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Appropriate Site Development: Microclimatic Approach Toward Green Landscape Design

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ABSTRACT

As green building adapted in most of new construction and development, practice of sustainable site planning become essential to create green built environment. While compromising with people demand, paradigm of employing natural resources should be considered to achieved not only the aesthetic goal, but also sustainable landscape as its response to site potential. The research aimed to review theories of green landscape design associated with appropriate site development (ASD) as Greenship Rating Tools of GBCI. Research used desktop survey at online database of microclimate aspect to conducted contextual analysis of study area. It also uses literature review of several principle of ASD to obtain the alternative design element that can be applied. From the discussion, the result show that land features have influence the specific behavior microclimate aspect, such as wind and temperature, which can be responded by applying indigenous vegetation and green material related to their support of sustainability.
Keywords: Appropriate site development, Microclimatic, Public space, Sustainable design

1. Introduction

Firstly, design decisions are a designer way to convey meaning and messages to observers. The tendency that design can influence behavior is shown in research on sustainable building designs that can change occupants' sustainable behavior. Huge amount of sunlight during the day that coming through transparent façade create a situation that encourages residents to consciously carry out activities in accordance with the green building principles used by the building, such as minimizing the use of lamp [1]. Even so, research on the relationship between interiors and behavior shows that there needs to be further thought as well as a balance between person's individuality, privacy, security, convenience, functionality, adaptability, community communication, and availability of decent space, to achieve a successful design [3].

Furthermore, the built environment which is a place created for people cannot be separated from nature which is the setting of the building and its supports. Architecture can both influenced and affected the surrounding area with its response to the design elements. In one hand, architect explore the shape, position and other detail of window and opening toreact the sun heat and light to building, to provide desire thermal comfort by maximizingthe sun energy and create certain ambience[17]. On the other hand, production of formand appearance of architecture eventually can shift surrounding "climate" or weather condition, such as the use of natural building material that comes from ecological friendly process, as well as establish energy efficient feature in building system [19]. Since global warming happen in unpredictable pattern, there is a challenging movement of building design to use sun energy for lighting, for instance. Passive solar design is one of building model that take advantage of sun energy to operate the building sustainably [20].

Speaking of sustainable design, not only doesit present in the form of building, but huge variety of sustainable built environment precedent are also found in landscape design both in public and private. Practically, the green design was adopted by many architects to support the sustainability of building, environment, and the people itself. In addition, a research states that the optimum benefit of green design, specifically green building, can be obtained by

combining a good process leads by the designer and proper usage by the user [15].

Research case study is the open area in lecture complex of Institut Teknologi Kalimantan, Balikpapan, Indonesia. The principle of resource sharing of building leads to issue to create a public space that accommodate space student activity, while simultaneously encourage social interaction of all type of user. University complex itself is in sub urban, near by the city's conservation forest, which give rather extreme wet tropical climate.

2. Material and Methods

This article reviews design consideration of natural resources to establish an optimal microclimate. Literature review was conducted to understand and compare the basic theories about green design strategies, particularly in appropriate site development as one of green building criteria. Comparison review ofseveral research of application and assessment of appropriate site development was organizedin tabulation to generate the suitable purpose criteria. All information was collected by desktop survey, from several research and precedent in rather similar project. Research techniques also includes the investigation of case study area data which was also compiled by online data. A desktop study is basically a research that conducted purely by secondary data, rather than field survey. Based on a research on violence and discrimination in South Africa, this type of research was done to show shifting phenomena on the focus topic. The data was visualized to examined series of event sequentially, that also presented the gap information about the issue [4].

2.1. Public space for community

Based on a research in Putrajaya, Malaysia, there are two criteria of attractive public space, which are place and context, in particular the character of the space, and people's attachment to the environment, relation of social and local cultural aspect of public space, as well as approachability.
In this research, planning orientation is not directed only at creating beautiful outdoor areas, but also public areas that support human activities. In accordance with the statement made about public space, activity is essential in the formation of space, for instance public space in urban areas, while also an aspect that attracts attention. [6]. The sustainability of outdoor activities is associated with the comfort of the created outdoor space,especially thermal comfort. Based on a study conducted in areas with a warm humid

climate, outdoor climatic conditions are a challenge for areas with high urbanization because it tend to have higher temperatures. Although the ability of the occupants has been adapted to climatic conditions, for example the wet tropics, but at the peak of high temperatures, most users cannot tolerate these temperatures [7].

2.2. Sustainable Landscape design

The basis for the investigation refers to thebasic concepts of outdoor and sustainable landscape. Referring to the history of landscape planning, the paradigm shifting of land intervention is carried out starting from exclusive land design for human development to environmental preservation oriented, so that it is no longer exclusive but is carried out on the entire land [8]. Land has a productive function, particularly as a provider of food anda natural habitat for food sources for animals. This indicates that the treatment of land must consider its long-term sustainability to support the life of the ecosystem in and above it. Disturbances that occur on one side of the land, the impact may be felt by the land in other parts of the area [2]. Recent development of landscape design particularly focuses on how the landscape design contribute to the development of future land.

Sustainable landscape is the approach that used to encourage long-term design of natural capital in built environment. While sustainable landscape is required formation and renovation, as well as conservation, it also involve a holistic deliberation of economic and political act to maintain the development goals achieved, which is the recreation of the field value [11]. Sustainable landscape design focuses on how project components, which are owner, landscape designer, contractor and maintenance professional have the same vision. The principle includes concentration on local regulation, local ecosystem andsensitivity to site potential, comprehensive purpose layout design by landscape designer and maintenance staff, as well as the use of indigenous plant and protection of nativespecies [18].

2.3. Appropriate site development

The principle of green building is buildingsthat have reduced or eliminated the negative impacts of development starting from the design, construction, and operational planning processes. A contrast differences betweenusual buildings and green buildings are efficient systems in energy, water, and other natural resources, use of renewable energy, waste reduction, indoor air comfort, use of sustainable materials and attention to the planning, construction, operational and post-

operational processes. [12]. Beneficial proveby applicate green building was shown in not only in terms of energy efficiency and natural resources that support economic and environmental sustainability but are correlated with community health which promotes welfare and quality of life [13].

Criteria of Appropriate Site Development (ASD) of new building according to Greenship Rating Tool of Green Building Council Indonesia includes basic green area, site selection, community accessibility, public transportation, bicycle facility, site landscaping, microclimate, and stormwater management [5]. In addition, the criteria of ASD for existing building are site management policy, motor vehicle reduction policy, community accessibility, site landscaping, heat island effect, storm water management, site management, and building neighborhood [9]. The application and assessment of Greenship rating tools has been carried out extensively by various function of both existing and new building.

2.1.1. Microclimate

Microclimate [2], which is define as climatic conditions in a definite area, is investigated to determine some improvement to be applied, to create desire weather condition. In normal condition, climate is already become a challenge to create a comfortable and convenient built environment. As climate change arise extremely, the response of changing microclimate is become more vital. In the latest report by the Intergovernmental Panel on Climate Change (IPCC) in 2021 (Sixth Assessment Report), the current climate conditions in some parts of the world are already far from the climate in the early and mid-20th century. These changes have changed the condition of the physical climate system that affects elements of society or ecosystems, thereby changing the magnitude, frequency, duration, seasonality, and spatial level of the related index [10].

- Related to green aspect concern, the improvement of microclimate around the building should be done to achieve the desire thermal comfort. Some essential points of microclimate aspect to complete the Grenship assessment are associated to designer responseof landscape elements [5]. Specifically, albedo is one aspect that becomes a benchmark for microclimate variable in ASD. Albedo is the capacity of a surface to reflect sunlight. The lighter the color of a surface, the greater the level of reflected light (high albedo), while dark-colored surfaces absorb sunlight (low albedo) [24]. The albedo value ranging between 0 and 1, while 0 means black in color and 1 is white. The greater sun light absorbed, Apply material whose average albedo values is minimum 0.3, in accordance with the total roof area that covered with pavement, or apply green roof with the minimum 50% of total roof area
- Apply material whose average albedo values is minimum 0.3, in accordance with the total area, except the roof, that covered with pavement [9]

3. Results and Discussions

Institut Teknologi Kalimantan is in the northof Balikpapan City, which surrounding mainly by green open space and bult in remote area. Developed in approximately 56 ha total area, the university has 7 building built in various elevation due to dynamic contour of the site. The construction of university building conducted by a massive site development because the site is originally a forest. While doing reforestation, landscape planning is carried out to provide public space for both students and lecturers. Various student activity outdoor occur in existing university park, for instance reading, discussing, outdoor lectures, doing project and gathering.

Source: (Google Earth, 2021)

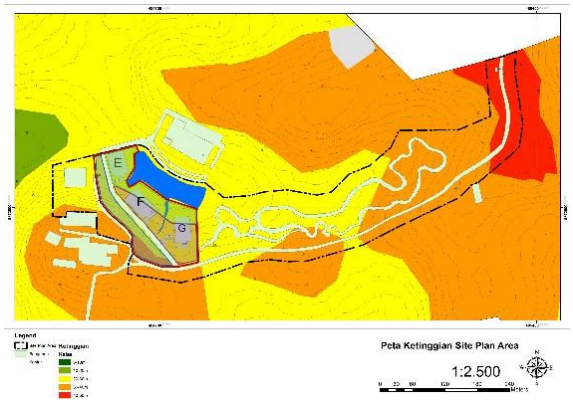
Figure 1: The area of Institut Teknologi Kalimantan

As shown at figure 1, the existing university area is surrounding by open space. Beside building and pathway, the area has a natural lake, which originally the water catchment area that form a big pond. Existing conditionof the study area is land with natural grass cover. When it rains heavily, some parts of the land are flooded, especially in the boundary area of natural pond.

In response to the microclimate of Balikpapan, the building adopted the basic principle of passive design, which is the use of window film to optimizing solar light while reduce the heat received. A glance at the city weatherpattern 10 m above the land (Figure 2), this research used the tendency of rain, wind, and temperature predicted by the data show on online real time

data at ventusky.com. In the average, wind speed in the study area is 10 km/h, the precipitation is 0.5 millimeters, and the temperature is around 30^0C. While the maximum thermal comfort standard of Indonesia based on temperature only, is 27.1^0C (according to SNI T-14-1993-03), the intervention of landscape elements was needed to decrease the perceived temperature.

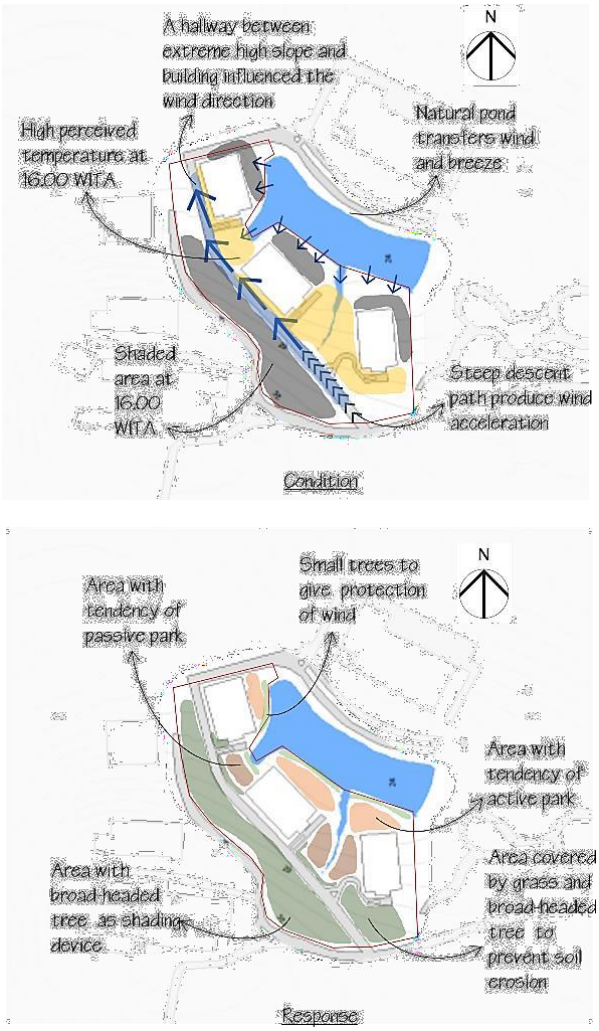
This research examined the open area between group of lecture buildings (Building E, F, and G) in the center of the university complex.Built in 2019, the outdoor area was used as themain circulation pathway between building and motorbike parking area. None of the student's outdoor activity was conducted because there are no park elements. In general,the area has already been developed as the building established. However, the detail land feature has not been designed yet.



Source: (Researcher, 2021)
Figure 2: Elevation Map of Study Area

Based on elevation map, although there are several ranges of contour, the average elevation of study area is the lowest among all. The shaded area around building E, F and G are divided into 3 different types of contours, the steep slopes is on the west part, the medium steep slope is in the middle, and the sloping land is in the north-east part of the bounded area. All features contribute to specific microclimate to the open area, especially wind and water, while the sunshade mainly influenced by the building.

In the west steep slope who's located almost 10 meters height difference, reeds and shrubs cover 100% land and give the eastern part shade from afternoon sun. this part play an important role to shape the hallway that influenced certain direction of wind parallel with the pathway. In addition, the steep downhill around the southeast is also contribute to wind acceleration due to vehicle high speed in that point. At the east part, the pond transferred small amount of wind to the east façade and open space at the east of the building. Rain behavior in site is not present specific direction but overflowing equally at all part.



Source: (Researcher, 2021)
Figure 3: Site Analysis of study area

Common response of existing condition is the purpose planting area around the building and the open space to control the potential wind and high temperature. Response map at figure 4 depict the dark green shade area that are recommended for grass cover and broad- headed trees to prevent soil erosion while give shelter for areas with the chance of high temperature. Around the pond side, the provision of shrub and green border is urged tosoften the wind from pond that might disturb people activity. The possibility of activity is considered by the probable of high perceived temperature produced by solar heat, and strongwind along

the hallway. Both passive and active park can be afforded by fitting the position of planting area. Areas between building predicted suitable to passive park, in case of heat acceptance in certain time. Whereas the tendency of proper area for activepark is area between building and the pond, which receive more shading.

Related to the ASD criteria, the tendency of softscape element, particularly the use of native plant would be best solution of the durability and the viability for both aesthetic visualization of the landscape and the existence of vegetation. The significant effect of indigenous plant is minimizing the process, emission, and fee of distributing new and invasive plant from another region. Not only does it give detriment from the mobilization, the likelihood of is sustainability is also doubtful. Fitting the specific character of the site, local vegetation that is planted naturally is tropical fruit tree, such as durian, rambutanand duku. Although the reforestation of these trees is implementable, careful consideration of safety should be done to prevent the disadvantage of fallen fruit. Plantation of shaded tree is recommended for passive park consider creating broad coverage shelter area.

Another landscape design element that shapes the environment comfort is pavement. The use of pavement is avoidable in wet area. Based on the chance of flooding, the needs of pedestrian and vehicle circulation, and people activity, pavement will be applied in most area of activity zone. Research shows that the reflective ability of pavement will affect the heat perceived by people walk on it [22]. Alternatively, cool pavement is certain type of pavement that able to maximize solar reflection and water evaporation, which indirectly reduce runoff [21]. However, the basic green design principle is not only seeing the application or the product separately. The continuous ecological friendly process of manufacture and distribution is required for a green material. Innovation of fly ash and bottom ash as the substitute production component of paving as one of the green alternatives to depress consumption of sand, while reduce waste. It proven to be impermeable at certain composition that can be used in street and parking area [23].

In terms of ASD criteria, the future development should avoid some material and certain color which has high albedo. Besides,to overcome and prevent glare from shiny building material, the material of outdoor element should employ the minimum of 0.3 albedo value. Recommendation of landscape material according to ASD criteria of albedo shown in table 1.

Table 1. Planned future material

Existing material	Recommendation material
Asphalt	Concrete or paving
Black or dark-colored bench	Lighter-colored bench or other landscape element (red, brown, green)
West façade	Greenery around the façade
Aluminum coating	Concrete pavement

Source: (Researcher, 2021)

The table above explain materials which can be used instead of materials that absorb high percentage of sun energy. Application of light and rough material are estimated become the purpose matter which maintain albedo ataverage level. Moreover, with accordance with vegetation as landscape element, there should be specific observation through tree albedo based on the leaves area, density and color.

Design decision of any development as a response of local natural potential tend to havea tight association with how the post- construction will shape. Conversely, many changes of microclimate can become the most challenging part application of design element.Appropriate site development of new and existing building has the same principle of reducing the impact of development that may be affect the sustainability of the site, building and the user itself. The use of native vegetation and green material can become small approach to achieved green design, while ensure the viability of the site.

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References

[1] Morgan, Erin F., "Does Design Affect Behavior? ACase Study of Pomona and Sontag Halls" (2012). Pomona Senior Theses. 50. https://scholarship.claremont.edu/pomona_theses/50

[2] Simonds, J O, Starke, BW. Landscape Architecture: A Manual of Environment Planning and Design. New York: The McGraw-Hill Companies Inc. 2006

[3] Hamdy Mahmoud, Heba-Talla, Interior

Architectural Elements That Affect Human Psychology and Behavior (October 19, 2017). ARChive, Vol. 1, No.1, 2017, Available at SSRN: https://ssrn.com/abstract=3055621

[4] Simon Bekker, Ilse Eigelaar-Meets, Gary Eva, and Caroline Poole. *Xenophobia and Violence in South Africa: a desktop study of the trends and a scan of explanations offered*. University of Stellenbosch. 2008.

[5] Divisi Rating dan Teknoogi Green Building Council Indonesia. Greenship Rating Tools untuk Bangunan Baru versi 1.2; Ringkasan kriteria dan tolok ukur. 2013 https://gbcindonesia.org/greens/new

[6] Moughtin C. Urban Design: Street and Square. Oxford: Architectural Press; 2003

[7] Baruti, M M, Johansson, E, Åstrand, J. Review of studies on outdoor thermal comfort in warm humid climates: challenges of informal urban fabric. International Journal of Biometeorology. 2019. 63 (10) 1449-1462

[8] Holden, R, Liversedge J. Landscape Architecture: An Introduction. London: Lauren King Publishing Ltd. 2014

[9] Divisi Rating dan Teknoogi Green Building Council Indonesia. Greenship Rating Tools untuk Existing Building versi 1.1; Ringkasan kriteria dan tolok ukur. 2016 https://gbcindonesia.org/greens/existing

[10] Ranasinghe, R., A. C. Ruane, R. Vautard, N. Arnell, E. Coppola, F. A. Cruz, S. Dessai, A. S. Islam, M. Rahimi, D. Ruiz Carrascal, J. Sillmann, M. B. Sylla, C. Tebaldi, W. Wang, R. Zaaboul, 2021, Climate Change Information for Regional Impact and for Risk Assessment Supplementary Material. In: Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Masson-Delmotte, V., P. Zhai, A. Pirani, S. L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M. I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J. B. R. Matthews, T. K. Maycock, T. Waterfield, O. Yelekçi, R. Yu and B. Zhou (eds.)]. Available from https://www.ipcc.ch/

[11] Paul Selman (2008) What do we mean by sustainable landscape?, Sustainability: Science, Practice and Policy, 4:2, 23-28, DOI:10.1080/15487733.2008.11908019

[12] World Green Building Council, "About Green Building" https://www.worldgbc.org/what-green-building

[13] United States Green Building Council, Press Room. "Benefits of Green Building" https://www.usgbc.org/press/benefits-of-green-building

[14] United States Environmental Protection Agency, 2016. "Climate Change and Heat Islands" https://www.epa.gov/heatislands/climate-change-and- heat-islands

[15] Anwar Subkiman, Kajian teori Integral dalam Efektivitas Tranformasi Kesadaran Lingkungan pada Bangunan Berkelanjutan. Jurnal Rekayasa Hijau. 2019,1 (2), 112-123

[16] Sri Novianthi Pratiwi, Ristya Arinta Safitri. Upaya Mengurangi Urban Heat Island Melalui Pemilihan Material (Studi Kasus: Rptra Meruya Selatan). Jurnal Abdi Masyarakat Indonesia, 2019, 1 (2), 42-47

[17] S.P. Honggowidjaja. Pengaruh Signifikan Tata Cahaya Pada Desain Interior. Dimensi Interior. 2003, 1 (1), 1-15

[18] Thomas W. Cook, Ann Marie VanDerZanden. Sustainable Landscape Management: Design, Construction, and Maintenance. New Jersey: John Wiley & Sons Inc. 2011

[19] Parmonangan Manurung. Arsitektur Berkelanjutan, Belajar dari Kearifan Arstektur Nusantara. Simposium Nasional APIXIII FT UMS. 2014.

[20] Peter F Smith. Architecture in a Climate of Change: A guide to sustainable design. Oxford: Architectural Press. 2005

[21] United States Environmental Protection Agency. "Heat Island Cooling Strategies" https://www.epa.gov/heatislands/heat-island-cooling- strategies

[22] Tsuyoshi Kinouchi, Tamotsu Yoshinaka, Noriyuki Fukae, and Manabu Kanda. Development Of Cool Pavement With Dark Colored High Albedo Coating. the Urban Environment, Vancouver, BC. 2004, 207-210

[23] Hadi Winarno, Damris Muhammad2, Rayandra Ashyar3 Yudha Gusti Wibowo. Pemanfaatan Limbah Fly Ash Dan Bottom Ash Dari PLTU Sumsel-5 Sebagai Bahan Utama Pembuatan Paving Block. Jurnal knika. 2019, 11 (1), 1067-1070

[24] Sid Perkins. (2019) Albedo is a simple concept that plays complicated roles in climate and astronomy. https://www.pnas.org/content/pnas/116/51/25369.full.pdf

[25] National Snow and Ice Data Center. Thermodynamics: Albedo. (2020) https://nsidc.org/cryosphere/seaice/processes/albedo.ht ml

[26] Veanti (2020) Kesetimbangan Energi di Bumi (Perspektif Iklim). https://veantiworld.com/kesetimbangan-energi-di-bumi-perspektif-iklim