

Factors Forming Green Building Criterias on Green Campus

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Abstract: Campus is an important and ideal place as a source of education that related with sustainable the campus is an important and ideal place as a source of education that related to the sustainable environment. The campus can be a role model in the sustainable concept application which is also known as a green concept. The aim of this study is to analyze what factors should be applied to the building on green campus. Green building criteria that used in the building are green-ship from Green Building Council Indonesia (GBCI) and previous research. Green building criterion in this research consists of twelve indicators which related to building materials, interior design, and energy conservation. This research was conducted in Universitas Sumatera Utara with population is the student with the sample size of 400 students. This research uses quantitative method and analysis by factor analysis. The results show that there are four factors that forming green building criteria on green campus, ie energy conservation, interior, indoor comfort, and material. The campus will earn great benefits if applying the green concept and supported by the application of the green concept in the building.

1 INTRODUCTION

Sustainability development should be provided for development activities and being an umbrella on human activities (Emanuel and Adams, 2011).

In the last two decades, the sustainability concept in university or campus has been a main concern (Yeh, 2006). University is known as an important place for promoting sustainable concepts and enhancing human capacity to address environmental and development issues in order to improve environmental and moral understanding, values and attitudes, abilities and habits toward sustainable development (United Nations, 1993) in (Huyuan and Yang, 2012).

One form of embodiment of sustainable concept is green concepts application on the building. Green building is a building that implements energy efficiency and conservation, conducts management of the building environment, water conservation, maintains indoor health and comfort, makes proper building site and uses environmentally friendly materials. The campus may realize green concepts application on the building and its environment. This

is supported by (UIGreenmetric, 2015), regarding the measurement for the green campus which refers to three factors, namely environment, economy and justice. Green campus application should refer to 3R namely Reuse, Reduce and Recycle.

Campus can be a role model of green concept application in both building and area. This study focuses on the factors forming green concepts to buildings within the green campus. The study purpose is to determine what factors that should be applied to the building on green campus.

2 GREEN CAMPUS

Sustainability development on campus with green concept prioritizes on planning and campus development. Based on (Abd-Razak, 2011), at campus development planning should have three aspects that considered, namely accessibility, security and social agreement. Integrated development planning influence three aspects of sustainability such as social, economy and environment.

The green campus is an international environment program for campus or university that focuses on environmental issues, innovation, and research and apply it on daily campus management. Green campus aims to realize awareness and environmental action as intrinsic part of education activities (Environmental Education, 2013).

The green campus has become a concern since last two decades. Education became one of the strategic places to promote the concept of sustainability (Huyuan and Yang, 2012). Green university means having sustainability regulations implemented on university operational and education procedures. The green university has several aspects such as operational, management and curriculum development (Yeh, 2006).

The green campus assessment conducted by (UIGreenMetric, 2015) based on six indicators and each indicator has different weighting. Currently, the UIGreenMetric indicator is a reference in green campus assessment in Indonesia. The six indicators are structuring and infrastructure, energy and climate change, waste management, water usage, transportation and education.

2.1 Green Building

One of the parties that focuses on green building issues is Green Building Council Indonesia (GBCI, 2016). GBCI have indicators that are used to assess the application of green concepts in buildings and issued certificate for buildings that have applied green concepts consists of platinum, gold and bronze awards. Certification is done on the new building, existing building, interior room, home, and area. Implementation of the green concept is not only applied at home, office and commercial buildings but also in the area such as commercial area, mixed-use area, industry and residential area.

(Yeh, 2006) argue that green campus has several categories which related to a physical item such as buildings, landscape and waste, while the nonphysical item is the curriculum. Operational, management and green purchasing related to investment on campus. Students and staff also participate in the application of green concepts on campus.

Based on (Brown, 2006), green building is a way to reduce energy consumption on the environment. There are six factors that cause green design on the buildings important, namely environmental impacts, materials, waste, energy, water and human health. Materials consist of construction activities in new construction, renovation, and destruction of buildings have an impact on natural resources.

Energy-related to energy consumption for the use of electrical energy and transportation. Human health namely the quality of space that affecting the health of its users such as pollution from furniture, carpets and so on.

There are six indicators that used in the assessment of green buildings according to (GBCI, 2016) namely: appropriate site development, energy efficiency and conservation, water conservation, material resources and cycle, indoor health and comfort and building environment management.

From some indicators which considered by (GBCI, 2016), there are the most important indicators for green building assessment namely energy efficiency and conservation. This indicator is the most important of its assessment because it can provide benefits on cost reduction for energy supply in buildings. In addition, the problem of indoor comfort and health and the use of materials is also assessed on green buildings. Meanwhile, the measurement of green areas, the most important indicator is the movement and connectivity (movement and connectivity). This is because in a region of the most important part is the connectivity of roads, pedestrian, and transportation systems associated with the movement of its inhabitants.

According to (Yeh, 2006), there are several categories related to the sustainable university which become a guidance in compiling Green University Evaluation Index System (GUEIS), namely: Green building and landscape planning, ie building based on green building standards such as LEED and plan a landscape that provides a more friendly campus space.

According to (Tamiami, 2018), green design concepts which applied on the campus can improve student's quality of life as users. Based on the result research on three campuses in Medan City, it is found that some indicators applied to the building can provide comfort for its users. These indicators are good natural lighting in classrooms, suitable ventilation, unpolluted air, and campus have a lot of plants. Students argue that buildings that have applied the green concept can improve their quality of life. Students feel they have a nice interaction with their colleagues and lecturers and have an optimistic feeling in their life.

According to research by (Fachrudin, 2016), that green campuses should have many plants in its landscape, free from air pollution, have clean water and have campus buses. The campus is designed with the green concept to maintain comfort to its users so that they will have better quality of life.

According to (Emanuel and Adams, 2011), one of the sustainable campus criteria is ecology and one of the indicators is green building. On a sustainable campus should use green building guidelines on existing buildings and new buildings.

Green building which being research focus consists of twelve indicators, namely: the using of LED lamp in classroom, natural lighting in building, natural air in building, the using of environmentally friendly material, the using of eco-friendly paint, building orientation, the use of double-glazed panel glass window, the use of sensor faucet, the use of solar panels for energy conservation, the use of energy-saving lights in the corridor, window's design in building and waste separating management.

2.2 Methodology

This research is quantitative research with data collection technique is questionnaire distribution. The population in this study are undergraduate students from Universitas Sumatera Utara (USU) from fifteen faculties, namely Faculty of Medicine, Faculty of Law, Faculty of Agriculture, Faculty of Engineering, Faculty of Economics, Faculty of Dentistry, Faculty of Cultural Sciences, Faculty of Mathematics and Natural Sciences, Faculty Social and Political Sciences, Faculty of Public Health, Faculty of Nursing, Faculty of Psychology, Faculty of Computer Science and Information Technology, Faculty of Pharmacy and Faculty of Forestry.

The target population in this study are undergraduate students enrolled from 2014 to 2017 as much as 25.127 students. The selection of students is because they are considered to have been on USU campus for more than one year so they can feel and assess the condition and design of USU campus. The sample size is calculated by using Slovin formula with confident level 5% as much as 400 students.

The questions in questionnaire form using Likert scale interval 1 to 5 (very not important to very important). The variables in this study is a green building consisting of twelve indicators. The analysis used is an analysis factor to classify the indicators included in the green building.

3 ANALYSIS

The analysis was carried out on twelve indicators that were part of the green building variable by using factor analysis. The result of factor analysis shows

that KMO and Bartlett's Test value for correlation between variables obtained is 0.810 which means greater than 0.5 (Table 1). The significance resulting from Bartlett's Test of Sphericity is 0.000 (Santoso, 2006).

Table 1. KMO and Bartlett's Test For Green Building

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		,810
Bartlett's Test of Sphericity	Approx. Chi-Square	136 3,806
	df	78
	Sig.	,000

The result is (Table 2), the factor is able to explain the variable of LED lamp equal to 0,512 or 51,20%, natural lighting is explained equal to 0,687 or 68,70%, natural air is explained equally to 0,576 or 57,60%, environmentally friendly material is explained equally to 0,694 or 69,40%, eco-friendly paint is explained equal to 0,679 or 67,90%, building orientation equal to 0,563 or 56,30%, the use of double glazed panel glass window is 0,607 or 60,7%, the use of sensor faucet is equal to 0,641 or 64,10%, solar panel is equal to 0,504 or 50,4%, energy saving lamp in corridor is equal to 0,657 or 65,7%, window design explained by 0,652 or 65,2% and waste management explained by 0, 573 or 57,30%. Because the explanation for all of variables are above 50%, so the fixed factor can be determined.

Table 2. Communalities For Green Building

	Initial	Extraction
LED lamp	1,000	,512
Natural lighting	1,000	,687
Natural air	1,000	,576

Env. Friendly material	1,00 0	,694
Eco-Friendly paint	1,00 0	,679
Building orientation	1,00 0	,563
Double glazed panel glass	1,00 0	,607
Sensor faucet	1,00 0	,641
Solar panel	1,00 0	,504
Energy saving lamp in corridor	1,00 0	,657
Window's design	1,00 0	,652
Waste management	1,00 0	,573

Extraction Method: Principal Component Analysis.

Table 3. Rotated Component Matrix^a

	Component			
	1	2	3	4
LED lamp	,025	-,133	,330	,620
Natural lighting	,229	,073	,793	,017
Natural air	-,231	,286	,657	,098
Env. Friendly material	,270	,768	,178	-,002

Eco-Friendly paint	,319	,753	,099	-,027
Building orientation	,096	,718	,107	,164
Double glazed panel glass	,140	,481	-,061	,594
Sensor faucet	,135	,102	-,056	,781
Solar panel	,651	,130	-,131	,214
Energy saving lamp in corridor	,805	,080	-,008	,049
Window's design	,742	,315	,015	,048
Waste management	,609	,161	,416	,047

Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 8 iterations.

Determination of input variables to a particular factor follows the large of correlation between variables with factors, ie to the large correlation (Table 3). Thus, there are four factors with several indicators. Factor 1 contains the variables related to energy conservation such as electrical energy conservation and waste that is the use of solar panels, energy saving lamps on the corridor, window design and waste management.

Factor 2 consists of several variables related to the interior of the building ie the use of environmentally friendly materials, the use of eco-friendly paint and building orientation.

Factor 3 contains the variables related to the comfort of indoor space there are Natural Lighting and Natural air.

Then, Factor 4 contains variables related to the material used in the building, ie the use of LED lamp in the classroom, Double glazed panel glass window and the use of sensor faucet.

Factors which formed in this research are: Factor 1 is called as energy conservation, factor 2 is referred to as interior, Factor 3 is referred to as indoor comfort and Factor 4 is called as material. Some of these factors are in accordance with the criteria set by GBCI (2016), Brown (2006) and Yeh (2006), ie energy conservation, materials, and indoor comfort.

Factor 1 has a correlation of 0.683, Factor 2 has a correlation of 0.631, factor 3 has a correlation of 0.669 and factor 4 has a correlation of 0.929 that is > 0.5 which means has a strong enough correlation. Thus Factor 1, Factor 2, Factor 3 and Factor 4 can be said precisely to summarize the 12 independent variables (Table 4).

Table 4. Component Transformation Matrix for Green Building

Component	1	2	3	4
1	,683	,631	,266	,255
2	-,631	,295	,669	,261
3	-,036	-,208	-,305	,929
4	,367	-,687	,624	,065

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

4 CONCLUSIONS

There are four factors that forming green criteria on buildings that are inside a green campus. The four factors are energy conservation, interior, indoor comfort, and material. In a building, indoor conditions and material are important and also the energy conservation issues in buildings and related to green building criteria. These four factors relate to the exterior and interior design of the building. For exterior design associated with energy conservation, while the interior design is related to the interior of the room, comfort of space and materials.

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