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Assessment green building in the learning center building using the greenship existing building tool

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Abstract

Climate change is a major global environmental issue that affects global warming, air quality, and human health, largely driven by unsustainable development practices. In response, the green building concept has emerged to promote efficient resource use and improved building energy performance. This study evaluates the sustainability performance of the Learning Center Building using the Green ship Existing Building version 1.1 assessment tool. The research methodology is aligned with the Green ship evaluation framework and involves structured field observations and semi-structured interviews with building management. The assessment results show that the Learning Center Building achieved 57 out of 117 points (48.72%), indicating compliance with green building criteria. Based on the Green ship classification system, the building is categorized under the Silver certification level. These findings demonstrate the applicability of the Green ship Existing Building tool in assessing sustainability performance of existing campus buildings and provide a foundation for future improvement strategies toward higher sustainability standards.

Keywords

Green building, Greenship existing building tools, Assessment, GBCI

Introduction

Climate change and global warming have become critical global challenges, largely driven by greenhouse gas emissions from the building sector, which accounts for a significant share of global energy consumption and carbon emissions [1], [2]. In developing countries, including Indonesia, rapid urbanization and increasing energy demand intensify these environmental pressures, making sustainable development in the construction sector an urgent priority [3]. Studies indicate that buildings contribute approximately 40% of global energy consumption and one-third of greenhouse gas emissions, highlighting the strategic importance of sustainable building management and planning [2], [4].

The green building concept has emerged as a systematic approach to promote environmental sustainability by integrating energy efficiency, resource conservation,

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and environmental management throughout the building life cycle [5-7]. In Indonesia, the Green Building Council Indonesia (GBCI) developed the Green ship rating system as the national framework for assessing sustainable building performance [8]. Green ship has been applied to various building types; however, systematic applications of the Green ship Existing Building v1.1 tool on operational campus buildings remain limited, particularly studies that provide category-based performance evaluation and scoring structures as a foundation for sustainability improvement strategies [9, 10].

This study applies the Green ship Existing Building v1.1 assessment system to evaluate the sustainability performance of the Learning Center Building, a campus facility in Yogyakarta that meets the minimum Green ship area requirement [11]. The research addresses the following question: How is the sustainability performance of the Learning Center Building evaluated based on the Green ship Existing Building v1.1 system, and which assessment categories contribute most significantly to the overall building rating?

This research contributes by providing a systematic, category-based sustainability assessment of an operational campus building and identifying priority improvement areas, thereby strengthening empirical evidence for the implementation of Green ship in existing higher education buildings in Indonesia.

Literature review

Green building represents an integrated sustainability approach that promotes resource efficiency, environmental protection, and energy efficiency throughout the building life cycle [12]. The World Green Building Council (WGBC) defines green buildings as those minimizing environmental and climate impacts during design, construction, and operation stages. Globally, sustainability rating systems such as BREEAM, LEED, GREEN STAR, GRIHA, and SAGRS have been developed to standardize sustainable building performance assessment [13].

In Indonesia, the Green Building Council Indonesia (GBCI) developed the Green ship certification system as a national, points-based sustainability assessment framework [11]. Green ship comprises five schemes; New Building, Existing Building, Home, Interior Space, and Neighborhood, covering diverse building typologies and development scales.

The Green ship Existing Building is designed to assess the sustainability performance of buildings that have been in operation for at least one year, with an emphasis on sustainable operation, maintenance, and environmental management [11].

The system consists of six assessment categories: Appropriate Site Development (ASD), Energy Efficiency and Conservation (EEC), Water Conservation (WAC), Material Resources and Cycle (MRC), Indoor Health and Comfort (IHC), and Building Environment Management (BEM), which are structured into prerequisite criteria, credits, and bonuses. Assessment is conducted through category-based scoring derived from field observations and interviews, with the aggregation of points determining the final certification level. Buildings scoring below 41 points (35%) do not meet the green building criteria, while certification levels consist of Bronze, Silver, Gold, and Platinum [14].

Method

This study employed a quantitative descriptive approach based on the Green ship Existing Building v1.1 assessment framework. Data were collected through structured field observations, semi-structured interviews with building management, and document analysis. Observations were conducted using a standardized checklist aligned with the six Green ship categories (ASD, EEC, WAC, MRC, IHC, and BEM), including direct inspection of building systems, site conditions, and operational infrastructure. Interviews focused on operational procedures, maintenance systems, energy and water management, and environmental management policies. All collected data were matched with Green ship scoring indicators, and points from each category were aggregated to determine the building's final rating based on the Green ship Existing Building classification system.

Results and discussion

The Learning Center is a six-story postgraduate academic facility with a total floor area of 5,027 m^2, functioning as a center for co-working activities, classrooms, research laboratories, and management offices.

Appropriate site development

The Appropriate Site Development (ASD) category achieved 10 points, indicating adequate site performance. The highest scores were obtained in Community Accessibility (3 points) and Building Neighborhood (2 points), reflecting good accessibility and environmental integration, while Site Landscaping scored 2 points, showing the presence of green elements with limited optimization. Appropriate Site Development category assessment results show in Table 1.

Table 1. Appropriate Site Development category assessment results

Code	Category	Points
ASD 1	Community Accessibility	3
ASD 2	Motor Vehicle Reduction	1
ASD 3	Site Landscaping	2
ASD 4	Heat Island Effect	0
ASD 5	Storm Water Management	1
ASD 6	Site Management	1
ASD 7	Building Neighborhood	2
	Maximum total points	**10**

Low scores were recorded for Motor Vehicle Reduction, Stormwater Management, and Site Management (each 1 point), while the Heat Island Effect criterion received no points, indicating the absence of mitigation strategies such as reflective roofing, vegetated surfaces, shaded pathways, and heat-reducing hardscape materials. Priority improvement measures include the implementation of cool roof systems, expansion of green open spaces, installation of permeable pavements, and enhancement of vegetative shading. Overall, the assessment results in Table 1 indicate that although the basic criteria for land development have been met, significant improvements are still needed, particularly in mitigating the heat island effect and optimizing land management, to improve overall sustainability performance.

Energy efficiency and conservation

According to the assessment results in Table 2, the Energy Efficiency and Conservation (EEC) category achieved 17 points, indicating that the building generally meets basic energy performance requirements. However, no points were obtained for On-Site Renewable Energy and Reduced Energy Emission, reflecting the absence of renewable energy systems and emission reduction strategies. Energy sustainability efforts therefore remain limited to conventional operational practices. Priority improvement measures include rooftop photovoltaic installation, energy benchmarking, and structured carbon reduction programs. Previous studies highlight the role of building orientation and spatial layout in thermal comfort [15], as well as the effectiveness of light-colored interior surfaces in reducing lighting energy demand [16]. In addition, recent research in Indonesia demonstrates that electricity consumption prediction models integrating green building parameters and neural network approaches can significantly support strategic energy management and sustainability planning [17]. These findings reinforce the need for integrated renewable energy adoption and emission reduction strategies.

Table 2. Energy Efficiency and Conservation category assessment results

Code	Category	Points
EEC 1	Optimized Efficiency Building Energy Performance	7
EEC 2	Testing, Re-commissioning or Retro-commissioning	1
EEC 3	System Energy Performance	4
EEC 4	Energy Monitoring and Control	2
EEC 5	Operation and Maintenance	3
EEC 6	On Site Renewable Energy	0
EEC 7	Less Energy Emission	0
	Maximum total points	**17**

Water conservation

Building water supply depends mainly on PDAM and groundwater sources, making conservation essential to prevent resource depletion and quality degradation. Water-saving efforts emphasize consumption reduction through efficient technologies and operational practices. As shown in Table 3, the Water Conservation category achieved 11 points, reflecting basic implementation, but weaknesses remain in monitoring and management systems. Limited performance in water monitoring and tap efficiency is largely caused by the absence of smart metering and the use of inefficient fixtures. Priority improvements include digital water monitoring, adoption of low-flow devices, and optimization of recycled water utilization.

Table 3. Water Conservation category assessment results

Code	Category	Points
WAC 1	Water Sub-Metering	1
WAC 2	Water Monitoring Control	0
WAC 3	Fresh Water Efficiency	5
WAC 4	Water Quality	0
WAC 5	Recycled Water	2
WAC 6	Potable Water	1
WAC 7	Deep Well Reduction	2
WAC 8	Water Tap Efficiency	0
	Maximum total points	**11**

Material resource and cycle

The Material Resource and Cycle (MRC) category emphasizes the sustainable management of construction materials and trash. According to the assessment results in Table 4, three criteria satisfied the stated benchmarks, yielding a total of 8 points for this category. The scores were derived from the execution of Material Purchasing Practices (3 points), Waste Management Practices (3 points), and Hazardous Waste Management (2 points), reflecting intentional strategies to manage hazardous materials and waste. The findings in Table 6 demonstrate that while fundamental material management techniques have been established, enhancements are necessary to foster a more sustainable material cycle.

Table 4. Material Resource and Cycle category assessment results

Code	Category	Points
MRC 1	Non ODS Usage	0
MRC 2	Material Purchasing Practice	3
MRC 3	Waste Management Practice	3
MRC 4	Hazardous Waste Management	2
MRC 5	Management of Used Good	0
	Maximum total points	**8**

Indoor health and comfort

Table 5. Indoor Health and Comfort category assessment results

Code	Category	Points
IHC 1	Outdoor Air Introduction	2
IHC 2	Environmental Tobacco Smoke Control	2
IHC 3	CO2 and CO Monitoring	1
IHC 4	Physical, Chemical and Biological Pollutants	0
IHC 5	Thermal Comfort	1
IHC 6	Visual Comfort	1
IHC 7	Acoustic Level	0
IHC 8	Building User Survey	0
	Maximum total points	**7**

Indoor environmental quality plays a critical role in supporting occupant health and comfort through effective HVAC systems, indoor air quality control, and optimized natural lighting and acoustic conditions [18]. Optimal thermal comfort is generally achieved within a temperature range of 23–29 °C and relative humidity of 18–50% [9]. As presented in Table 5, the Indoor Health and Comfort (IHC) category achieved 7 points, indicating partial compliance with comfort standards. However, performance remains limited in pollution management, acoustic quality, and user perception assessment, mainly due to the absence of formal air quality monitoring, adequate acoustic treatment, and structured occupant feedback mechanisms. Priority improvement strategies include the installation of indoor air quality monitoring systems, enhancement of acoustic comfort measures, and regular user satisfaction surveys.

Building environment management

The Building Environment Management (BEM) category focuses on sustainable planning, operation, and maintenance practices. As presented in Table 6, only three criteria met the assessment benchmarks, resulting in a total score of 4 points, indicating an initial commitment to green building management. However, the Innovations and Green Occupancy/Lease criteria received no points, reflecting limited innovation capacity and weak user engagement due to the absence of structured sustainability programs and systematic participation mechanisms. Priority improvement strategies include the development of green standard operating procedures (SOPs), implementation of sustainability training programs, establishment of innovation-based management systems, and the adoption of green occupancy policies. After evaluating the six Green ship assessment categories, the recapitulation results are presented in Table 7, summarizing the points and corresponding percentages obtained.

Table 6. Building Environment Management category assessment results

Code	Category	Points
BEM 1	Innovations	0
BEM 2	Design Intent and Owner's Project Requirement	2
BEM 3	Green Operational and Maintenance Team	1
BEM 4	Green Occupancy/Lease	0
BEM 5	Operation and Maintenance Training	1
	Maximum total points	**4**

Table 7. Calculation Recapitulation

No	Category	Points	Percentage
1	Appropriate Site Development-ASD	10	8.55%
2	Energy Efficiency and Conservation-EEC	17	14.53%
3	Water Conservation-WAC	11	9.40%
4	Material Resources and Cycle-MRC	8	6.84%
5	Indoor Health and Comfort-IHC	7	5.98%
6	Building Environment Management-BEM	4	3.42%
	Total Points	**57**	**48.72%**
	Predicate		**Silver**

The Energy Efficiency and Conservation (EEC) category achieved the highest score (17 points; 14.53%), indicating strong energy performance of the Learning Center Building. In contrast, the Building Environment Management (BEM) category recorded the lowest score (4 points; 3.42%), reflecting limited sustainability governance and management practices. Based on the cumulative assessment results, the building achieved a total score of 57 points (48.72%), meeting the green building criteria and obtaining the silver certification level. Figures 1 and 2 present the comparative distribution of achievement points and percentage scores across the Green ship Existing Building categories.

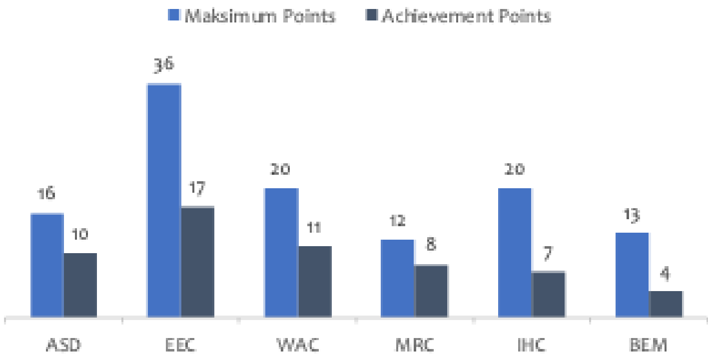

Figure 1. Comparison of Achievement Points for Each Existing Building Greenship Category

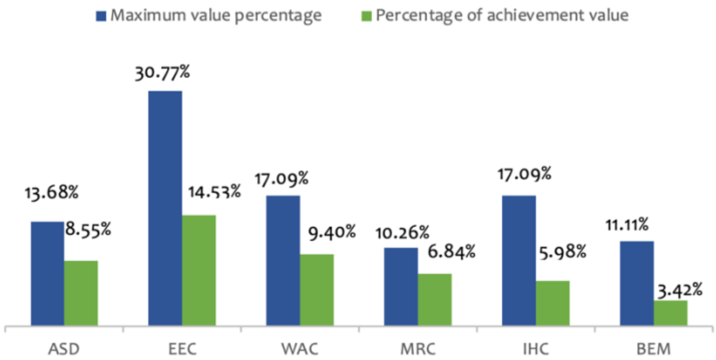

Figure 2. Comparison of Percentages Points for Each Existing Building Greenship Category

The ASD category achieved 10 of 16 points (8.55%), EEC 17 of 36 points (14.53%), WAC 11 of 20 points (9.40%), MRC 8 of 12 points (6.84%), IHC 7 of 20 points (5.98%), and BEM 4 of 13 points (3.42%), indicating the weakest performance in environmental management. Green building implementation contributes to pollution reduction, occupant comfort, and energy and carbon emission efficiency through integrated sustainable design, construction, and operation strategies [19]. Key approaches for maintaining indoor comfort include energy-efficient lighting systems, LED technology, control systems, renewable energy integration, indoor air quality management, and thermal regulation systems [20].

Conclusion

The Greenship Existing Building assessment shows that the Learning Center Building achieved 57 out of 117 points (48.72%), resulting in a silver certification level. The building demonstrates compliance with basic green building criteria, particularly in energy efficiency, site development, and water conservation.

However, weaknesses remain in renewable energy integration, indoor environmental quality management, and sustainability governance. This study provides a practical sustainability improvement framework by identifying low-performing categories and priority interventions, contributing to the development of green campus sustainability strategies in Indonesia.

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References

[1] Y. Geng, W. Ji, Z. Wang, B. Lin, and Y. Zhu, "A review of operating performance in green buildings: Energy use, indoor environmental quality and occupant satisfaction," *Energy and Buildings,* vol. 183, pp. 500-514, 2019.

[2] A. E. Husin, K. Kristiyanto, L. Sinaga, and E. J. Arif, "Analysis of critical factors affecting green office retrofits based on the latest green building regulations in Indonesia," *Journal of Infrastructure, Policy and Development,* vol. 8, p. 3790, (2024).

[3] B. Wiryomartono, "'Green building'and sustainable development policy in Indonesia since 2004," *International Journal of Sustainable Building Technology and Urban Development,* vol. 6, no. 2, pp. 82-89, 2015.

[4] F. Rahmawati, P. Setijanti, and C. Utomo, "The effect of green building application to property value," *IPTEK Journal of Proceedings Series,* vol. 2, (2016).

[5] M. A. Berawi, P. Miraj, R. Windrayani, and A. R. B. Berawi, "Stakeholders' perspectives on green building rating: A case study in Indonesia," *Heliyon,* vol. 5, no. 3, 2019.

[6] C. A. Cantika and Y. V. Paramitadevi, "Implementation of Green Building Aspects Based on the Green Building Council Indonesia: A Case Study in the Regional Library Building of East Java Province," *Journal of Architectural Research and Education,* vol. 4, pp. 27-36, (2022).

[7] A. Zakiah, "Green Building Implementation Challenge for Housing from Developer Perspective in Indonesia," *ARSITEKTURA,* vol. 21, pp. 39-50, (2023).

[8] G. Mardhiyana, D. Larasati, S. Nadia, and F. Triadi, "Sustainable Impact Consideration In Comparison Green Building Rating Tools In Indonesia," *Jurnal Arsitektur ARCADE: Vol,* vol. 7, pp. 510-520, (2023).

[9] R. Purwaningsih, H. Prastawa, N. Susanto, S. Saptadi, and B. Pirogo, "Assessment of green building score based on greenship rating of the green building council of Indonesia," in *AIP Conference Proceedings*, 2018, vol. 2019, no. 1: AIP Publishing.

[10] C. M. Sujana, "Analysis of the implementation of green building on the Syahdan Campus building based on the Green Building Council Indonesia (GBCI) specifications," in *IOP Conference Series: Earth and Environmental Science*, (2024), vol. 1324: AIP Conference, p. 012024.

[11] *Ringkasan Tolak Ukur Greenship Existing Building V 1.1*, GBCI, (2016).

[12] R. Surya, M. A. Berawi, and M. Sari, "Development of a Green Building Assessment System at The Green Building Planning Stage in Indonesia," in *E3S Web of Conferences*, (2024), vol. 517: EDP Sciences, p. 05017.

[13] M. Ahmed, M. Abul, and J. Mallick, "World green building rating systems: A comparative study," in *Proceedings of the International Conference Cum Exhibition On Building Utilities, New Delhi, India*, 2016, pp. 1-3.

[14] D. K. Sudarsana, K. D. Harmayani, and M. Kristianty, "Analisis Penerapan Greenship Existing Building Versi 1.1 Pada Bangunan Gedung Umalas Hotel Dan Residence " *A Scientific Journal of Civil Engineering,* vol. 24, pp. 161-67, (2020).

[15] H. U. Khan, U. Ullah, A. Ullah, S. K. U. Rehman, and A. Zaki, "Sustainable energy buildings or net zero energy buildings," in *AIP Conference Proceedings*, 2023, vol. 2846, no. 1: AIP Publishing.

[16] S. Ferrari, M. Zoghi, T. Blázquez, and G. Dall'O, "New Level (s) framework: Assessing the affinity between the main international Green Building Rating Systems and the european scheme,"

Renewable and Sustainable Energy Reviews, vol. 155, p. 111924, (2022).
[17] N. W. Utomo, A. Zaki, and S. Riyadi, "Optimizing electricity consumption prediction in Indonesia through neural networks and green building considerations," in *AIP Conference Proceedings*, 2025, vol. 3320, no. 1: AIP Publishing LLC, p. 020006.
[18] H. Karimi, M. A. Adibhesami, H. Bazazzadeh, and S. Movafagh, "Green buildings: Human-centered and energy efficiency optimization strategies," *Energies,* vol. 16, no. 9, p. 3681, 2023.
[19] M. Hussein and R. Matdan, "Greening the existing building (Chancellery Building-University Technical Malaysia Melaka)," *J Mech Eng Technol,* vol. 10, pp. 1-19, 2018.
[20] T. Ahmad, M. J. Thaheem, and A. Anwar, "Developing a green-building design approach by selective use of systems and techniques," *Architectural Engineering and Design Management,* vol. 12, pp. 29-50, (2016).