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Comparative Study of Physical Design Principles in Green Hospital Concept (Case Study: Teaching Hospital)

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Abstract. A teaching hospital that pays attention to environmental impact is the main vision in developing campus teaching hospitals in Indonesia. The concept of a green hospital is a trend that needs to be followed because hospital operational activities have a fairly high impact on users and the surrounding environment. Therefore, this study aims to examine the design principles of a hospital's physical building with a green hospital concept, especially in teaching hospitals. Using a comparative study method on several study objects, the main design principles that should be applied in developing teaching hospitals with a green hospital concept can be found. Based on the results of the comparison of the three comparative objects studied, the SPETE principle (safety, patient-centeredness, efficiency, timeliness, and effectiveness) was found to be the key to developing a teaching hospital with a green concept. This principle should be applied in the physical design of the building so that the hospital building has a more positive impact on users and the surrounding environment. These five aspects certainly greatly influence the shape and physical arrangement of the hospital building so that they can be guidelines in future teaching hospitals.

Keywords: Green Hospital, Physical Design Principle, SPETE, Teaching Hospital.

1. Introduction

Hospitals are public facilities with a high level of vulnerability to the environment. The COVID-19 pandemic itself, for example, gives us an idea that hospitals in Indonesia are still very minimal in terms of capacity and quality. In addition to these factors, hospital infrastructure is also one of the keys to the success of health services in a region. This is also a special concern for academics to conduct more in-depth studies regarding how a hospital has a more positive impact, especially on users and the surrounding environment.

The concept of a green hospital is an interesting topic to research and develop. This is because the concept of a green hospital, in general has a vision of reducing the environmental impact of a hospital, which has the potential to cause hazards to the environment and worsen the condition of users in it. The physical condition of the hospital is certainly one of the parameters that need to be considered to see the success of a hospital with a green concept.

The government of the Republic of Indonesia, through the Ministry of Health, has also made the concept of a green hospital one of its concerns in developing hospital facilities. The guidelines for environmentally friendly hospitals [1] explain that the design and construction criteria for green hospitals emphasize the concept of green buildings, so this concept is relevant to adopting in the development of a physical hospital building. But is there a difference between a general hospital and a teaching hospital, of course, there is because there is an additional function in the form of education in hospital facilities that should provide educational services to prospective doctors and also the surrounding community, so hospital buildings are required to be more user-friendly, visitors, and provide education to the surrounding environment. This study aims to compare how the principles of physical design of buildings in green hospitals are applied to several case studies of teaching hospitals so that later, it is expected to get conclusions and validity related to their application in the field. This study is limited to several case studies in Malaysia and two in Indonesia. All three are the main teaching hospitals affiliated with the hospital management on campus.

2. Literature Review and Methods

2.1 Previous research review

The concept of a green hospital in an academic hospital still needs to be studied further because two main functions are accommodated in one room and one integrated area in an academic hospital [1]. However, hospitals implementing the green hospital concept and their infrastructure must also meet the criteria for sustainable green buildings [2]. Research on assessing green building performance in hospital case studies has been conducted in various locations. However, each location has unique values and problems, so assessing the level of green building performance in hospital objects will produce differences in each case study [3]. Many previous studies have discussed the general assessment of hospital green buildings [4]. However, only a few have studied specific objects, such as inpatient buildings and the main hospital building that operates 24 hours a day and seven days a week. This shows a very high level of building operation and needs special attention because the burden of hospital resources will be drained for the operation of inpatient buildings.

Many previous studies, such as those conducted, only reveal the assessment of green building performance without implementing building optimization strategies so that the level of greenness of the building can increase. [5]. Research on the specific object of educational hospital buildings in Indonesia and Southeast Asia is still rare. Therefore, a comparative study is needed to determine how the green hospital concept is applied in educational hospitals, especially in Southeast Asia. Based on the [6] criteria, the physical design of hospital buildings should meet 5 fundamental criteria: Safety, Patient-centeredness, efficiency, timeliness, and effectiveness (SPETE). These five criteria will serve as our lens in examining the application of the green hospital concept in each case study. The five basic criteria are interconnected; for example, the physical design that ensures safety must also consider the behavior and needs of patients and other users within the building. Additionally, the design should prioritize efficiency and effectiveness in construction and operation. Similarly, other criteria also mutually influence each other, so different locations and typologies may yield different results.

Research on teaching hospitals is very limited, resulting in a knowledge gap between applying green hospital concepts in educational and non-educational hospitals[7]. This is influenced by the different user activity patterns, even though in Indonesia, many general hospitals also serve as affiliated educational hospitals for certain campuses. Therefore, it is

necessary to establish specific criteria for selecting the case studies to be researched. In this study, we compare three different Teaching Hospitals. One teaching hospital is in Malaysia, while the other two are in Indonesia. Typologically, they differ: one campus serves as the Main Teaching Hospital, another as a Satellite Teaching Hospital, and the third as a Teaching Hospital in a commercial area. These distinct typologies undoubtedly significantly impact operational practices and the services provided. Therefore, the novelty of this research will provide insights into applying the green hospital concept in teaching hospitals, particularly in terms of physical design and operations.

2.2 Methods

This study uses a comparative method [8] with descriptive narrative analysis to discuss each variable studied. This method is often used to find similar or different aspects of several variables studied so that conclusions can be drawn from the research questions asked. This study took case studies in several locations, including the UCSI Malaysia Teaching Hospital, UGM Academic Hospital, and the Dr. Sardjito Yogyakarta General Teaching Hospital.

The data used are secondary data from various literature sources, both in articles and audio-visual information. The three objects are compared using tabulation techniques, and conclusions are drawn using descriptive narrative techniques. In the tabulation technique, it can be identified how the differences and shortcomings of the SPETE criteria application manifest, both in terms of physical design and operational aspects. Then, data synthesis is conducted regarding the quality of implementing these criteria and drawing conclusions on which Teaching Hospital is most appropriate based on these criteria.

3. Discussion and Result

3.1. Case Study

In this study, we have selected three case studies of Teaching hospitals with quite different characteristics, both in terms of location, status, physical design patterns, and their level of services. These three case studies were chosen to understand how the SPETE criteria are applied to each study object and to determine which Teaching hospital is most appropriate for each criterion and how the application manifests. Before conducting the analysis, here is a brief narrative about the three study objects.

3.1.1. UCSI Teaching Hospital

UCSI Hospital is the pioneer of UCSI Health Metropolis, a major project designed by Kun Lim Architect to develop Springhill City into a dynamic center for healthcare, education, and innovation. In addition to the hospital, UCSI Health Metropolis will include a luxury hotel, convention center, lifestyle shopping center, skin science and aesthetic center, sports facilities, nursing homes, practice laboratories, and a new UCSI University campus. UCSI Hospital has a site area of ±16 hectares, located at Avenue 3, Persiaran Springhill, 71010 Port Dickson, Negeri Sembilan, Malaysia. Its location is in the middle of an empty land that is still a garden in Springhill City. The distance from UCSI Hospital to the center of Port Dickson is 15 km, and to Seremban City is 20 km. Access to the site is supported by a toll exit leading to Springhill City. The UCSI Hospital is affiliated with the UCSI University Faculty of Medicine, working together on projects involving real-time big data analysis, medical expertise, and scientific innovation. This affiliation aims to educate and nurture future doctors and nurses to be their best by providing them access to a

medical institution led by UCSI Hospital specialists, supporting clinical practice and patient-centered care models, as shown in Figure 1.

Figure 1. From upper left (UCSI Teaching Hospital Building Mass , UCSI Teaching Hospital Masterplan, UCSI Teaching Hospital Emergency and Accident Installation, UCSI Teaching Hospital Emergency Room.) From the Bottom Left (UCSI Teaching Hospital Operation Teather, UCSI Teaching Hospital Block-Plan, UCSI Teaching Hospital Landscape Design, and The last is UCSI Teaching Hospital Location on maps).

3.1.2. UGM Academic Hospital

UGM Academic Hospital has been designated as a Satellite Teaching Hospital for Dr. Sardjito General Hospital and FK-KMK UGM based on the Decree of the Minister of Health of the Republic of Indonesia. This hospital offers integrated services focusing on quality for the Hospital Community and patients. In the context of the capacity of Dr. Sardjito General Hospital, which is not balanced with the number of students, the development of the hospital as a place for clinical education is crucial to maintain the quality of graduates in the health sector according to UGM's vision as a World Class Research University. UGM Hospital addresses the challenges of developing global hospital services that tend to be integrated, multi-professional, and comprehensive. This is the background to establishing the Gadjah Mada University Academic Hospital.

UGM Hospital, previously named Academic Hospital on January 4, 2010, was then updated on March 1, 2011, to become UGM Academic Hospital. The RSA UGM building has five floors and occupies an area of 44,637 m2 with a total building area of 9,282.5 m2. It is located on Jalan Kabupaten (Ring Road), Kronggahan, Trihanggo, Gamping, Sleman, Yogyakarta, Indonesia, which is directly adjacent to the rice field area and is located in a non-dense residential area. Currently, RSA UGM has developed into a large class-A hospital, with more than 750 beds and more than 3000 employees. This hospital is important in educating doctors, specialist and sub-specialist doctors, nurses, nutritionists, pharmacists, and other health fields, as shown in Figure 2.

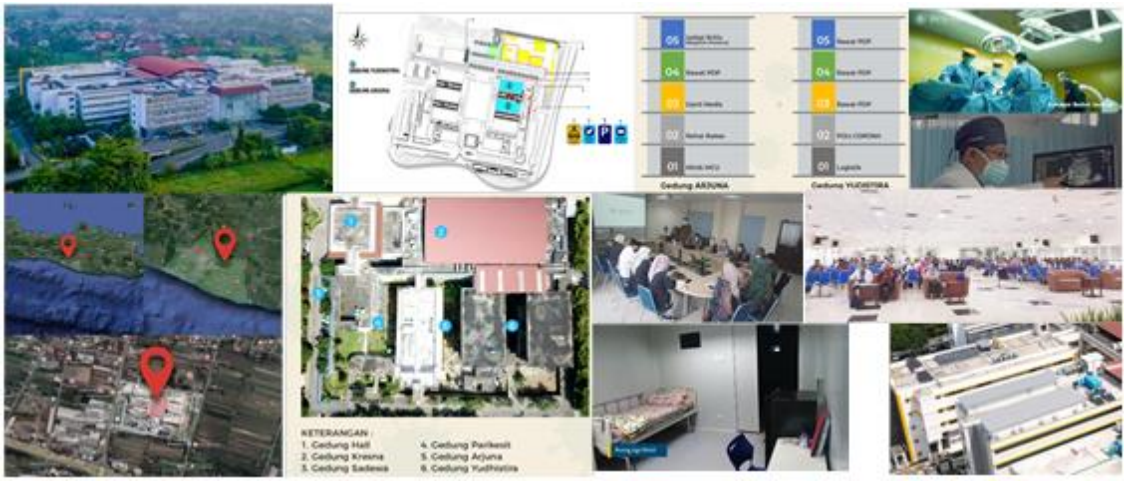

Figure 2. From upper left (UGM Academic Hospital Building Mass , UGM Academic Hospital Block-Plan, UGM Academic Hospital each floor function, UGM Academic Hospital Operation Teather and Obgyn Clinic) From the Bottom Left (UGM Academic Hospital Location on Map, UGM Academic Hospital Building Mass Plan, UGM Academic Hospital Academic discussion room and Student dormitory, UGM Academic Hospital Hall and the sustainable energy resources installation (PV) on the building rooftop).

3.1.3. Dr. Sardjito General and Teaching Hospital Yogyakarta

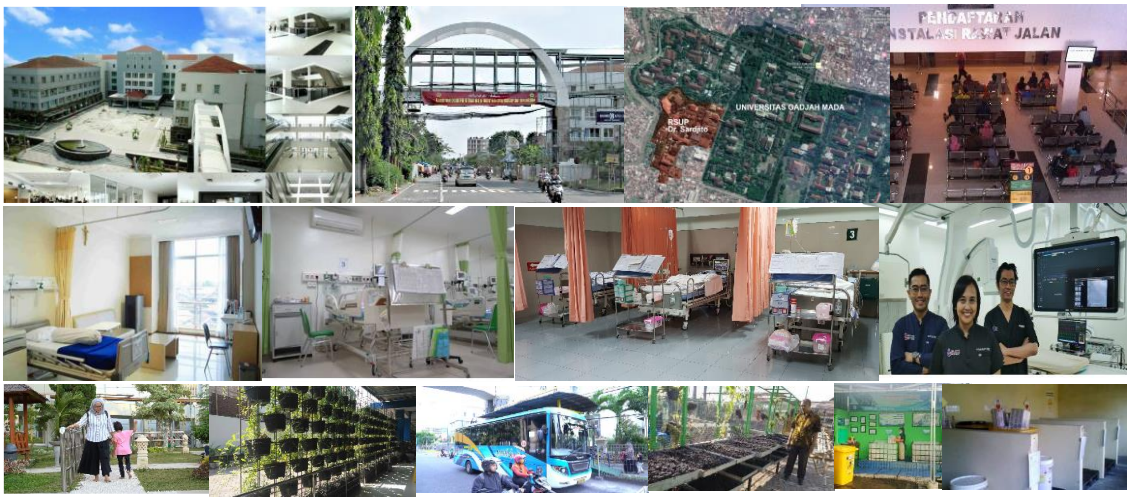

Figure 3. From upper left (Dr.Sardjito Hospital Building Mass , Dr.Sardjito Hospital Location (beside the UGM campus), Dr.Sardjito Hospital polyclinic, From middle left (Dr.Sardjito Hospital Inpatient Room, Dr.Sardjito Hospital ICU Room, Dr.Sardjito Hospital Emergency Room, Dr.Sardjito Radiology Room). From the Bottom Left (Dr.Sardjito Hospital Landscape design, Dr.Sardjito Hospital vertical garden, Dr.Sardjito Hospital Bus Shelter, Dr.Sardjito Hospital non medic waste management).

Dr. Sardjito Hospital, known as Sardjito Hospital, is a general hospital in Yogyakarta. The address is at Jl. Kesehatan Jl. Kesehatan Sendowo No.1, Sendowo, Sinduadi, Kec. Mlati, Sleman Regency, Special Region of Yogyakarta. Dr. Sardjito Hospital is a Class A General Hospital with a building area of 60,373.69 M on 8.3 hectares and a capacity of 903 beds, the highest referral in the Special

Region of Yogyakarta Province and southern Central Java. Thus, Dr Sardjito Hospital is a health service centre, health education centre, and research development centre.

In addition to medical services, Dr. Sardjito Hospital provides referral services for medical and non-medical knowledge and skills. As a type B teaching hospital, Dr. Sardjito Hospital plays an important role in training doctors and specialist doctors. Since the idea stage, Dr. Sardjito Hospital has proposed that this hospital become a teaching hospital so that its location is directly adjacent to the Faculty of Medicine, Public Health, and Nursing UGM to facilitate affiliation between the two. Supporting the affiliation is a connecting bridge that facilitates access from the Outpatient Installation (IRJ) of Dr. Sardjito Hospital with the Radiopoetro Building of FK UGM as shown in Figure 3.

3.2. Comparison of Physical Design Principles

In this study, we have selected three case studies of Teaching hospitals with quite different characteristics, both in terms of location, status, physical design patterns, and their level of services. These three case studies were chosen to understand how the SPETE criteria are applied to each study object and to determine which Teaching hospital is most appropriate for each criterion and how the application manifests. Before conducting the analysis, here is a brief narrative about the three study objects.

3.2.1. Physical Design of UCSI Teaching Hospital, Malaysia

Location and Layout : (1) UCSI Hospital is located on a 16-hectare site in Springhill, Port Dickson, with two primary blocks covering an area of approximately 4,645 square meters. (2) Block 1: A medical campus dedicated to academic functions like lecture halls, seminar rooms, and a library. (3) Block 2: The hospital block, covering 4,645 square meters, includes over 500 inpatient beds and dedicated spaces for skills training in nursing and multi-discipline labs. These facilities support the UCSI Medical Faculty's educational focus.

Sustainable Design Features: Orientation and Landscaping: (1) The building's orientation follows a north-south axis, reducing direct solar gain in Malaysia's tropical climate. (2) Landscaping incorporates roof, sky, and courtyard greens to enhance microclimate control, with a combined green space area of 10.6 hectares.

Local Materials and Passive Design: (1) Locally sourced materials that suit Malaysia's tropical conditions help optimize passive cooling and ventilation. (2) Roof gardens and wall shading further reduce energy needs by providing natural insulation and shaded walkways.

Green Building Systems: (1)Energy and Water Management: The hospital incorporates solar panels that generate renewable electricity, significantly lowering energy demands. (2) Rainwater harvesting systems reduce the reliance on potable water, supplying water for non-drinking purposes. (3) Energy-efficient Lighting: LED lighting throughout the facility minimizes energy usage, contributing to both cost savings and reduced environmental impact.

3.2.2. Physical Design of UGM Academic Hospital, Yogyakarta

Location and Layout : (1)Situated in Sleman, Yogyakarta, the UGM Academic Hospital covers a 44,637 square meter plot. (2) The hospital's main building spans five floors with a total built area of 9,282.5 square meters. (3) Cluster Design: Designed in clusters, the layout supports integrated healthcare and educational functions, with departments arranged to encourage multi-professional collaboration and interprofessional learning.

Sustainable Design Features: (1) Natural Lighting and Ventilation: Each room includes large windows and open spaces for natural lighting and air circulation, creating a healthier

environment for patients and staff. (2) Lightweight Materials: Non-conventional materials, such as sandwich panels, reduce construction time and environmental impact, ensuring swift, clean installations and lower embodied energy in the building. (3)Renewable Energy Integration: Solar photovoltaic (PV) panels on the roof support renewable energy use, minimizing dependence on fossil fuels and cutting energy costs.

Green Building Systems: (1) Advanced Water and Waste Management: Wastewater is treated using a Reverse Osmosis (RO) system to recycle water for non-potable uses. Water-saving fixtures, such as efficient flush systems, further reduce water consumption. (2) HVAC and Lighting Efficiency: Retrofitted LED lights replace conventional bulbs throughout the building, saving energy and reducing heat load. Smart building systems adjust HVAC and lighting based on occupancy, which lowers operational costs and minimizes environmental impact[9]. (3) Digital Healthcare: A hospital-wide digital system supports paperless operations, improving workflow efficiency and reducing paper waste. An online platform also allows patients to check schedules, access information, and streamline appointments, minimizing waiting times.

3.2.3. Physical Design of RSUP Dr. Sardjito, Yogyakarta

Location and Layout : (1) RSUP Dr. Sardjito spans an 8.3-hectare plot with a built-up area of 60,373.69 square meters. It is directly connected to the UGM Faculty of Medicine, enhancing accessibility for students and faculty through connecting walkways. (2) Integrated Medical and Educational Spaces: The layout features various medical specialties, emergency and surgical units, and extensive spaces for teaching and research. This integration supports high-level medical education and clinical care[10].

Sustainable Design Features: (1) Landscape and Green Areas: The hospital's landscape design includes vertical gardens, terrace gardens, roof gardens, and healing gardens. A medicinal plant garden and hydroponic plant installations provide visual appeal and therapeutic benefits. (2) Low-impact Building Materials: Non-toxic materials such as PE and PPR piping are used instead of traditional PVC to reduce the building's environmental footprint. The walls feature paints free of mercury and other harmful chemicals, improving indoor air quality and safety.

Green Building Systems: (1) Composting and Waste Segregation: The hospital has a waste management system with composting facilities and a waste bank to process and recycle waste. Organic waste from the cafeteria and gardens is composted and used to fertilize the hospital's green spaces. (2) Rainwater Harvesting and LED Lighting: Over 600 biopores and 70 water absorption wells are spread across the site to absorb rainwater, minimizing stormwater runoff and helping replenish groundwater. (3) Energy-efficient LED lighting replaces traditional lighting, saving costs and lowering the facility's energy footprint[11], [12].

Table 1. Safety and Patient-centeredness Criteria Application Comparison between Three Case Studies

	UCSI Teaching Hospital	UGM Academic Hospital	Dr. Sardjito Teaching Hospital
Safety*	The location is quite far from residential areas, and there is a lot of green space Distinguish between infectious and non-infectious areas Inclusive design for all purposes, including hospitality services Has sterilisation rooms for students	Located around the campus area. Focus on non-infectious spaces Inclusive design with easy-to-access circulation patterns The design prioritises user safety (because there are academic support facilities - separation of functions and hierarchy of sterile rooms) It has sterilisation rooms and also a dormitory for students	This is a class A regional general hospital Complete facilities with differentiated infectious and non-infectious services The sterile room hierarchy is very strict to ensure user safety and security and the use of an advanced waste management system.
Patient-centeredness	Using modern design, the building design is dynamic and not rigid and pays attention to visual comfort and space The location is close to the resort, making it possible for patients seeking treatment to stay at the resort because it is only 10 minutes from the UCSI Teaching Hospital (Travel Healthcare)	The compact building design with a centralized circulation pattern makes it easier to mobilize patients within the site The space design pays attention to visual comfort and views facing the void, which is a transitional green space between building masses. There are complete support facilities for patients and patient waiters	The service rooms are grouped into several main services so that patients can easily access them according to their needs, and each Polyclinic is separate with very complete facilities Building density reduces the view of users and patients Linear service flow minimises shuttles

* safety criteria based on mass building, room, hierarchy and function, and infected potential area

Table 2. Efficiency and Timeliness Criteria Application Comparison between Three Case Studies

	UCSI Teaching Hospital	UGM Academic Hospital	Dr. Sardjito Teaching Hospital
Efficiency*	The elongated shape makes the space quite efficient and makes maintenance easier The use of transparent materials in some spaces can reduce artificial lighting and energy centralised circulation patterns so that mobility becomes efficient	The compact shape makes circulation and space efficient and easy to maintain. The hierarchical grouping of installations makes the utility system less complicated and efficient, thereby reducing the building's embodied energy. placing medical and pharmaceutical support warehouses close by reduces mobility	The grouping of polyclinics and service centre units creates efficient circulation and utility patterns, thereby reducing operational costs The specialist doctor station becomes more centralised according to the service building, reducing mobility
Timeliness**	Different outpatient and inpatient clinic space patterns make service fast There needs to be a shuttle service for those who choose the travel health care package because the distance between the hospital and the resort is 10 minutes, but this service is prioritised for non-emergency services The services within the hospital itself are quite easy in terms of speed and responsiveness due to the centralised arrangement of medical support facilities in the middle	Medical support facilities are located on the ground floor, making it easier to load and distribute. The downside is that vertical transportation is the backbone of building operations The compact location makes service speed faster and more responsive Mobilisation time in the building is quite short because of this centralised circulation pattern	Grouping polyclinics makes services fast and specific The mobility of doctors and medical professional students does not take much time just to mobilize within the building The flow in the building is quite complicated because it is a type A hospital building which has complete and varied services, but the distance between buildings is not too far, making the service faster and more responsive.

*Efficiency based on the building mass and shape, circulation, room organization, and also the utility

**Timeliness based on the building accessibility, hierarchy, room separation and transportation

Table 3. Effectiveness Criteria Application Comparison between Three Case Studies

	UCSI Teaching Hospital	UGM Academic Hospital	Dr. Sardjito Teaching Hospital
Effectiveness*	The effectiveness of the building envelope in supporting natural lighting is very good because there are many openings and open spaces outside The elongated building design with large open spaces allows the use of a natural ventilation system in the building The quality of lighting in the building is quite good with a fairly high proportion of room heights and several secondary skins to reduce glare but introduce natural light smoothly	The presence of shading devices on the facade reduces glare and also direct solar radiation to the building mass The use of voids between buildings makes natural lighting in the building quite effective The existence of a green transition space means that noise can be reduced quite well	The varying building designs are generally oriented towards the north and south sides for the openings, which pay close attention to climatic conditions so that natural lighting will be effective. The density of the building and several voids in the building make noise from the road low.

* Effectiveness based on the function and room quality

3.3. Evaluation and Finding

This evaluation suggests that while each hospital excels in different SPETE criteria, UCSI Educational Hospital and RSUP Dr Sardjito frequently emerge as leaders, with RS Akademik UGM providing notable patient-centred services. These findings could serve as guidelines for optimizing green hospital designs in teaching environments. Suppose we focus strictly on the physical design aspects of the three hospitals and assess them using the SPETE criteria (safety, patient-centeredness, efficiency, timeliness, and effectiveness). In that case, we can narrow down which hospital's architectural and structural features best align with each criterion[13].

The most appropriate hospital for this Safety Criteria is RSUP Dr Sardjito because the physical design includes highly specialised areas dedicated to intensive care and burn treatment, essential for patient safety. These areas are equipped with isolation rooms and negative-pressure environments, which physically reduce the risk of infection and contamination. Additionally, the hospital layout supports secure patient flow, reducing accident risks and enhancing emergency response efficiency Table 1.

The most appropriate hospital for Patient-Centeredness criteria is RS Akademik UGM because its physical design includes spacious, comfortable inpatient rooms, green roofing, and vertical gardens, all of which contribute to a therapeutic and patient-centred environment. Natural light and ventilation enhance comfort, while dedicated telemedicine and consultation

spaces support a calming and patient-focused experience[14]. The overall design considers patient comfort and interaction with natural surroundings, which aligns with a patient-centred approach Table 1.

The most appropriate hospital for efficiency criteria is UCSI Educational Hospital. Its physical design incorporates energy-efficient technologies, such as solar panels, LED lighting, and rainwater harvesting systems, to reduce operational demands[15]. These features support resource conservation and operational efficiency, impacting the hospital's energy footprint. Additionally, UCSI's layout minimises patient movement within the hospital, allowing for a more streamlined experience that reduces unnecessary resource usage Table 2.

The most appropriate hospital for timeliness criteria is RSUP Dr Sardjito because The physical design of RSUP Dr Sardjito emphasizes quick access to emergency services, with a centralized emergency department that is well-connected to key treatment areas, enabling swift patient transfer. The hospital's proximity to main transport routes and well-designed triage areas allow for rapid response times[16]. Otherwise, the integrated waste management area and the utility in the hospital support the timeliness criteria for waste management in the RSUP Dr. Sardjito. This physical arrangement supports quick access for emergency cases, enhancing timeliness Table 2.

The most appropriate hospital for effectiveness criteria is UCSI Educational Hospital because integrating educational facilities within the hospital's physical layout supports healthcare and teaching effectiveness. Dedicated spaces for problem-based learning (PBL), simulation labs, and digital anatomy facilities enable students to learn near clinical areas, allowing theoretical knowledge to be applied immediately in practical settings[17]. This cohesive layout contributes to effective learning and patient care delivery, making UCSI's physical design the most supportive of effectiveness in a teaching hospital context. The quality of daylighting, large landscaping, and the elongated building mass are the effectiveness criteria because the building shape potentially maximizes the natural resources inside the building [18](Table 3).

4. Conclusion

Based on the results of the comparison of the three comparative objects studied, the SPETE principle (safety, patient-centeredness, efficiency, timeliness, and effectiveness) was the key to developing a teaching hospital with a green concept. This principle should be applied in the physical design of the building so that the hospital building has a more positive impact on users and the surrounding environment. These five aspects certainly greatly influence the shape and physical arrangement of the hospital building so that they can be guidelines in future teaching hospitals.

Based on the comparison and evaluation, we can conclude that every teaching hospital has applied the green hospital concept, especially on the SPETE criteria, with the finding as : (1) Safety: All hospitals incorporate specific design elements and protocols to prioritize patient safety. UCSI emphasizes technological integration for real-time data tracking, while RS Akademik UGM and RSUP Dr. Sardjito focus on isolation capabilities within critical care units. (2) Patient-Centeredness: Each hospital offers unique patient-centred initiatives. UCSI's health tourism packages cater to personalized needs, RS Akademik UGM uses telemedicine for remote engagement, and RSUP Dr. Sardjito offers comprehensive community outreach and education.
(3) Efficiency: All hospitals implement digital and energy-saving solutions. UCSI and RS Akademik UGM focus on digital administration and patient flow, while RSUP Dr. Sardjito's automated systems provide further energy efficiency. (4) Timeliness: Emergency response capabilities are well-integrated into all three hospitals. UCSI and RSUP Dr. Sardjito benefit from their proximity to

major roads, while RS Akademik UGM enhances timeliness through well-organized emergency and ICU care. (5) Effectiveness: The effectiveness of care in all hospitals is supported by integrating educational and healthcare facilities, enabling practical learning experiences and access to advanced treatment methods. Each institution's approach to sustainable design also positively impacts patient outcomes.

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