator and ramp
9	Security and safety facilities	Available in some buildings (boom gate, security post, CCTV, access door)
10	Health infrastructure facilities for students, academics, and administrative staff's well being	Health clinic (Makara Satelite Clinic)
11	Conservation: plant, animal, and wildlife, genetic resources for food and agriculture secured in either medium or long-term conservation facilities	Not available

CONCLUSION

Open green space is very important for both all urban areas, including university campuses. This understanding led to the implementation of UIGMWUR to stimulate campus stakeholders to engage in efforts to develop more sustainable urban campuses. It was discovered from this research that it is difficult to increase the amount of open green space in limited space only by optimizing the existing area. It is clearly necessary to move forward with the two additional proposed solutions: (1) optimize building space, (2) build a parking building. Building intensity should be increased to fulfill current regulations about building coverage ratio (BCR) and in-building parking facilities should be constructed, with current parking areas converted into parks so that there is more open green space available.

This research should be continued in greater detail, especially with respect to the perceptions of the campus society since the staff perception was quite different from the general perception. There is also a need for other studies to be carried out after the renovation process is complete in order to evaluate the effect of the recommended optimization efforts.

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