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Retrofitting Healthcare Facility Based on Regulation of Green Performance Assessment in Indonesia

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Abstract. The construction and building sector are growing rapidly, on the other hand, the world is facing a new challenge to adapt the green method in order to maintain the environment sustainability. The major environmental issues such as resources, air, water, energy has become a global issue for decades. Based on data from World Green Building Council, the building and construction sector globally responsible for 36% of energy consumption, 38% of energy-related carbon emissions, 50% of resource consumption, and expected to double in total footprint by 2060. The government as a prime mover of a nation have to take an action for encouraging people to immediately implementing the green building concept, by issuing an official regulation that applies nationally and set a feasible standard for actualization. This study aims to give a better understanding about the new regulations and which factors are most influential based on previous studies.

INTRODUCTION

The major environmental issues such as resources, air, water, energy has become a global issue for decades. Based on data from World Green Building Council, the building and construction sector globally responsible for 36% of energy consumption, 38% of energy related carbon emissions, 50% of resource consumption, and expected to double in total footprint by 2060[1]. This directly indicates that building and construction must be held responsible for the notably sources of environmental damage, and a numerous of mandatory and voluntary drivers for firm and sector-level change have evolved to influence changes within the industry.

Along with the raised awareness of the environmental issues, green building has been gradually popularized and implemented increasing number of countries, and has become the main direction of the development of the building industry in the world[2]. Green building allows for the creation of environmentally efficient buildings through the use of an integrated design approach, reducing the negative impact of buildings on the environment and occupants. As a design tool, it can set sustainable design priorities and goals, develop appropriate sustainable design strategies, and determine performance measures to guide the sustainable design and decision-making processes. It can also be used as a management tool to organize and structure environmental concerns during the design, construction, and operations phases[3]. Green design does not only make a positive impact on public health and the environment, it also reduces operating costs, enhances building and organizational marketability, increases occupant productivity, and helps create a sustainable community[4]. Generally, green buildings are energy efficient, water conserving, durable and non-toxic, with high-quality spaces and high-recycled content materials, which presents solution for our environmental issues. Consequently, understanding green buildings is vital, which highlights the need of green rating tools to assess the performance of buildings.

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Many governments and non-profit organization developing a green building assessment tool worldwide. One of the earliest and most profound assessment tools is the UK’s Building Research Establishment Environment Assessment Method (BREEAM) developed in the year 1990. The main function of this assessment tool primary on building specification evaluation including the design, construction and use[5]. Leadership in Energy and Environmental Design (LEED), the second oldest tool established in the year 1998 which was Developed by United States Green Building Council (USGBC). Currently there are 135 countries implementing LEED as certification assessment tools. Similar to BREEAM, LEED has also been the earliest model that is being adopted and modified accordingly to one countries environment and nature[6]. Green Star is a voluntary sustainability rating system first launched in 2003 by the Green Building Council of Australia[7]. The Green Star rating system focusing on 9 criteria; Management; Indoor Environment Quality; Energy; Transport; Water; Materials; Land Use & Ecology; Emissions and Innovation. Indonesia has Greenship, a rating tool developed by Green Building Council Indonesia, an independent not for profit organization founded in 2009 by leading professionals and companies in the building industry.

Nevertheless, green and sustainable buildings have attracted the attention of Indonesian governments. The publications of Regulation of the Ministry of Public Works and Public Housing No. 21 of 2021 on Assessment for Green Building Performances is a benchmark for remarkable action to encourage people implementing green building in Indonesia. There are 2 categories of buildings, recommended and mandatory, building coverage for this assessment are New Buildings, Existing Buildings, Green Community Residential, and Green Areas. There are five schemes for New Building Assessment in each phase; Planning Phase, Engineering Design Phase, Construction Phase, Utilization Phase, and Demolition Phase. Two schemes are available for two steps of implementation in Existing Building; Utilization Phase, and Demolition Phase. Green Community Residential has four schemes as follow; Administration Preparation, Construction Phase, Utilization Phase, and Demolition Phase. Green Areas has four schemes assessment; Engineering Design Phase, Construction Phase, Utilization Phase, and Demolition Phase.

Many studies have been conducted on adaptation of green building concept for new buildings, but only a few have been conducted on existing buildings. Whereas in developing countries, the number of new buildings is only 2% from total number of buildings, implying that approximately 98 percent of the total number of buildings are existing buildings. The aim of this study is to gain a better understanding of green building criteria performance assessment for existing building, particularly on healthcare facility based on the new Regulation of the Ministry of Public Works and Public Housing No. 21 year 2021 and which factors are most influential based on the previous studies.

Green Building

The development of buildings can be traced back to the energy crisis of the 1960s, which inspired important research and activities to improve energy efficiency and reduce pollution. Combined with the energetic environmental movement of the time, these early experiments led to the contemporary GB movement, which stems from the focus on energy-saving and environmentally-friendly building practices. Green buildings are not the same across the worlds, the definition corresponds to the requirements of the development of the construction industry in countries and regions. Table 1 shows some GB definitions from different organizations.

TABLE 1. List of Green Building Definition

Country	Organization	Definition
USA	World Green Building Council	A GB is a building that, in its design, construction, or operation reduces or eliminates negative impacts, and can create positive impacts, on our climate and natural environment [8]
	U.S. Green Building Council (USGBC)	Building planning, design, construction, and operation with some central and superficial considerations: Impact on energy consumption, water consumption, indoor climate quality, material consumption, and building location[9].
UK	Building Research Establishment	The GB Certification BREEAM could represent the concept of GBs that are more sustainable environments that promote the well-being of the people who live and work there, conserve natural resources and make more attractive real estate investments[10].

TABLE 1. Continued

Country	Organization	Definition
German	German Sustainable Building Council (DGNB)	Sustainable buildings mean conscious use and deployment of existing resources, minimizing energy consumption and protecting the environment [11].
France	Haute Qualite Environment (HQE)	Certified sustainable buildings confirms the overall performance of the building and the performance of the four areas (energy, environment, health and comfort) considered by the certification system.[12].
Australia	Green Building Council Australia	Green Building integrate principles of sustainable development, confluence the needs of the present without compromising the future[12].
Singapore	Inter-Ministerial Committee on Sustainable Development (IMCSD)	Green building is energy and water efficient, with a high quality and healthy indoor environment, incorporate with green spaces and constructed from eco-friendly materials[13].

Regulation of the Ministry of Public Works and Public Housing No. 21 of 2021

Green Performance Assessment Tool are considered as one of the most powerful and effective ways to improve building performance. In the last decade, numerous of assessment tools have been and are being developed by the government or profit and non-profit organizations worldwide. Indonesia government created Green Performance Assessment Tool which attached in Regulation of the Ministry of Public Works and Public Housing No. 21 of 2021. The regulation describing Green Building as a building which fulfill the standard of technical building and has measurable significant performance in saving energy, water, and other resources through the application of Green Building principles according to the function and classification in each phase of building life-cycle. While, the application of green building concept to an existing building called *Retrofitting,* retrofitting is an effort to adjust the building performance that has been utilized to meet the requirements of green building standard.

New buildings and existing buildings classified as mandatory explained as follow:

a) Building class 4 (Residential Building) and 5 (Commercial and Office Building) with 4 story and minimum area 50.000 m^2,
b) Building class 6 (Commercial Only), 7 (Warehouse) and 8 (Laboratory and Industrial Building) with 4 story and minimum area 5000 m^2,
c) Building class 9a (Healthcare Facility) with minimum area 20.000 m^2,
d) Building class 9b (Convention Center) with minimum area 10.000 m^2,

Other specific buildings above classified as recommended category. There are two schemes to assess existing building performance; Utilization Phase and Demolition Phase. Utilization Phase is a phase of operating building accordance with predetermined functions and classifications, such as maintenance, and periodic inspection activities in accordance with green building requirements. Demolition is a phase of dismantling or demolishing all or part of a building, its components, building materials, and/or its infrastructure and facilities. The following are Green Performance Indicator scoring for Utilization Phase in an existing building based on Regulation of the Ministry of Public Works and Public Housing No. 21 of 2021.

TABLE 2. Green Performance Indicator for Utilization Phase based on Regulation of the Ministry of Public Works and Public Housing No. 21 of 2021

No.	Parameter	Points
A.	**Green Building Organization and Governance**	**83**
1	Environmental Conservation Policy and Standard Operational Procedure for Green Building Utilization	18
2	Regulation requirements	2
3	Operation and Maintenance Methods and Performance	5
4	Emergency Response	1
5	Building Management Capacity Development	4

TABLE 2. Continued

No.	Parameter	Points
6	Retrofitting Planning for Performance Adjustment	53
B.	**Retrofitting Construction Process**	**26**
1	Green Construction for Retrofitting Process	13
2	Retrofitting Construction Report	13
C.	**Maintaining Green Building Performance during Utilization Phase**	**50**
1	Site Management	1
2	Energy Use Efficiency	16
3	Water Use Efficiency	13
4	Indoor Air Quality	9
5	Waste Management	9
6	Wastewater Management	2
D.	**The Role Of The Owner/User Of The Green Building**	**6**
	TOTAL	**165**

According to the table above, indicator with highest points for utilization phase assessment is Green Building Organization and Governance category where Retrofitting Planning for Performance Adjustment gives 53 points. Maintaining Green Building Performance during Utilization Phase also has a significant point with 50 points. The two categories are promising to fulfil in order to receive high marks. Green Performance Indicator scoring for Demolition Phase in an existing building are assessed as below,

TABLE 3. Green Performance Indicator for Demolition Phase based on Regulation of the Ministry of Public Works and Public Housing No. 21 of 2021

No.	Parameter	Points
A.	**Demolition Procedures**	**95**
1	Documentation of Building Construction Materials	14
2	Documentation of the Structure and/or Part of the Building to be Demolished	48
3	Documentation of Materials and/or Waste to be Reused	33
B.	**Environmental Site Recovery Efforts**	**70**
1	Building Site Recovery Efforts	52
2	Construction Waste Management Efforts	17
	TOTAL	**165**

Documentation of the Structure and/or Part of the Building to be Demolished, and Building Site Recovery Efforts are two indicators with highest point for Demolition Phase assessment. Table below shows the rating benchmark of existing building based on Regulation of the Ministry of Public Works and Public Housing No. 21 of 2021.

TABLE 4. Score Rating

No	Rating	Percentage (of Total 165 Points)
1	Pratama	45% - 65%
2	Madya	>65% - 80%
3	Utama	> 80% - 100%

METHODOLOGY

This study is divided into five stages, the first step in this research is to conduct a literature review about Green Building and Green Assessment. Second, conduct a semi-structured interview with Projects Experts, Project Planners, and Green Experts consisted to justify and validate the previous literature review findings. Third, create a questionnaire based on main categories that have been determined and described with indicators of the application of the green building concept in healthcare facilities, using the literature and green rating system. These indicators are transformed into research variables that is graded on a likert scale. Step four involved conducting a survey by distributing questionnaires to gather information from expert perceptions about the most influence factors in retrofitting of a healthcare facility project. Step five is to process the survey results, using Social Science Statistical Package (SPSS).

Based on the previous study, the application of Green Building in Healthcare Facility consists of the following key indicator,

TABLE 5. Green Building Indicator

Variable	Aspects	Indicator
X1-1	Material	Solar cell[14]
X1-2		Glass[14]
X1-3		AC VRV[15]
X1-4		LED Lamp[16]
X1-5	Appropriate Design	Landscape[17]
X1-6		Public Transport[17]
X1-7		Environment Sustainability[17]
X1-8		Accessability[17]
X1-9		Visual Comfort [18]
X1-10	Water Conservation	Water Consumption[17]
X1-11		Alternate resource[17]
X1-12		Water Efficiency[17]
X1-13	Air Quality	Monitoring Carbon Emission[17]
X1-14		Thermal Comfort[17]
X1-15	Energy Conservation	Energy Consumption[19]
X1-16		Control and Monitor Energy[20]
X1-17		Renewable Resource[17]
X1-18		Building Energy Performance[20]
X1-19		Energy Efficiency[16] [17]
X1-20		Natural Light[18]
X1-21	Stakeholder Support	Green Building Commitment[21]
X1-22		Regulation and Incentive[22]

TABLE 6. Healthcare Facility Indicator

Variable	Aspects	Indicator
X2-1	Design	Lighting[23]
X2-2		Air Quality[23]
X2-3		Water Consumption[24]
X2-4		Acoustic Comfort[25]
X2-5		Visual Comfort[25]
X2-6	Economic	Cost[25]
X2-7	Social	Improve Wellness[26]
X2-8		Reduce Infection Rate[27]
X2-9		Patients Safety[27]
X2-10		Recovery Rate[27]

From the above factors, the variables that have the most influential factor on retrofitting healthcare facility are obtained. The questions raised in the questionnaire use likert scale, which is used in surveys and an independent scoring scale used to measure the level of respondents' opinions on a certain question. The likert scale used in this questionnaire is in the scale of 1 to 6, whereas 1 = "Very Strongly Disagree"; 2 = "Strongly Disagree"; 3 = "Disagree"; 4 = "Agree"; 5 ="Strongly Agree"; 6 = "Very Strongly Agree".

RESULTS AND DISCUSSION

The Most Influential Factor

The process using Social Science Statistical Package (SPSS) is carried out. After determining each aspect and indicator, the next step is to synthesize to obtain the total weight of existing standard. The result data below shows the overall ranking of the strongest influential factor in retrofitting healthcare facility based on this research.

TABLE 7. the Most Influential Factor on Retrofitting Healthcare Facility

Indicator
Energy Efficiency[16] [17]
Building Energy Performance [20]
Monitoring Carbon Emission [17]
Water Efficiency[17]
Air Quality[23]
Visual Comfort[18][25]
Acoustic Comfort[25]
Environment Sustainability[17]
Green Building Commitment[21]
Recovery Rate[27]

Healthcare facility known to have a large energy consumption from various factors and energy systems, such as building envelopes, orientation, room configuration, HVAC systems, lighting systems, occupant's behavior, refrigerant, office equipment and particularly the medical equipment. The large energy consumption outcome energy efficiency to the most influence factors in green building performance, various rating systems in the world also give high points to energy category, such as LEED, BREEAM, BCA Green Mark and the latest green assessment recently released by Indonesian government, Regulation of the Ministry of Public Works and Public Housing No. 21 of 2021 also give high points to energy, 34 points were given for Planning Retrofitting of Energy Use Efficiency and 16 points to Building Energy Performance during the Utilization Phase.

Kun Lu et al.[28] conducted a study to calculate carbon emission in a healthcare facility building located in Anhui, China and the results show that the reinforced concrete engineering contributes to the largest proportion of carbon emissions (around 49.64%) in the construction stage, and the HVAC (heating, ventilation, and air conditioning) generates the largest proportion (around 53.63%) in the operational stage[28]. Building with conventional concept in fact produce high carbon emission during the utilization phase which may led to the climate, therefore it is required to escalate the existing building performance towards the net zero carbon building, Indonesian government has realized this and made several building categories mandatory for applying the concept of green building, including healthcare facility building if the area is more than 20,000 m^2 based on the Regulation of the Ministry of Public Works and Public Housing No. 21 of 2021.

Water consumption for healthcare facility is high, therefore water conservation is the right method to do to save the water for the future. Water conservation for green building can be achieve by water metering, harvesting rainwater, greywater recycling and reuse, using water fixture and alternative water resources. Good air quality gives a significant influence for occupant wellness, this becomes very important, particularly for healthcare facility. The concept of green building supply more fresh air than conventional buildings, avoid certain materials that are sources of indoor air contaminants, provide individual thermal comfort control and offer improved maintenance[29]. A good air quality will also reduce the infection risks and increase the recovery rate. Therefore, air quality is equally important for both green buildings and healthcare facility.

Indoor Environmental Quality consists of visual and acoustics comfort. Daylight factors, luminance, and luminance intensity all are the main contributor to visual comfort[25]. Besides, when considering noise and room acoustics, the most important parameters are sound pressure level and reverberation time[25]. Both are priorities when it comes to healthcare facility based on green building concept, if both factors can meet according to the standards, it will give a good impact and also increase the patient's recovery rate. All factors mention in Table 5 and Table 6 aim to reach the environmental sustainability, and another factor that should not be overlooked is the stakeholders' commitment for implementing the green building concept.

CONCLUSION

The construction and building sector is growing rapidly, on the other hand the world is facing new challenges to adapt green methods to preserve the environment. From construction phase to utilization phase of building, adapting the green concept will bring more feedback, such as cost efficiency and environmental protection for the next generation. Based on research from previous studies it shows that the most influential factors for retrofitting healthcare facility are; energy efficiency; building energy performance; monitoring carbon emission; water efficiency; air quality; visual comfort; acoustic comfort; environment sustainability; green building commitment; and recovery rate. The Indonesian government has issued a new regulation to promote the green building concept and this should be followed by an incentive policy to encourage green building development and retrofitting. The results of this study can be a recommendation for healthcare facility that will retrofit existing buildings.

REFERENCES

[1] "The Net Zero Carbon Buildings Commitment | World Green Building Council." https://www.worldgbc.org/thecommitment (accessed Oct. 09, 2021).

[2] Y. Shi and X. Liu, "Research on the literature of green building based on the web of science: A scientometric analysis in citespace (2002-2018)," *Sustain.*, vol. 11, no. 13, 2019, doi: 10.3390/su11133716.

[3] H. H. Ali and S. F. Al Nsairat, "Developing a green building assessment tool for developing countries - Case of Jordan," *Build. Environ.*, vol. 44, no. 5, pp. 1053–1064, 2009, doi: 10.1016/j.buildenv.2008.07.015.

[4] K. M. Fowler and E. M. Rauch, "Sustainable Building Rating Systems Summary," *Contract*, no. July 2006, pp. 1–55, 2006.

[5] "Introduction." https://www.breeam.com/communitiesmanual/content/00_introduction/03_introduction.htm (accessed Oct. 07, 2021).

[6] J. D. Reed, "International Comparison of Sustainable Rating Tools," *JOSRE*, no. January, pp. 1–15, 2014, doi: 10.1515/9781400827688.1.

[7] Green Building Council of Australia, "A decade of Green Building," p. 37, 2010, [Online]. Available: https://www.gbca.org.au/uploads/170/34474/A_decade_of_green_building_.pdf.

[8] "World Green Building Trends 2018 SmartMarket Report | World Green Building Council." https://www.worldgbc.org/news-media/world-green-building-trends-2018-smartmarket-report-publication (accessed Sep. 21, 2021).

[9] "What is green building? | U.S. Green Building Council." https://www.usgbc.org/articles/what-green-building (accessed Sep. 21, 2021).

[10] "BREEAM: What is BREEAM?" https://web.archive.org/web/20150923194348/http://www.breeam.org/about.jsp?id=66 (accessed Sep. 21, 2021).
[11] "Sustainable building | DGNB." https://www.dgnb.de/en/topics/sustainable-building/ (accessed Sep. 21, 2021).
[12] "HQE benefits - HQE certification advantages." https://www.behqe.com/cerway/benefits (accessed Sep. 21, 2021).
[13] BCA, "Singapore: Leading the way for green buildings in the tropics.," pp. 1–38, 2014, [Online]. Available: https://www.bca.gov.sg/greenmark/others/sg_green_buildings_tropics.pdf.
[14] J. Wang, C. Yu, and W. Pan, "Relationship between operational energy and life cycle cost performance of high-rise office buildings," *J. Clean. Prod.*, vol. 262, p. 121300, 2020, doi: 10.1016/j.jclepro.2020.121300.
[15] N. L. Latifah and E. Y. Rahadian, "Strategi Green Building untuk Optimalisasi Penghematan Energi Operasional Bangunan terkait Rancangan Ventilasi dan Pengkondisian Udara pada Gedung Kantor Pengelola Bendungan Sei Gong - Batam," *J. Inst. Teknol. Nas.*, vol. 2, pp. 7–12, 2018.
[16] S. S. A. Azis, "Improving present-day energy savings among green building sector in Malaysia using benefit transfer approach: Cooling and lighting loads," *Renew. Sustain. Energy Rev.*, vol. 137, no. November 2020, p. 110570, 2021, doi: 10.1016/j.rser.2020.110570.
[17] Menteri Pekerjaan Umum dan Perumahan Rakyat Republik Indonesia, "Peraturan Menteri Pekerjaan Umum dan Perumahan Rakyat Republik Indonesia Nomor 21 th 2021," pp. 1–38, 2021, [Online]. Available: https://jdih.pu.go.id/detail-dokumen/2882/1.
[18] A. G. Mainini, D. Bonato, T. Poli, and A. Speroni, "Lean strategies for window retrofit of Italian office buildings: Impact on energy use, thermal and visual comfort," *Energy Procedia*, vol. 70, no. January 2016, pp. 719–728, 2015, doi: 10.1016/j.egypro.2015.02.181.
[19] Z. Zheng, J. Wu, Z. Lian, and H. Zhang, "A method to evaluate building energy consumption based on energy use index of different functional sectors," *Sustain. Cities Soc.*, vol. 53, p. 101893, 2020, doi: 10.1016/j.scs.2019.101893.
[20] H. Kim and W. Park, "A study of the energy efficiency management in Green Standard for Energy and Environmental Design (G-SEED)-certified apartments in South Korea," *Sustain.*, vol. 10, no. 10, 2018, doi: 10.3390/su10103402.
[21] J. Zhang, H. Li, A. O. Olanipekun, and L. Bai, "A successful delivery process of green buildings: The project owners' view, motivation and commitment," *Renew. Energy*, vol. 138, no. August, pp. 651–658, 2019, doi: 10.1016/j.renene.2019.02.002.
[22] C. Y. Sun, Y. G. Chen, R. J. Wang, S. C. Lo, J. T. Yau, and Y. W. Wu, "Construction cost of green building certified residence: A case study in Taiwan," *Sustain.*, vol. 11, no. 8, pp. 21–25, 2019, doi: 10.3390/su11082195.
[23] R. S. Ulrich *et al.*, "A Review of the Research Literature on Evidence-Based Healthcare Design," *Heal. Environ. Res. Des.*, vol. 1, no. Part I, 2008.
[24] A. Rijananto Pamungkas, T. L. A. Sucipto, E. S. Murtiono, and A. Farkhan, "Kajian Implementasi Green Building Konservasi Air Rumah Sakit Uns Berdasarkan Sistem Sertifikasi Edge (Excellence in Design for Greater Efficiencies)," *Indones. J. Civ. Eng. Educ.*, vol. 4, no. 2, 2019, doi: 10.20961/ijcee.v4i2.27774.
[25] E. R. C. M. Huisman, E. Morales, J. van Hoof, and H. S. M. Kort, "Healing environment: A review of the impact of physical environmental factors on users," *Build. Environ.*, vol. 58, pp. 70–80, 2012, doi: 10.1016/j.buildenv.2012.06.016.
[26] Ulrich RS., "How Design Impacts Wellness." Health Forum J 1992;35(5):20e5.
[27] J. Reiling, R. G. Hughes, and M. R. Murphy, "The Impact of Facility Design on Patient Safety," *Patient Saf. Qual. An Evidence-Based Handb. Nurses*, 2008.
[28] K. Lu *et al.*, "Development of a carbon emissions analysis framework using building information modeling and life cycle assessment for the construction of hospital projects," *Sustain.*, vol. 11, no. 22, pp. 1–18, 2019, doi: 10.3390/su11226274.
[29] J. M. Logue, T. E. Mckone, M. H. Sherman, and B. C. Singer, "Hazard assessment of chemical air contaminants measured in residences," *Indoor Air*, vol. 21, no. 2, pp. 92–109, 2011, doi: 10.1111/j.1600-0668.2010.00683.x.